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.

# Relationships

Relationships are an attribute of entities or devices and describe the kind of relationship that an entity or device has with another entity. They describe the structure of a set of entities and are therefore essential to providing semantics for a system.

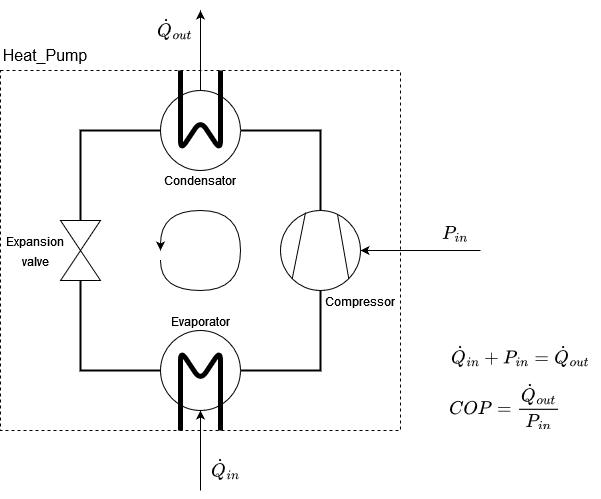
Relationships appear as an attribute of one entity (in Brick called ‘subject’) that references (links) the related entity (in Brick called ‘object’).

|  |  |
| --- | --- |
| KEY | VALUE |
| feeds | |  |  | | --- | --- | | KEY | VALUE | | type | Relationship | | value | <ref\_entity> | | definition | The subject is upstream of the object in the context of some sequential process; some media is passed between them. | |
| hasPart | |  |  | | --- | --- | | KEY | VALUE | | type | Relationship | | value | <ref\_entity> | | definition | The subject is composed in part of the entity given by the object. | |
| hasLocation | |  |  | | --- | --- | | KEY | VALUE | | type | Relationship | | value | <ref\_entity> | | definition | Subject is physically located in the location given by the object. | |
| isFedBy | |  |  | | --- | --- | | KEY | VALUE | | type | Relationship | | value | <ref\_entity> | | definition | Inverse of the 'feeds' relation. | |
| isLocationOf | |  |  | | --- | --- | | KEY | VALUE | | type | Relationship | | value | <ref\_entity> | | definition | Inverse of the 'hasLocation' relation. | |
| isPartOf | |  |  | | --- | --- | | KEY | VALUE | | type | Relationship | | value | <ref\_entity> | | definition | Inverse of the 'hasPart' relation. | |
| isRegulatedBy | |  |  | | --- | --- | | KEY | VALUE | | type | Relationship | | value | <ref\_entity> | | definition | Inverse of the 'regulates' relation. | |
| regulates | |  |  | | --- | --- | | KEY | VALUE | | type | Relationship | | value | <ref\_entity> | | definition | The subject contributes to or performs the regulation of the substance given by the object. | |

# Diagram Description automatically generatedOverview: Entities and typical relationships

# Equipment

## Heat\_Pump



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

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 |

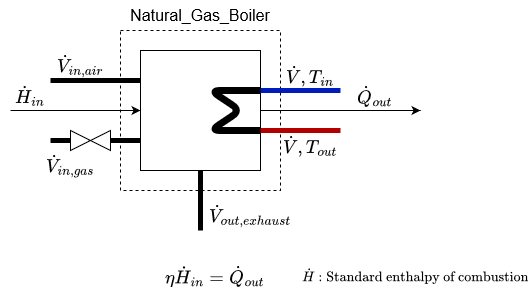
Water Flow Sensor

|  |  |
| --- | --- |
| 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



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 |

## Diagram Description automatically generatedCogeneration\_Plant

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

A picture containing diagram

Description automatically generatedThis 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.

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 |

## Diagram Description automatically generatedPV\_Panel

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

Diagram

Description automatically generated

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 |

## Diagram Description automatically generatedSolar\_Thermal\_Collector

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.

A picture containing table

Description automatically generated

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

Diagram

Description automatically generated with medium confidenceUsed 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 |

## Valve

Diagram

Description automatically generated  
Can be used both for a standard and a 3-way valve. There are two valve position and three flow sensors provided, the sign of the flow indicates the direction (positive flow goes into the valve, negative goes out). If you are modeling a standard valve, just do not use the third flow sensor and second position sensor (or delete the corresponding devices in FiBEM). Add additional devices like pressure or temperature sensors if needed.

Entity

|  |  |
| --- | --- |
| KEY | VALUE |
| id | urn:ngsi\_ld:<system\_name>:Valve:<int> |
| type | Valve |
| ontology | |  |  | | --- | --- | | KEY | VALUE | | type | text | | value | Brick | |
| definition | |  |  | | --- | --- | | KEY | VALUE | | type | text | | value | A device that regulates, directs or controls the flow of a fluid by opening, closing or partially obstructing various passageways. | |

Devices

Flow Sensor (3x)

|  |  |
| --- | --- |
| KEY | VALUE |
| device\_id | Valve\_<int>\_Flow\_Sensor\_<int> |
| entity\_name | urn:ngsi-ld:<system\_name>:Valve:<int>:Flow\_Sensor:<int> |
| 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>:Valve:<int> |
| dynamic\_attrs | volumeFlow |

Valve Position Sensor (2x)

|  |  |
| --- | --- |
| KEY | VALUE |
| device\_id | Valve\_<int>\_Valve\_Position\_Sensor\_<int> |
| entity\_name | urn:ngsi-ld:<system\_name>:Valve:<int>: Valve\_Position\_Sensor:<int> |
| entity\_type | Valve\_Position\_Sensor |
| definition | type: text, value: Measures the current position of a valve in terms of the percent of fully open. |
| isPartOf | type: Relationship, value: urn:ngsi-ld:<system\_name>:Valve:<int> |
| dynamic\_attrs | valvePosition |

Valve Command (2x)

|  |  |
| --- | --- |
| KEY | VALUE |
| device\_id | Valve\_<int>\_Valve\_Command\_<int> |
| entity\_name | urn:ngsi-ld:<system\_name>:Valve:<int>: Valve\_Command:<int> |
| 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>:Valve:<int> |
| dynamic\_attrs | valvePosition |

## Diagram Description automatically generatedPump

Entity

|  |  |
| --- | --- |
| KEY | VALUE |
| id | urn:ngsi\_ld:<system\_name>:Pump:<int> |
| type | Pump |
| ontology | |  |  | | --- | --- | | KEY | VALUE | | type | text | | value | Brick | |
| definition | |  |  | | --- | --- | | KEY | VALUE | | type | text | | value | Machine for imparting energy to a fluid, causing it to do work, drawing a fluid into itself through an entrance port, and forcing the fluid out through an exhaust port. | |

Devices

Flow Sensor

|  |  |
| --- | --- |
| KEY | VALUE |
| device\_id | Pump\_<int>\_Flow\_Sensor |
| entity\_name | urn:ngsi-ld:<system\_name>:Pump:<int>: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>:Pump:<int> |
| dynamic\_attrs | volumeFlow |

Entrance – Pressure Sensor

|  |  |
| --- | --- |
| KEY | VALUE |
| device\_id | Pump\_<int>\_Entrance\_Pressure\_Sensor |
| entity\_name | urn:ngsi-ld:<system\_name>:Pump:<int>:Entrance:Pressure\_Sensor |
| entity\_type | Pressure\_Sensor |
| definition | type: text, value: Measure the amount of force acting on a unit area. |
| isPartOf | type: Relationship, value: urn:ngsi-ld:<system\_name>:Pump:<int> |
| dynamic\_attrs | pressure |

Exhaust – Pressure Sensor

|  |  |
| --- | --- |
| KEY | VALUE |
| device\_id | Pump\_<int>\_Exhaust\_Pressure\_Sensor |
| entity\_name | urn:ngsi-ld:<system\_name>:Pump:<int>:Exhaust:Pressure\_Sensor |
| entity\_type | Pressure\_Sensor |
| definition | type: text, value: Measure the amount of force acting on a unit area. |
| isPartOf | type: Relationship, value: urn:ngsi-ld:<system\_name>:Pump:<int> |
| dynamic\_attrs | pressure |

Electrical Power Sensor

|  |  |
| --- | --- |
| KEY | VALUE |
| device\_id | Pump\_<int>\_Electrical\_Power\_Sensor |
| entity\_name | urn:ngsi-ld:<system\_name>:Pump:<int>:Electrical\_Power\_Sensor |
| entity\_type | Electrical\_Power\_Sensor |
| definition | type: text, value: Measures the amount of instantaneous electric power consumed. |
| isPartOf | type: Relationship, value: urn:ngsi-ld:<system\_name>:Pump:<int> |
| dynamic\_attrs | power |

Electrical Power - Command

|  |  |
| --- | --- |
| KEY | VALUE |
| device\_id | Pump\_<int>\_Electrical\_Power\_Command |
| entity\_name | urn:ngsi-ld:<system\_name>:Pump:<int>:Electrical\_Power: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>:Pump:<int> |
| dynamic\_attrs | power |

## Radiator

Diagram

Description automatically generated with low confidence

Entity

|  |  |
| --- | --- |
| KEY | VALUE |
| id | urn:ngsi\_ld:<system\_name>:Radiator:<int> |
| type | Radiator |
| ontology | |  |  | | --- | --- | | KEY | VALUE | | type | text | | value | Brick | |
| definition | |  |  | | --- | --- | | KEY | VALUE | | type | text | | value | Heat exchangers designed to transfer thermal energy from one medium to another. | |

Devices

Valve Position Sensor

|  |  |
| --- | --- |
| KEY | VALUE |
| device\_id | Radiator\_<int>\_Valve\_Position\_Sensor |
| entity\_name | urn:ngsi-ld:<system\_name>:Radiator:<int>:Valve\_Position\_Sensor |
| entity\_type | Valve\_Position\_Sensor |
| definition | type: text, value: Measures the current position of a valve in terms of the percent of fully open. |
| isPartOf | type: Relationship, value: urn:ngsi-ld:<system\_name>:Radiator:<int> |
| dynamic\_attrs | valvePosition |

Valve Command

|  |  |
| --- | --- |
| KEY | VALUE |
| device\_id | Radiator\_<int>\_Valve\_Command |
| entity\_name | urn:ngsi-ld:<system\_name>:Radiator:<int>:Valve\_Command |
| entity\_type | Valve\_Position\_Sensor |
| definition | type: text, value: Measures the current position of a valve in terms of the percent of fully open. |
| isPartOf | type: Relationship, value: urn:ngsi-ld:<system\_name>:Radiator:<int> |
| dynamic\_attrs | valvePosition |

Heat Out – Thermal Power Sensor

|  |  |
| --- | --- |
| KEY | VALUE |
| device\_id | Radiator\_<int>\_Thermal\_Power\_Sensor |
| entity\_name | urn:ngsi-ld:<system\_name>:Radiator:<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>:Radiator:<int> |
| dynamic\_attrs | heatFlow, temperature |

Entrance – Water Flow Sensor (dV/dT\_1)

|  |  |
| --- | --- |
| KEY | VALUE |
| device\_id | Radiator\_<int>\_Entrance\_Water\_Flow\_Sensor |
| entity\_name | urn:ngsi-ld:<system\_name>:Radiator:<int>:Entrance: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>:Radiator:<int> |
| dynamic\_attrs | volumeFlow |

## Battery

A picture containing chart

Description automatically generated

Entity

|  |  |
| --- | --- |
| KEY | VALUE |
| id | urn:ngsi\_ld:<system\_name>:Battery:<int> |
| type | Battery |
| ontology | |  |  | | --- | --- | | KEY | VALUE | | type | text | | value | Brick | |
| definition | |  |  | | --- | --- | | KEY | VALUE | | type | text | | value | A container that stores chemical energy that can be converted into electricity and used as a source of power. | |

Devices

Electrical Power Sensor

|  |  |
| --- | --- |
| KEY | VALUE |
| device\_id | Battery\_<int>\_Electrical\_Power\_Sensor |
| entity\_name | urn:ngsi-ld:<system\_name>:Battery:<int>:Electrical\_Power\_Sensor |
| entity\_type | Electrical\_Power\_Sensor |
| definition | type: text, value: Measures the amount of instantaneous electric power consumed. |
| isPartOf | type: Relationship, value: urn:ngsi-ld:<system\_name>:Battery:<int> |
| dynamic\_attrs | power |

State of charge – Sensor

|  |  |
| --- | --- |
| KEY | VALUE |
| device\_id | Battery\_<int>\_SOC\_Sensor |
| entity\_name | urn:ngsi-ld:<system\_name>:Battery:<int>:SOC\_Sensor |
| entity\_type | Sensor |
| definition | type: text, value: A Sensor is an input point that represents the value of a device or instrument designed to detect and measure a variable (ASHRAE Dictionary). |
| isPartOf | type: Relationship, value: urn:ngsi-ld:<system\_name>:Battery:<int> |
| dynamic\_attrs | soc |