FiBEM model

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Introduction

The FiBEM model defines entities that describe the components of buildings (or building energy systems respectively). These entities follow the FIWARE ngsi-v2 format, so that they can be instantiated in a FIWARE application. The model follows types and definitions from the Brick Schema ontology in order to provide the semantics for the model.

A complete documentation on how data models are defined in FIWARE can be found here: https://fiware-tutorials.readthedocs.io/en/latest/entity-relationships.html and here: https://fiware-tutorials.readthedocs.io/en/latest/iot-agent.html#what-is-an-iot-agent.

A short overview is given here:

- A FIWARE application uses an entity-relationship model that is a virtual representation of the considered real-life system. The Entities are held by the FIWARE Orion Context Broker.
- The objective of a FIWARE application is to monitor and control a real-life system, for example a smart house or a production site. This means that the real-life system is equipped with a set of sensors and actuators that can measure and control the different components of the system. FIWARE needs to connect to these sensors and actuators.
- To connect to the sensors and actuators so called devices and an IoT agent are used. Devices are a special type of entity that describe a sensor or an actuator and usually reference an entity of which they logically are a part of. An IoT agent provides the necessary services to link in- and outgoing data over a communication protocol (for example MQTT) to the devices.
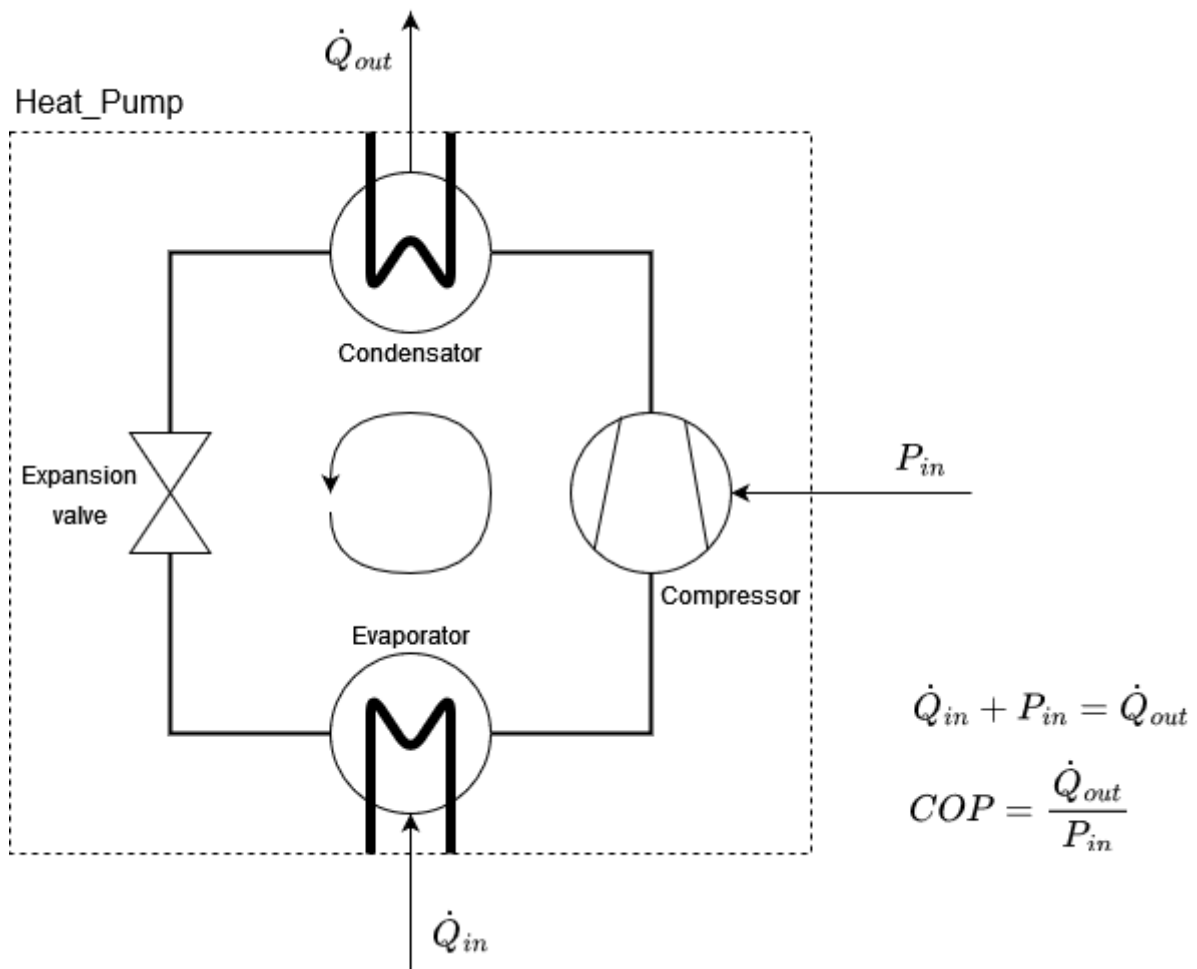
The structure of the FiBEM model is as follows:

- Dynamic device attributes: These are the definitions of the attributes that can be measured and controlled by devices, like temperature, pressure or volume flow. They are added to their corresponding devices under the "dynamic_attrs" key.
- Relationships: The definitions of the different types of relationships that exist between entities. Entities do not have fixed relationships: Depending on the system, the user adds the relationships manually to the entities. However there exists a guide of common relationships and automatic methods to set these.
- Devices: Definitions of Entities that describe sensors/actuators and send/receive data over an IoT Agent. They reference their parent Entities.
- Entities: Virtual representation of real-life objects.

For every device, relationship and entity the type and definition are given by the Brick ontology. For some rare cases, where a suiting type could not be found within the Brick ontology, a custom type and definition have been added. This is mainly the case for the Heat_Pump entity, which can neither be found in Brick nor in some of the other widely used ontologies such as Saref.

Equipment

Heat_Pump

$$\dot{Q}_{in} + P_{in} = \dot{Q}_{out}$$

$$COP = \frac{\dot{Q}_{out}}{P_{in}}$$

Entity

KEY	VALUE	
id	urn:ngsi_ld:<system_name>:Heat_Pump:<int>	
type	Heat_Pump	
ontology	KEY	VALUE
	type	text
	value	Brick, extended by EBC
definition	KEY	VALUE
	type	text
	value	A device that transfers heat between spaces with the use of electrical energy, based on the refrigeration [vapor-compression] cycle.

Devices

Condenser – Thermal Power Sensor

KEY	VALUE
device_id	Heat_Pump_<int>_Condenser_Thermal_Power_Sensor
entity_name	urn:ngsi-ld:<system_name>:Heat_Pump:<int>:Condenser:Thermal_Power_Sensor
entity_type	Thermal_Power_Sensor
definition	type: text, value: Measures the amount of instantaneous power consumed
isPartOf	type: Relationship, value: urn:ngsi-ld:<system_name>:Heat_Pump:<int>
dynamic_attrs	heatFlow, temperature

Evaporator – Thermal Power Sensor

KEY	VALUE
device_id	HeatPump_<heat_pump_number>_Evaporator_Thermal_Power_Sensor
entity_name	urn:ngsi-ld:<system_name>:Heat_Pump:<int>:Evaporator:Thermal_Power_Sensor
entity_type	Thermal_Power_Sensor
definition	type: text, value: Measures the amount of instantaneous power consumed
isPartOf	type: Relationship, value: urn:ngsi-ld:<system_name>:Heat_Pump:<int>
dynamic_attrs	heatFlow, temperature

Compressor – Power Sensor

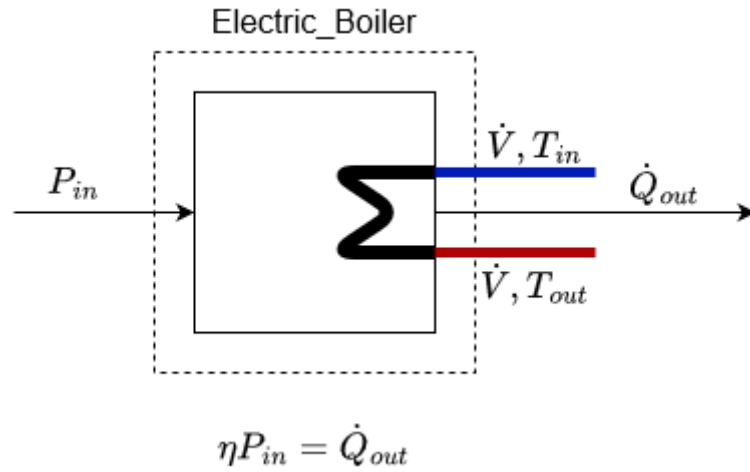| KEY	VALUE
device_id	HeatPump_<heat_pump_number>_Compressor_Electrical_Power_Sensor
entity_name	urn:ngsi-ld:<system_name>:Heat_Pump:<id>:Compressor:Electrical_Power_Sensor
entity_type	Electrical_Power_Sensor
definition	type: text, value: Measures the amount of instantaneous power consumed
isPartOf	type: Relationship, value: urn:ngsi-ld:<system_name>:Heat_Pump:<int>
dynamic_attrs	power

Compressor – Power Command (Actuator)

KEY	VALUE
device_id	HeatPump_<int>_Compressor_Command
entity_name	urn:ngsi-ld:<system_name>:Heat_Pump:<int>:Compressor:Command
entity_type	Command
definition	type: text, value: A Command is an output point that directly determines the behavior of equipment and/or affects relevant operational points.
isPartOf	type: Relationship, urn:ngsi-ld:<system_name>:Heat_Pump:<int>
dynamic_attrs	power

Heat_Pump – Coefficient of performance

KEY	VALUE
device_id	HeatPump_<heat_pump_number>_COP
entity_name	urn:ngsi-ld:<system_name>:Heat_Pump:<int>:COP
entity_type	COP
definition	type: text, value: Coefficient of performance
isPartOf	type: Relationship, urn:ngsi-ld:<system_name>:Heat_Pump:<int>
dynamic_attrs	COP

Electric_Boiler

Electric_Boiler

$$\eta P_{in} = \dot{Q}_{out}$$

Entity

KEY	VALUE	
id	urn:ngsi_ld:\<system_name\>:Electric_Boiler:\<int\>	
type	Electric_Boiler	
ontology	KEY	VALUE
	type	text
	value	Brick
definition	KEY	VALUE
	type	text
	value	A closed, pressure vessel that uses electricity for heating water or other fluids to supply steam or hot water for heating, humidification, or other applications.

Devices

Power Sensor

KEY	VALUE
device_id	Electric_Boiler_<int>_Electrical_Power_Sensor
entity_name	urn:ngsi-ld:<system_name>:Electric_Boiler:<int>:Electrical_Power_Sensor
entity_type	Electrical_Power_Sensor
definition	type: text, value: Measures the amount of instantaneous power consumed
isPartOf	type: Relationship, value: urn:ngsi-ld:<system_name>:Electric_Boiler:<int>
dynamic_attrs	power

Power Command (Actuator)

KEY	VALUE
device_id	Electric_Boiler_<int>_Power_Command
entity_name	urn:ngsi-ld:<system_name>:Electric_Boiler:<int>:Power_In:Command
entity_type	Command
definition	type: text, value: A Command is an output point that directly determines the behavior of equipment and/or affects relevant operational points.
isPartOf	type: Relationship, value: urn:ngsi-ld:<system_name>:Electric_Boiler:<int>
dynamic_attrs	power

Thermal Power Sensor

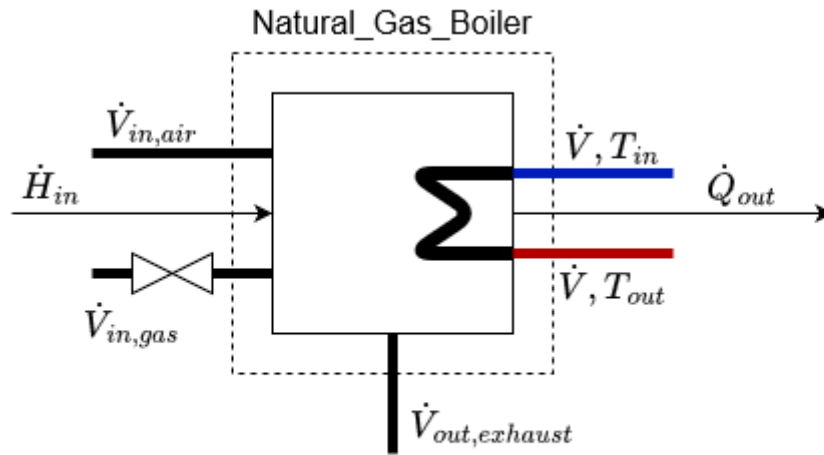| KEY	VALUE
device_id	Electric_Boiler_<int>_Thermal_Power_Sensor
entity_name	urn:ngsi-ld:<system_name>:Electric_Boiler:<int>:Thermal_Power_Sensor
entity_type	Thermal_Power_Sensor
definition	type: text, value: Measures the amount of instantaneous power consumed
isPartOf	type: Relationship, value: urn:ngsi-ld:<system_name>:Electric_Boiler:<int>
dynamic_attrs	heatFlow, temperature

Water Flow Sensor

KEY	VALUE
device_id	Electric_Boiler_<int>_Water_Flow_Sensor
entity_name	urn:ngsi-ld:<system_name>:Electric_Boiler:<int>:Water_Flow_Sensor
entity_type	Water_Flow_Sensor
definition	type: text, value: Measures the rate of flow of water
isPartOf	type: Relationship, value: urn:ngsi-ld:<system_name>:Electric_Boiler:<int>
dynamic_attrs	volumeFlow

Conversion Efficiency

KEY	VALUE
device_id	Electric_Boiler_<int>_conversionEfficiency
entity_name	urn:ngsi-ld:<system_name>:Electric_Boiler:<int>:conversionEfficiency
entity_type	conversionEfficiency
definition	type: text, value: The percent efficiency of the conversion process (usually to power or energy) carried out by the entity
isPartOf	type: Relationship, value: urn:ngsi-ld:<system_name>:Electric_Boiler:<int>
dynamic_attrs	conversionEfficiency

Natural_Gas_Boiler

Natural_Gas_Boiler

$$\dot{V}_{in,air}$$

$$\dot{H}_{in}$$

$$\dot{V}_{in,gas}$$

$$\dot{V}_{out,exhaust}$$

$$\dot{V}, T_{in}$$

$$\dot{Q}_{out}$$

$$\dot{V}, T_{out}$$

$$\eta \dot{H}_{in} = \dot{Q}_{out} \qquad \dot{H} : \text{Standard enthalpy of combustion}$$

Entity

KEY	VALUE	
id	urn:ngsi_ld:<system_name>:Natural_Gas_Boiler:<int>	
type	Natural_Gas_Boiler	
ontology	KEY	VALUE
	type	text
	value	Brick
definition	KEY	VALUE
	type	text
	value	A closed, pressure vessel that uses natural gas for heating water or other fluids to supply steam or hot water for heating, humidification, or other applications.

Devices

Natural Gas Flow Sensor

KEY	VALUE
device_id	Natural_Gas_Boiler_<int>_Natural_Gas_Flow_Sensor
entity_name	urn:ngsi-ld:<system_name>:Natural_Gas_Boiler:<int>:Natural_Gas_Flow_Sensor
entity_type	Flow_Sensor
definition	type: text, value: Measures the rate of flow of some substance
isPartOf	type: Relationship, value: urn:ngsi-ld:<system_name>:Natural_Gas_Boiler:<int>
dynamic_attrs	volumeFlow

Natural Gas Valve Command (Actuator)

KEY	VALUE
device_id	Natural_Gas_Boiler_<int>_Natural_Gas_Valve_Command
entity_name	urn:ngsi-ld:<system_name>:Natural_Gas_Boiler:<int>: Valve_Command
entity_type	Valve_Command
definition	type: text, value: Controls or reports the openness of a valve (typically as a proportion of its full range of motion)
isPartOf	type: Relationship, value: urn:ngsi-ld:<system_name>:Natural_Gas_Boiler:<int>
dynamic_attrs	valvePosition

Thermal Power Sensor

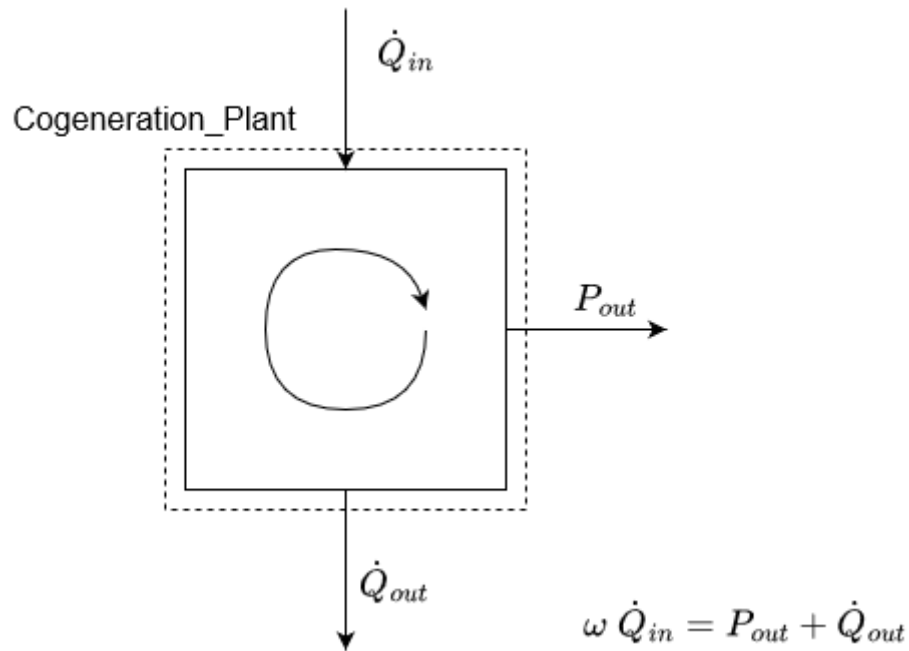| KEY	VALUE
device_id	Natural_Gas_Boiler_<int>_Thermal_Power_Sensor
entity_name	urn:ngsi-ld:<system_name>:Natural_Gas_Boiler:<int>:Thermal_Power_Sensor
entity_type	Thermal_Power_Sensor
definition	type: text, value: Measures the amount of instantaneous power consumed
isPartOf	type: Relationship, value: urn:ngsi-ld:<system_name>:Natural_Gas_Boiler:<int>
dynamic_attrs	heatFlow, temperature

Water Flow Sensor

KEY	VALUE
device_id	Natural_Gas_Boiler_<int>_Water_Flow_Sensor
entity_name	urn:ngsi-ld:<system_name>:Natural_Gas_Boiler:<int>:Water_Flow_Sensor
entity_type	Water_Flow_Sensor
definition	type: text, value: Measures the rate of flow of water
isPartOf	type: Relationship, value: urn:ngsi-ld:<system_name>:Natural_Gas_Boiler:<int>
dynamic_attrs	volumeFlow

Conversion Efficiency

KEY	VALUE
device_id	Natural_Gas_Boiler_<int>_conversionEfficiency
entity_name	urn:ngsi-ld:<system_name>:Natural_Gas_Boiler:<int>: conversionEfficiency
entity_type	conversionEfficiency
definition	type: text, value: The percent efficiency of the conversion process (usually to power or energy) carried out by the entity
isPartOf	type: Relationship, value: urn:ngsi-ld:<system_name>:Natural_Gas_Boiler:<int>
dynamic_attrs	conversionEfficiency

Cogeneration_Plant

$$\omega \, \dot{Q}_{in} = P_{out} + \dot{Q}_{out}$$

Entity

KEY	VALUE		
id	urn:ngsi_ld:<system_name>:Cogeneration_Plant:<int>		
type	Cogeneration_Plant		
ontology	KEY	VALUE	
	type	text	
	value	Brick, extended by EBC	
definition	KEY	VALUE	
	type	text	
	value	A Cogeneration or combined heat and power plant is a machine that uses a heat engine to generate both electrical power and useful heat at the same time.	

Devices

Heat in – Thermal Power Sensor

KEY	VALUE
device_id	Cogeneration_Plant_<int>_Heat_In_Thermal_Power_Sensor
entity_name	urn:ngsi-ld:<system_name>:Cogeneration_Plant:<int>:Heat_In:Thermal_Power_Sensor
entity_type	Thermal_Power_Sensor
definition	type: text, value: Measures the amount of instantaneous power consumed
isPartOf	type: Relationship, value: urn:ngsi-ld:<system_name>:Cogeneration_Plant:<int>
dynamic_attrs	heatFlow, temperature

Heat in Command (Actuator)

KEY	VALUE
device_id	Cogeneration_Plant_<int>_Heat_In_Heating_Command
entity_name	urn:ngsi-ld:<system_name>:Cogeneration_Plant:<int>:Heat_In:Heating_Command
entity_type	Heating_Command
definition	type: text, value: Controls the amount of heating to be delivered (typically as a proportion of total heating output)
isPartOf	type: Relationship, value: urn:ngsi-ld:<system_name>:Cogeneration_Plant:<int>
dynamic_attrs	heatFlow, temperature

Power Out – Electrical Power Sensor

KEY	VALUE
device_id	Cogeneration_Plant_<int>_Power_Out_Electrical_Power_Sensor
entity_name	urn:ngsi-ld:<system_name>:Cogeneration_Plant:<int>:Power_Out:Electrical_Power_Sensor
entity_type	Electrical_Power_Sensor
definition	type: text, value: Measures the amount of instantaneous power consumed
isPartOf	type: Relationship, value: urn:ngsi-ld:<system_name>:Cogeneration_Plant:<int>
dynamic_attrs	power

Heat Out – Thermal Power Sensor

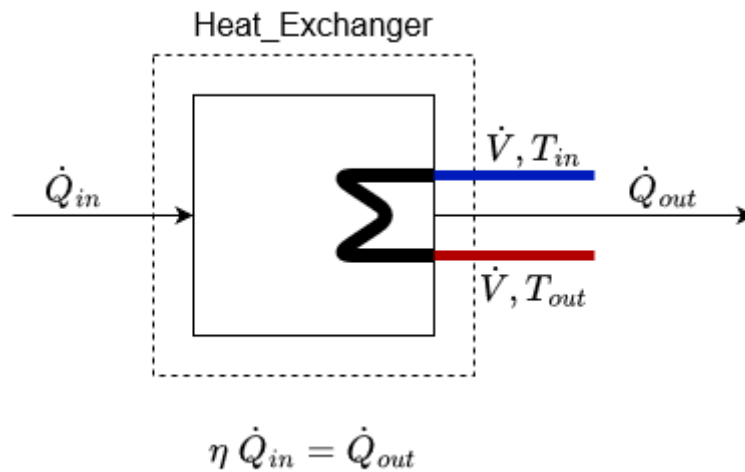| KEY	VALUE
device_id	Cogeneration_Plant_<int>_Heat_Out_Thermal_Power_Sensor
entity_name	urn:ngsi-ld:<system_name>:Cogeneration_Plant:<int>:Heat_Out:Thermal_Power_Sensor
entity_type	Thermal_Power_Sensor
definition	type: text, value: Measures the amount of instantaneous power consumed
isPartOf	type: Relationship, value: urn:ngsi-ld:<system_name>:Cogeneration_Plant:<int>
dynamic_attrs	heatFlow, temperature

Conversion Efficiency

KEY	VALUE
device_id	Cogeneration_Plant_<int>_conversionEfficiency
entity_name	urn:ngsi-ld:<system_name>:Cogeneration_Plant:<int>:conversionEfficiency
entity_type	conversionEfficiency
definition	type: text, value: The percent efficiency of the conversion process (usually to power or energy) carried out by the entity
isPartOf	type: Relationship, value: urn:ngsi-ld:<system_name>:Cogeneration_Plant:<int>
dynamic_attrs	conversionEfficiency

Heat_Exchanger

This entity describes a simple heat exchanger that gets heat from a heat source and passes it with a certain efficiency to a heat sink. It can be utilized wherever necessary; a typical example would be a connection to a heat distribution system. As the objective is often to warm a water circuit, one side is modeled with a water circuit.

$$\eta \, \dot{Q}_{in} = \dot{Q}_{out}$$

Entity

KEY	VALUE		
id	urn:ngsi_ld:<system_name>:Heat_Exchanger:<int>		
type	Heat_Exchanger		
ontology	KEY	VALUE	
	type	text	
	value	Brick	
definition	KEY	VALUE	
	type	text	
	value	A heat exchanger is a piece of equipment built for efficient heat transfer from one medium to another. The media may be separated by a solid wall to prevent mixing or they may be in direct contact [BEDES].	

Devices

Heat in – Thermal Power Sensor

KEY	VALUE
device_id	Heat_Exchanger_<int>_Heat_In_Thermal_Power_Sensor
entity_name	urn:ngsi-ld:<system_name>:Heat_Exchanger:<int>:Heat_In:Thermal_Power_Sensor
entity_type	Thermal_Power_Sensor
definition	type: text, value: Measures the amount of instantaneous power consumed
isPartOf	type: Relationship, value: urn:ngsi-ld:<system_name>:Heat_Exchanger:<int>
dynamic_attrs	heatFlow, temperature

Heat out – Thermal Power Sensor

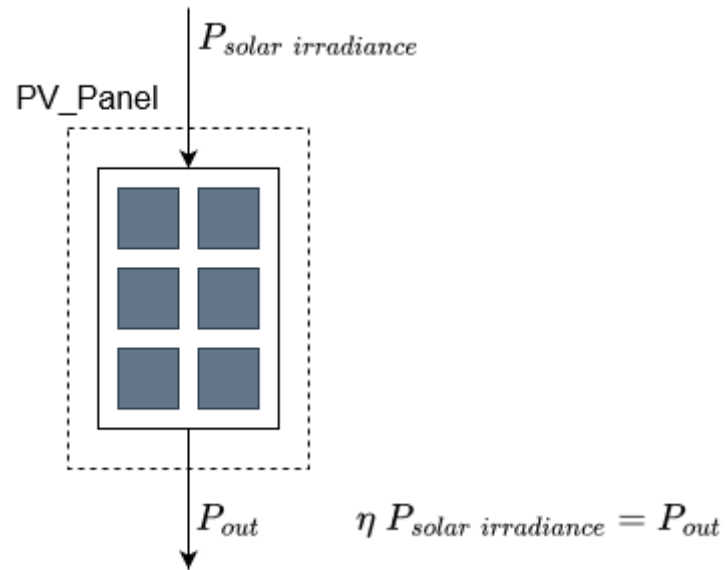| KEY	VALUE
device_id	Heat_Exchanger_<int>_Heat_Out_Thermal_Power_Sensor
entity_name	urn:ngsi-ld:<system_name>:Heat_Exchanger:<int>:Heat_Out:Thermal_Power_Sensor
entity_type	Thermal_Power_Sensor
definition	type: text, value: Measures the amount of instantaneous power consumed
isPartOf	type: Relationship, value: urn:ngsi-ld:<system_name>:Heat_Exchanger:<int>
dynamic_attrs	heatFlow, temperature

Conversion Efficiency

KEY	VALUE
device_id	Heat_Exchanger_<int>_conversionEfficiency
entity_name	urn:ngsi-ld:<system_name>:Heat_Exchanger:<int>:conversionEfficiency
entity_type	conversionEfficiency
definition	type: text, value: The percent efficiency of the conversion process (usually to power or energy) carried out by the entity
isPartOf	type: Relationship, value: urn:ngsi-ld:<system_name>:Heat_Exchanger:<int>
dynamic_attrs	conversionEfficiency

Water Flow Sensor

KEY	VALUE
device_id	Heat_Exchanger_<int>_Water_Flow_Sensor
entity_name	urn:ngsi-ld:<system_name>: Heat_Exchanger:<int>:Water_Flow_Sensor
entity_type	Water_Flow_Sensor
definition	type: text, value: Measures the rate of flow of water
isPartOf	type: Relationship, value: urn:ngsi-ld:<system_name>: Heat_Exchanger:<int>
dynamic_attrs	volumeFlow

PV_Panel

$$\eta\, P_{solar\ irradiance} = P_{out}$$

Entity

KEY	VALUE		
id	urn:ngsi_ld:\<system_name\>:PV_Panel:\<int\>		
type	PV_Panel		
ontology	KEY	VALUE	
	type	text	
	value	Brick	
definition	KEY	VALUE	
	type	text	
	value	An integrated assembly of interconnected photovoltaic cells designed to deliver a selected level of working voltage and current at its output terminals packaged for protection against environment degradation and suited for incorporation in photovoltaic power systems.	

Devices

The outside conditions (like direct and diffuse solar irradiance) are modeled by the "outside" entity.

Power out – Electrical Power Sensor

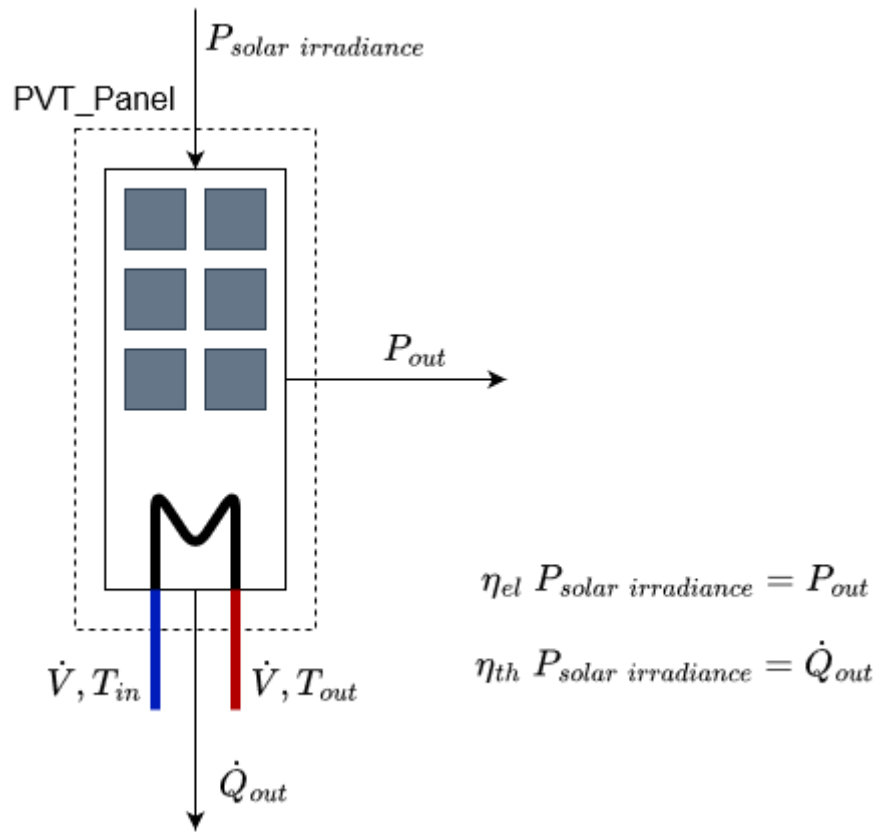| KEY	VALUE
device_id	PV_Panel_<int>_Power_Out_Electrical_Power_Sensor
entity_name	urn:ngsi-ld:<system_name>:PV_Panel:<int>:Power_Out:Electrical_Power_Sensor
entity_type	Electrical_Power_Sensor
definition	type: text, value: Measures the amount of instantaneous power consumed
isPartOf	type: Relationship, value: urn:ngsi-ld:<system_name>:PV_Panel:<int>
dynamic_attrs	power

PV Cells – Temperature Sensor

KEY	VALUE
device_id	PV_Panel_<int>_PV_Cells_Temperature_Sensor
entity_name	urn:ngsi-ld:<system_name>:PV_Panel:<int>:PV_Cells:Temperature_Sensor
entity_type	Temperature_Sensor
definition	type: text, value: Measures temperature: the physical property of matter that quantitatively expresses the common notions of hot and cold
isPartOf	type: Relationship, value: urn:ngsi-ld:<system_name>:PV_Panel:<int>
dynamic_attrs	temperature

Conversion Efficiency

KEY	VALUE
device_id	PV_Panel_<int>_conversionEfficiency
entity_name	urn:ngsi-ld:<system_name>:PV_Panel:<int>:conversionEfficiency
entity_type	conversionEfficiency
definition	type: text, value: The percent efficiency of the conversion process (usually to power or energy) carried out by the entity
isPartOf	type: Relationship, value: urn:ngsi-ld:<system_name>:PV_Panel:<int>
dynamic_attrs	conversionEfficiency

PVT_Panel

$$\eta_{el}\, P_{solar\ irradiance} = P_{out}$$

$$\eta_{th}\, P_{solar\ irradiance} = \dot{Q}_{out}$$

Entity

KEY	VALUE	
id	urn:ngsi_ld:\<system_name\>:PVT_Panel:\<int\>	
type	PVT_Panel	
ontology	KEY	VALUE
	type	text
	value	Brick
definition	KEY	VALUE
	type	text
	value	A type of solar panels that convert solar radiation into usable thermal and electrical energy.

Devices

Power out – Electrical Power Sensor

KEY	VALUE
device_id	PVT_Panel_<int>_Power_Out_Electrical_Power_Sensor
entity_name	urn:ngsi-ld:<system_name>:PVT_Panel:<int>:Power_Out:Electrical_Power_Sensor
entity_type	Electrical_Power_Sensor
definition	type: text, value: Measures the amount of instantaneous power consumed
isPartOf	type: Relationship, value: urn:ngsi-ld:<system_name>:PVT_Panel:<int>
dynamic_attrs	power

Heat out – Thermal Power Sensor

KEY	VALUE
device_id	PVT_Panel_<int>_Heat_Out_Thermal_Power_Sensor
entity_name	urn:ngsi-ld:<system_name>:PVT_Panel:<int>:Heat_Out:Thermal_Power_Sensor
entity_type	Thermal_Power_Sensor
definition	type: text, value: Measures the amount of instantaneous power consumed
isPartOf	type: Relationship, value: urn:ngsi-ld:<system_name>:PVT_Panel:<int>
dynamic_attrs	heatFlow, temperature

PV Cells – Temperature Sensor

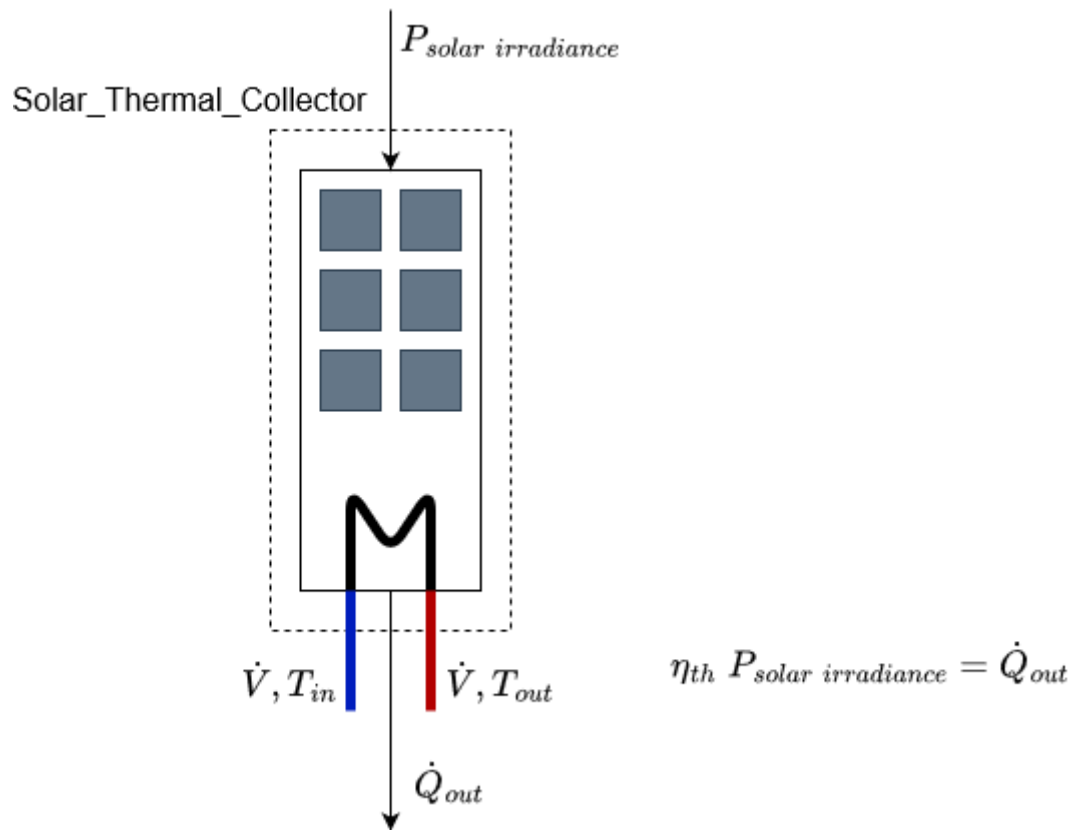| KEY	VALUE
device_id	PVT_Panel_<int>_PV_Cells_Temperature_Sensor
entity_name	urn:ngsi-ld:<system_name>:PVT_Panel:<int>:PV_Cells:Temperature_Sensor
entity_type	Temperature_Sensor
definition	type: text, value: Measures temperature: the physical property of matter that quantitatively expresses the common notions of hot and cold
isPartOf	type: Relationship, value: urn:ngsi-ld:<system_name>:PVT_Panel:<int>
dynamic_attrs	temperature

Heat out – Water Flow Sensor

KEY	VALUE
device_id	PVT_Panel_<int>_Heat_Out_Water_Flow_Sensor
entity_name	urn:ngsi-ld:<system_name>:PVT_Panel:<int>:Heat_Out:Water_Flow_Sensor
entity_type	Water_Flow_Sensor
definition	type: text, value: Measures the rate of flow of water
isPartOf	type: Relationship, value: urn:ngsi-ld:<system_name>:PVT_Panel:<int>
dynamic_attrs	volumeFlow

conversionEfficiency

KEY	VALUE
device_id	PVT_Panel_<int>_conversionEfficiency
entity_name	urn:ngsi-ld:<system_name>:PVT_Panel:<int>:conversionEfficiency
entity_type	conversionEfficiency
definition	type: text, value: The percent efficiency of the conversion process (usually to power or energy) carried out by the entity
isPartOf	type: Relationship, value: urn:ngsi-ld:<system_name>:PVT_Panel:<int>
dynamic_attrs	eta_el, eta_th

Solar_Thermal_Collector

$$P_{solar\ irradiance}$$

Solar_Thermal_Collector

$$\dot{V}, T_{in} \qquad \dot{V}, T_{out}$$

$$\dot{Q}_{out}$$

$$\eta_{th}\ P_{solar\ irradiance} = \dot{Q}_{out}$$

Entity

KEY	VALUE	
id	urn:ngsi_ld:<system_name>:Solar_Thermal_Collector:<int>	
type	Solar_Thermal_Collector	
ontology	KEY	VALUE
	type	text
	value	Brick
definition	KEY	VALUE
	type	text
	value	A type of solar panels that converts solar radiation into thermal energy.

Devices

Heat out – Thermal Power Sensor

KEY	VALUE
device_id	Solar_Thermal_Collector_<int>_Heat_Out_Thermal_Power_Sensor
entity_name	urn:ngsi-ld:<system_name>:Solar_Thermal_Collector:<int>:Heat_Out:Thermal_Power_Sensor
entity_type	Thermal_Power_Sensor
definition	type: text, value: Measures the amount of instantaneous power consumed
isPartOf	type: Relationship, value: urn:ngsi-ld:<system_name>:Solar_Thermal_Collector:<int>
dynamic_attrs	heatFlow, temperature

Heat out – Water Flow Sensor

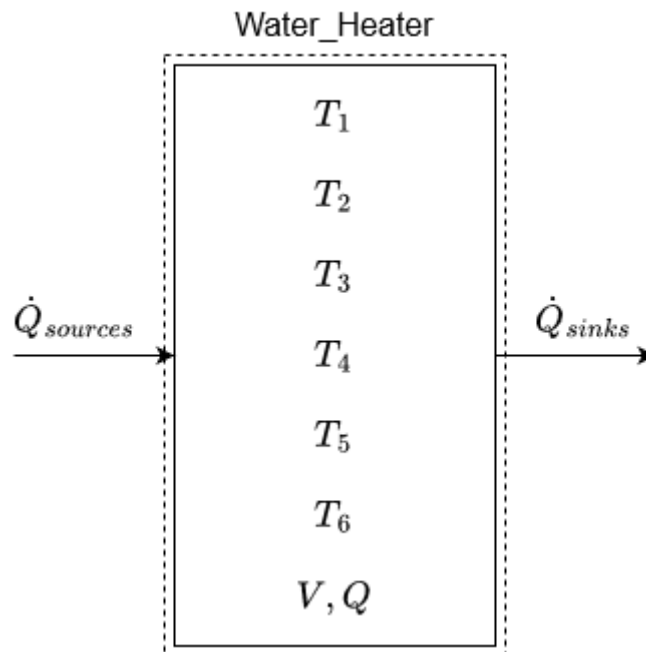| KEY	VALUE
device_id	Solar_Thermal_Collector _<int>_Heat_Out_Water_Flow_Sensor
entity_name	urn:ngsi-ld:<system_name>: Solar_Thermal_Collector:<int>:Heat_Out:Water_Flow_Sensor
entity_type	Water_Flow_Sensor
definition	type: text, value: Measures the rate of flow of water
isPartOf	type: Relationship, value: urn:ngsi-ld:<system_name>: Solar_Thermal_Collector:<int>
dynamic_attrs	volumeFlow

conversionEfficiency

KEY	VALUE
device_id	Solar_Thermal_Collector_<int>_conversionEfficiency
entity_name	urn:ngsi-ld:<system_name>: Solar_Thermal_Collector:<int>:conversionEfficiency
entity_type	conversionEfficiency
definition	type: text, value: The percent efficiency of the conversion process (usually to power or energy) carried out by the entity
isPartOf	type: Relationship, value: urn:ngsi-ld:<system_name>: Solar_Thermal_Collector:<int>
dynamic_attrs	eta_th

Water_Heater

The 'water heater' entity is generally intended to describe a thermal energy storage that uses water. The modeled standard FIWARE devices include an array of temperature sensors, a volume and a total heat sensor to get the total stored heat energy. Water heaters obtain heat from an external source (e.g., a solar thermal system or a heat pump) and usually pass heat to one or multiple warm water cycles (drinking water, heating water). As the in- and outgoing heat flows can be very different in every setup they are not modeled as devices but can be added in FiBEM if needed.

Water_Heater

T_1

T_2

T_3

$\dot{Q}_{sources}$ $\quad$ $\dot{Q}_{sinks}$

T_4

T_5

T_6

V, Q

Entity

KEY	VALUE		
id	urn:ngsi_ld:<system_name>:Water_Heater:<int>		
type	Water_Heater		
ontology	KEY	VALUE	
	type	text	
	value	Brick	
definition	KEY	VALUE	
	type	text	
	value	An apparatus for heating and usually storing hot water.	

Devices

Temperature Sensor (x6)

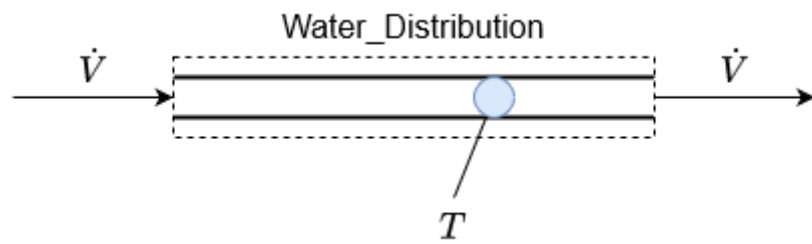| KEY	VALUE
device_id	Water_Heater_<int>_ Temperature_Sensor_<int>
entity_name	urn:ngsi-ld:<system_name>:Water_Heater:<int>:Temperature_Sensor:<int>
entity_type	Temperature_Sensor
definition	type: text, value: Measures temperature: the physical property of matter that quantitatively expresses the common notions of hot and cold
isPartOf	type: Relationship, value: urn:ngsi-ld:<system_name>:Water_Heater:<int>
dynamic_attrs	temperature

Enthalpy Sensor

KEY	VALUE
device_id	Water_Heater_<int>_ Enthalpy_Sensor
entity_name	urn:ngsi-ld:<system_name>:Water_Heater:<int>:Enthalpy_Sensor
entity_type	Enthalpy_Sensor
definition	type: text, value: Measures the total heat content of some substance
isPartOf	type: Relationship, value: urn:ngsi-ld:<system_name>:Water_Heater:<int>
dynamic_attrs	enthalpy

Capacity Sensor

KEY	VALUE
device_id	Water_Heater_<int>_ Capacity_Sensor
entity_name	urn:ngsi-ld:<system_name>:Water_Heater:<int>:Capacity_Sensor
entity_type	Capacity_Sensor
definition	type: text, value: Capacity sensor.
isPartOf	type: Relationship, value: urn:ngsi-ld:<system_name>:Water_Heater:<int>
dynamic_attrs	volume

Water_Distribution

Used to represent pipes, useful for hydraulic systems.

Entity

KEY	VALUE	
id	urn:ngsi_ld:<system_name>:Water_Distribution:<int>	
type	Water_Distribution	
ontology	KEY	VALUE
	type	text
	value	Brick
definition	KEY	VALUE
	type	text
	value	Utilize a water distribution source to represent how water is distributed across multiple destinations (pipes).

Devices

Trace Heat Sensor

KEY	VALUE
device_id	Water_Distribution_<int>_Trace_Heate_Sensor
entity_name	urn:ngsi-ld:<system_name>:Water_Distribution:<int>:Trace_Heat_Sensor
entity_type	Trace_Heate_Sensor
definition	type: text, value: Measures the surface temperature of pipelines carrying temperature-sensitive products; typically used to avoid frosting/freezing.
isPartOf	type: Relationship, value: urn:ngsi-ld:<system_name>:Water_Distribution:<int>
dynamic_attrs	temperature

Water Flow Sensor

KEY	VALUE
device_id	Water_Distribution_<int>_Water_Flow_Sensor
entity_name	urn:ngsi-ld:<system_name>:Water_Distribution:<int>: Water_Flow_Sensor
entity_type	Water_Flow_Sensor
definition	type: text, value: Measures the rate of flow of water.
isPartOf	type: Relationship, value: urn:ngsi-ld:<system_name>:Water_Distribution:<int>
dynamic_attrs	volumeFlow