

FiBEM model

Table of Contents

Introduction.....	2
Equipment	3
Heat_Pump.....	3
Electric_Boiler.....	5
Natural_Gas_Boiler	7
Cogeneration_Plant.....	9

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 hardware-in-the-loop test bench. 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.

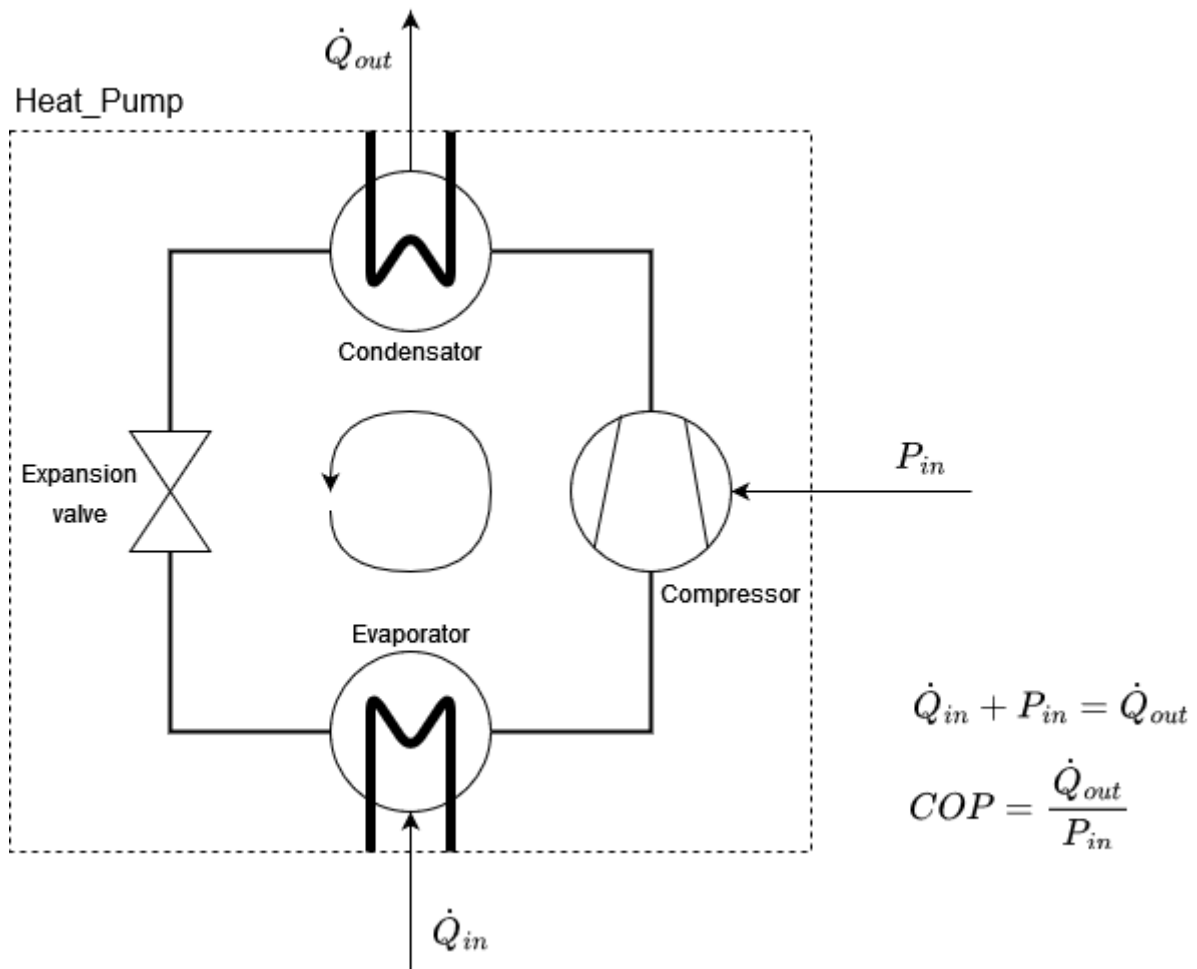
The structure of the FiBEM model is as follows:

- 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 mainly is 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



Entity

KEY	VALUE	
id	urn:ngsi_Id:<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-Id:<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-Id:<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-Id:<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-Id:<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-Id:<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-Id:<system_name>:Heat_Pump:<int>
dynamic_attrs	power

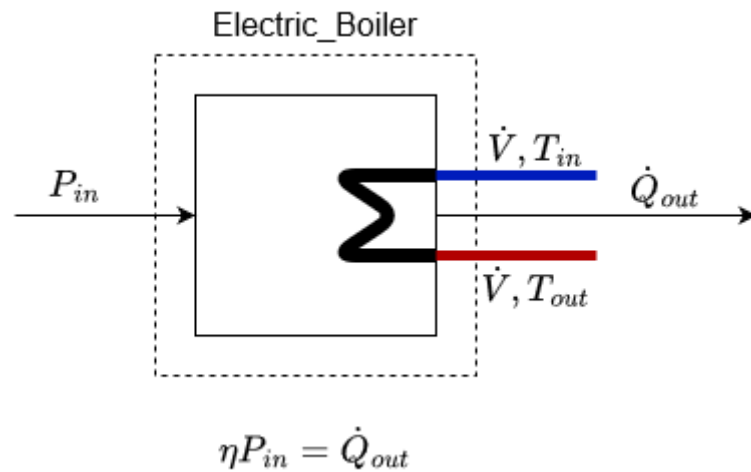
Compressor – Power Command (Actuator)

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

Electric_Boiler



Entity

KEY	VALUE	
id	urn:ngsi_Id:<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-Id:<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-Id:<system_name>:Electric_Boiler:<int>
dynamic_attrs	power

Power Command (Actuator)

KEY	VALUE
device_id	Electric_Boiler_<int>_Power_Command
entity_name	urn:ngsi-Id:<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-Id:<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-Id:<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-Id:<system_name>:Electric_Boiler:<int>
dynamic_attrs	heatFlow, temperature

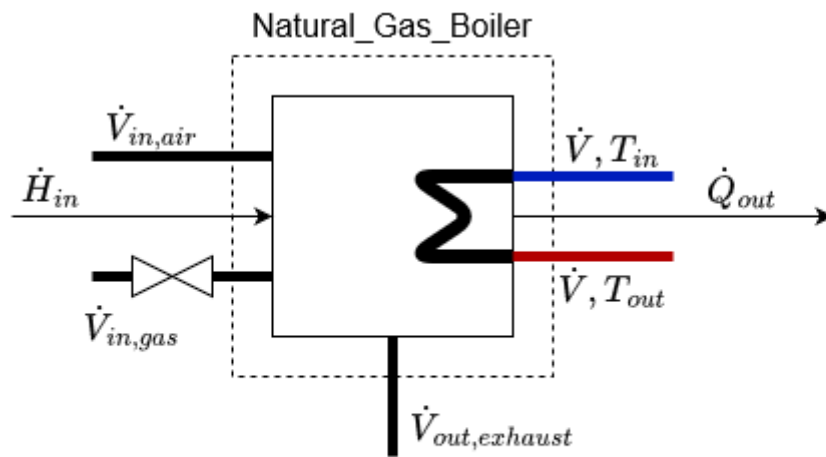
Water Flow Sensor

KEY	VALUE
device_id	Electric_Boiler_<int>_Water_Flow_Sensor
entity_name	urn:ngsi-Id:<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-Id:<system_name>:Electric_Boiler:<int>
dynamic_attrs	volumeFlow

Conversion Efficiency

KEY	VALUE
device_id	Electric_Boiler_<int>_conversionEfficiency
entity_name	urn:ngsi-Id:<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-Id:<system_name>:Electric_Boiler:<int>
dynamic_attrs	conversionEfficiency

Natural_Gas_Boiler



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

Entity

KEY	VALUE	
id	urn:ngsi_Id:<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