Flexible Loads

SGAM Toolbox Reference Example

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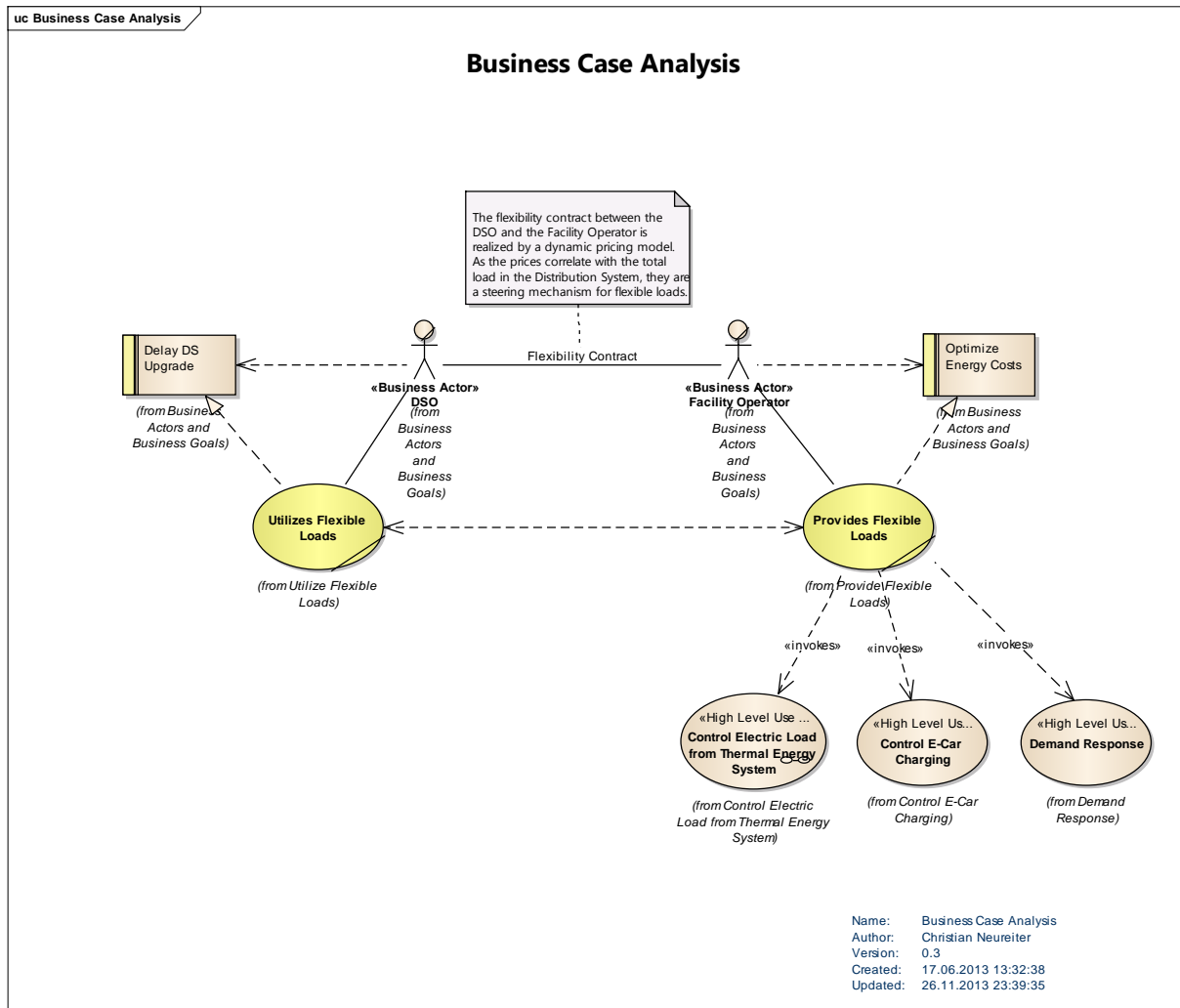# Table of Contents

1. Introduction

This document is the automatically generated documentation for the SGAM Toolbox Reference Example "Flexible Loads". It demonstrates the structure of a Smart Grid System that is modeled by utilizing the SGAM Toolbox.

The demonstration example is a simplified and fictive example that focuses on the demonstration of the SGAM Toolbox usage rather than on a good real life example.

It assumes a facility that is able to produce and store thermal energy (hot water). To do so, the facility is equipped with a Combined Heat and Power Plant (CHP), a Heat Pump (HP) and a storage for thermal energy. The operation of the CHP and the HP affect the Distribution System in different ways. As the CHP produces heat AND electric energy, it reduces the load to the Distribution System. Contrasting to this, the Heat Pump *needs* electric energy for the generation of thermal energy and hence, increases the load to the Distribution System

The Distribution System Operator, who is responsible for the stability of the grid, is interested in using the provided flexibility. To do so, he offers dynamic energy prices to the facility once every 24 hours. As the facility operates according to the actual prices, during periods of cheap energy the heat pump will be activated (which increases the load for the distribution system) and during periods of expensive energy the Combined Heat and Power Plant (reduction of electric load) will be used for the generation of heat.

2.   SGAM Business Layer

Listing: 1 - Business Case Analysis

2.1   Business Actors and Business Goals

Element	Notes
«Business Actor» **DSO**	The Distribution System Operator (DSO) is responsible for the operation of the Distribution Grid (DG)
«Business Actor» **Facility Operator**	The Facility Operator (FO) is responsible for the operation of a facilities technical systems. He is interested in optimizing the operational costs.
«Business Goal»	The DSO wants to delay the system upgrade as long as possible as this saves money.

Delay DS Upgrade	
«Business Goal» **Optimize Energy Costs**	The Facility Operator is interested in minimizing the operational costs of the facility. He has various possibilities to reach this goal.

2.2   «BC» Provide Flexible Loads

Listing: 2 - Provide Flexible Loads

Element	Notes
«business use case» **Provides Flexible Loads**	By providing flexible loads, the Facility Operator is able to optimize his energy costs. This means, the activation of various loads can be scheduled over time. The decision if a load is activated or scheduled is based on the energy price.

2.3   «BC» Utilize Flexible Loads

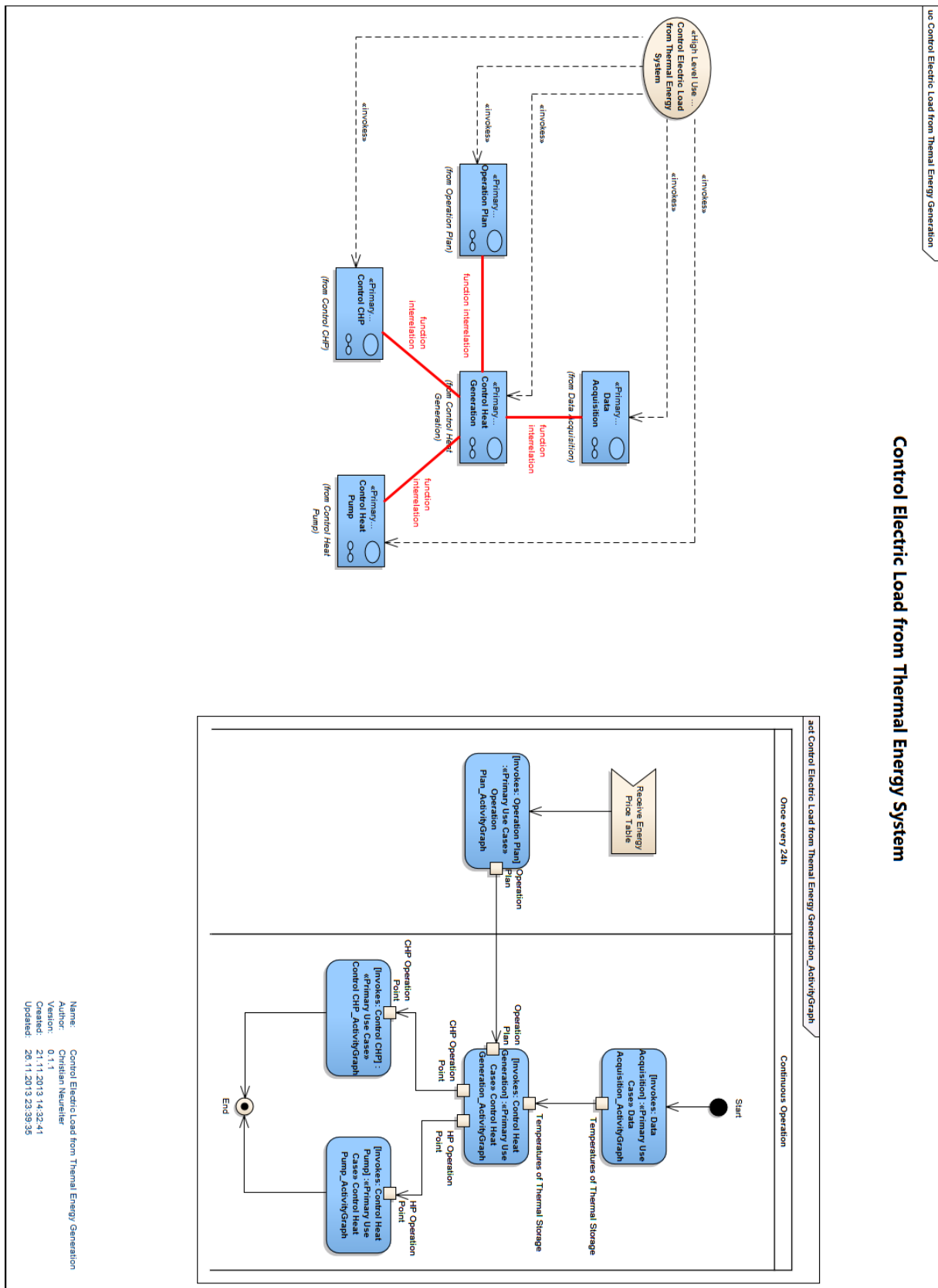| Element	Notes
«business use case» **Utilizes Flexible Loads**	The utiliziation of flexible loads helps to prevent peaks in Distribution System that would indicate an expensive upgrade of the grid. The DSO utilizes flexible loads by a dynamic pricing concept. This means, when the load in the Distribution System is high, the energy price is also high, and when the load in the Distribution System is low, the energy price is low as well.

2.3   «BC» Utilize Flexible Loads

3.   SGAM Function Layer

Listing: 3 - High Level Use Case Overview

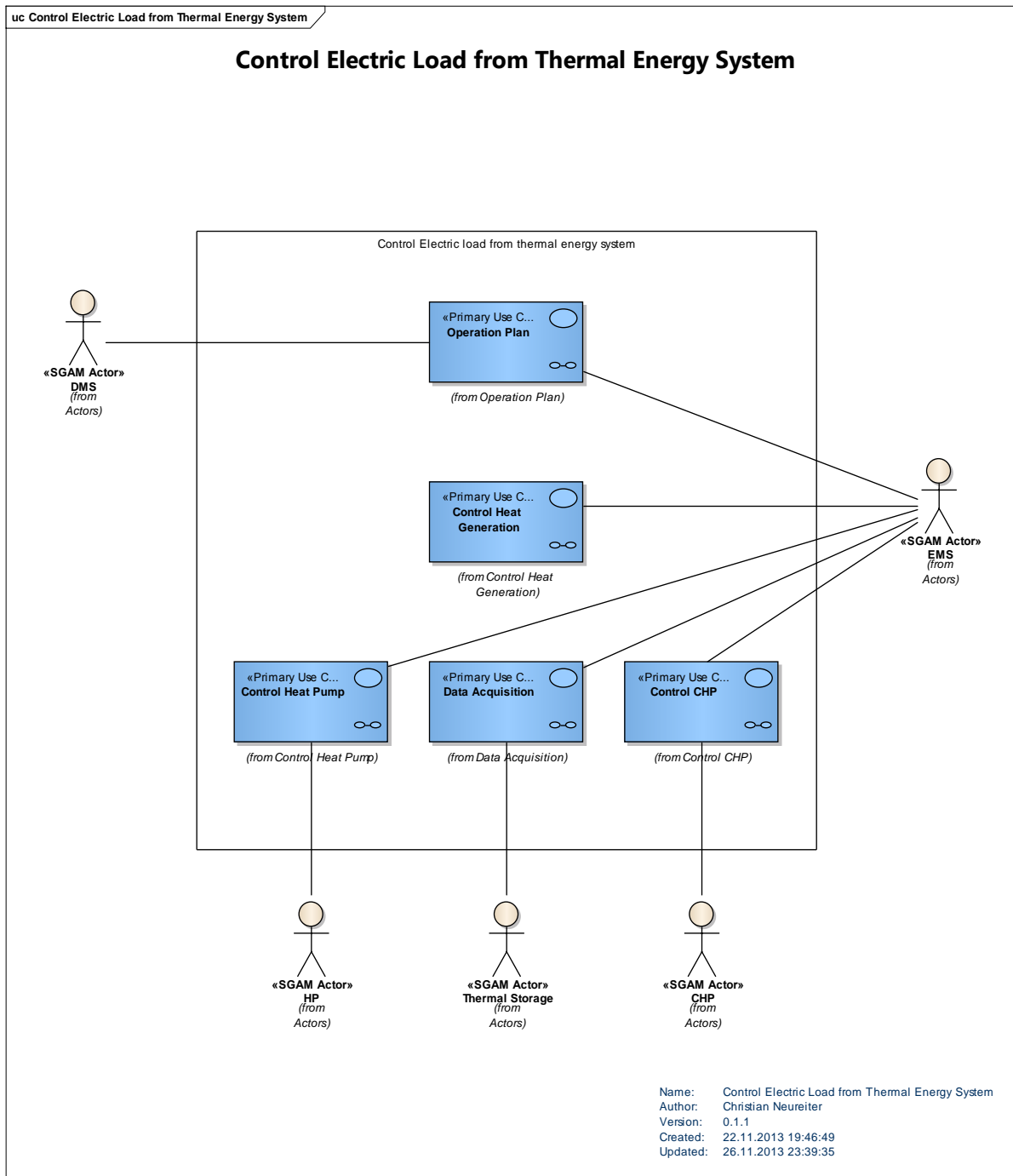## 3.1   Actors

Element	Notes
«SGAM Actor» **DMS**	A system which provides applications to monitor and control a distribution grid from a centralized location, typically the control center. A DMS typically has interfaces to other systems, like an GIS or an OMS
«SGAM Actor» **EMS**	The Energy Management System (EMS) is a facility specific system that is operating various energy consuming or producing systems in the domain of the facility.
«SGAM Actor» **CHP**	The Combined Heat and Power Plant (CHP) is a combustion system, that is able to generate thermal and electric energy. It has a changeable Operation Point, so an external System is able to control the operation of the CHP.
«SGAM Actor»	Heat Pump (HP)

HP	
«SGAM Actor» **Thermal Storage**	Storage for thermal energy (Hot Water)

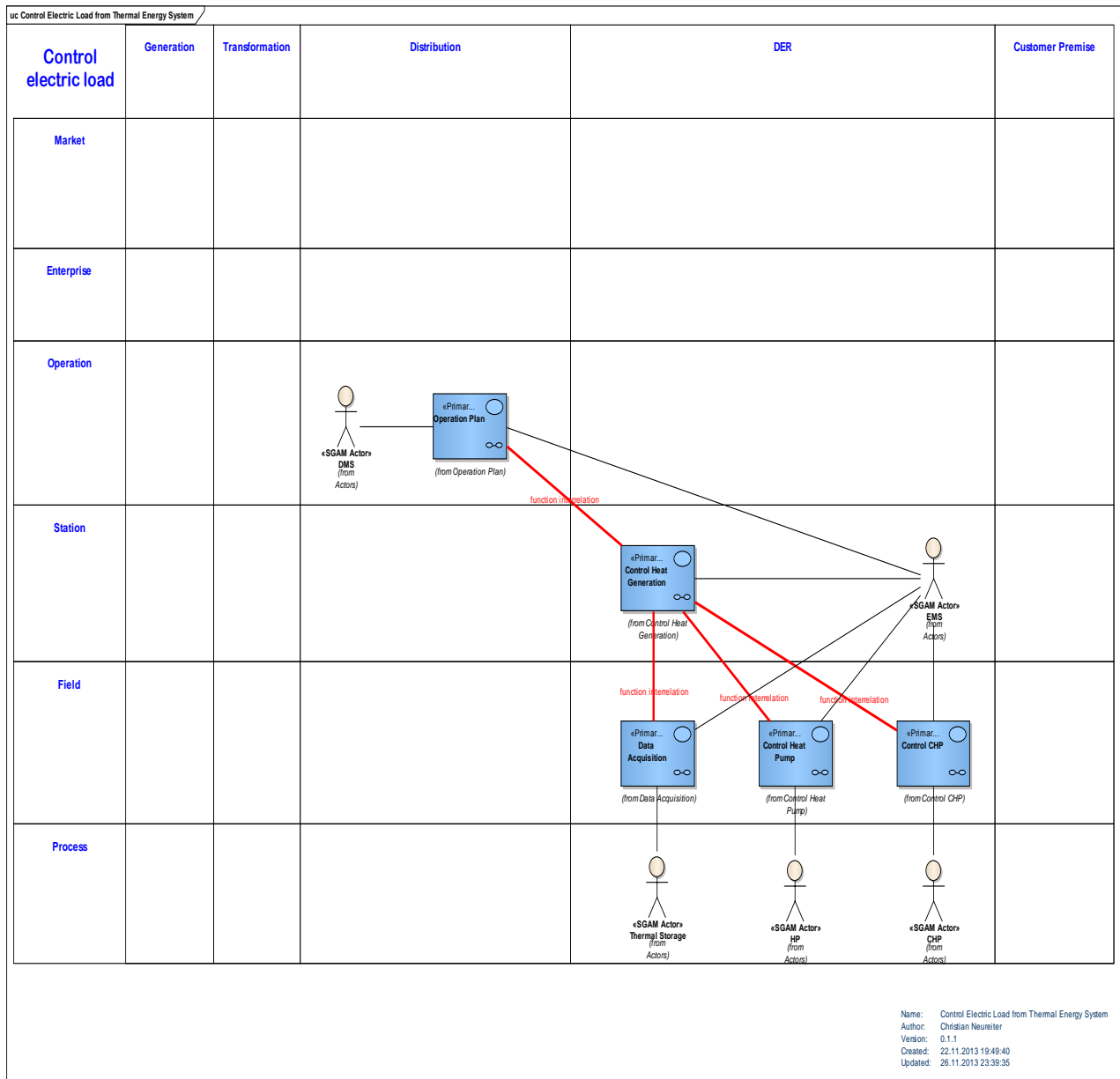## 3.2 «HLUC» Control Electric Load from Thermal Energy System

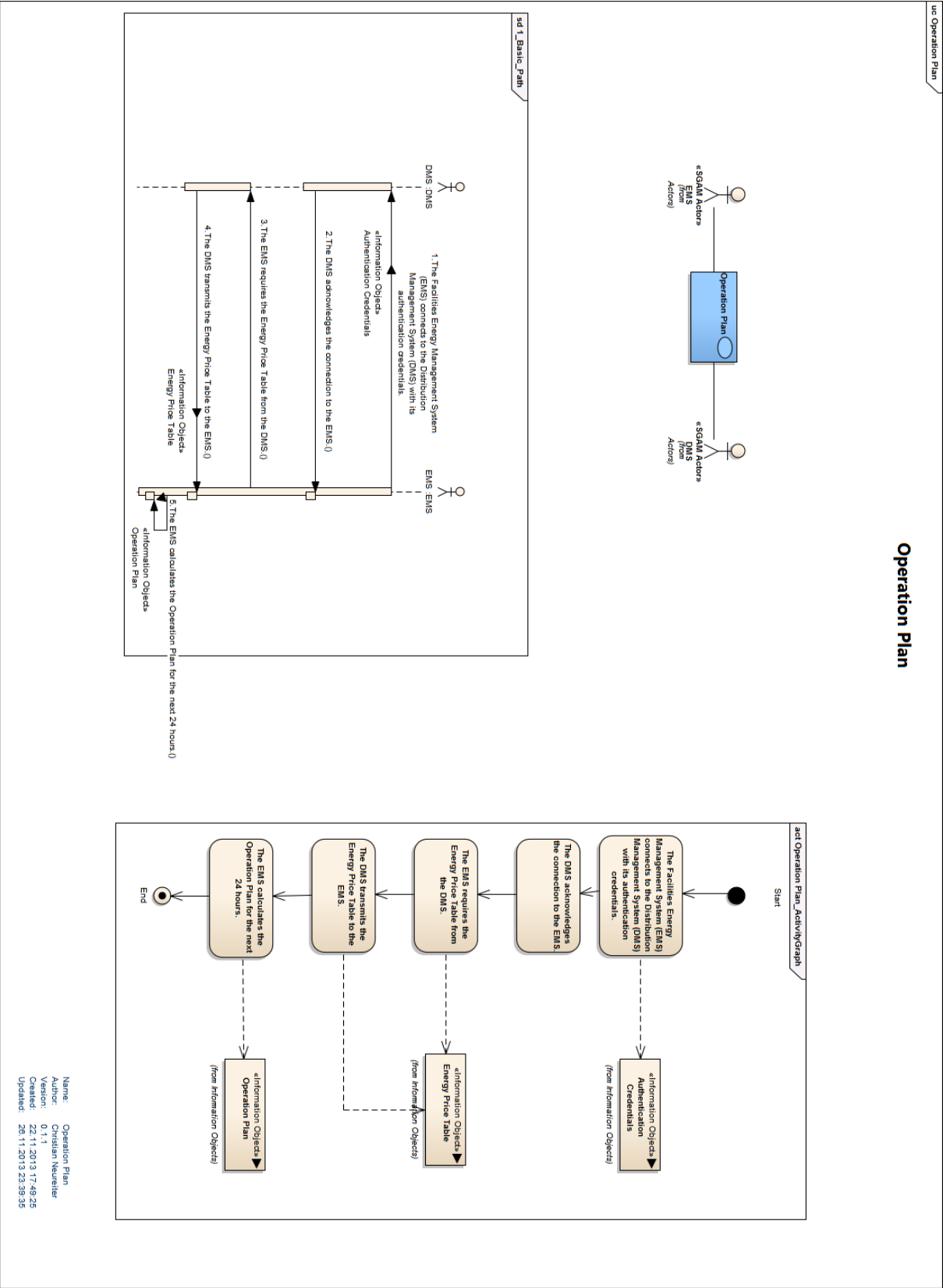Listing: 4 - Control Electric Load from Themal Energy Generation

uc Control Electric Load from Thermal Energy System

Control Electric Load from Thermal Energy System

Control Electric load from thermal energy system

«SGAM Actor»
DMS
(from Actors)

«Primary Use C...
Operation Plan

(from Operation Plan)

«Primary Use C...
Control Heat Generation

(from Control Heat Generation)

«SGAM Actor»
EMS
(from Actors)

«Primary Use C...
Control Heat Pump

(from Control Heat Pump)

«Primary Use C...
Data Acquisition

(from Data Acquisition)

«Primary Use C...
Control CHP

(from Control CHP)

«SGAM Actor»
HP
(from Actors)

«SGAM Actor»
Thermal Storage
(from Actors)

«SGAM Actor»
CHP
(from Actors)

Name:	Control Electric Load from Thermal Energy System
Author:	Christian Neureiter
Version:	0.1.1
Created:	22.11.2013 19:46:49
Updated:	26.11.2013 23:39:35

Listing: 5 - Control Electric Load from Thermal Energy System

Listing: 6 - Control Electric Load from Thermal Energy System

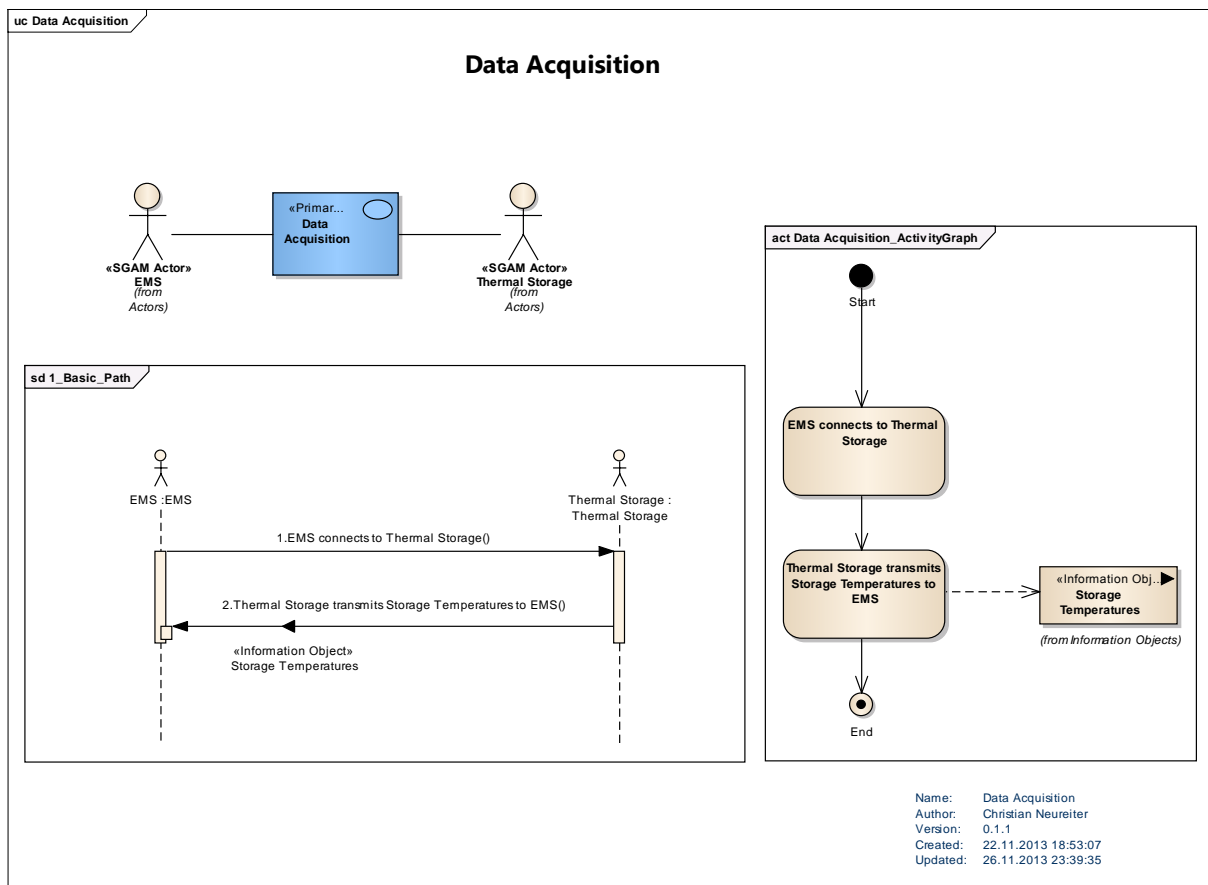| Element	Notes
«High Level Use Case» **Control Electric Load from Thermal Energy System**	This Use Case controls the generation of thermal energy (hot water) in respect to the dynamic energy prices. When the energy price is high, the CHP is used to generate thermal energy and when the energy price is low, the HP is used.

3.2.1 «PUC» Operation Plan

Listing: 7 - Operation Plan

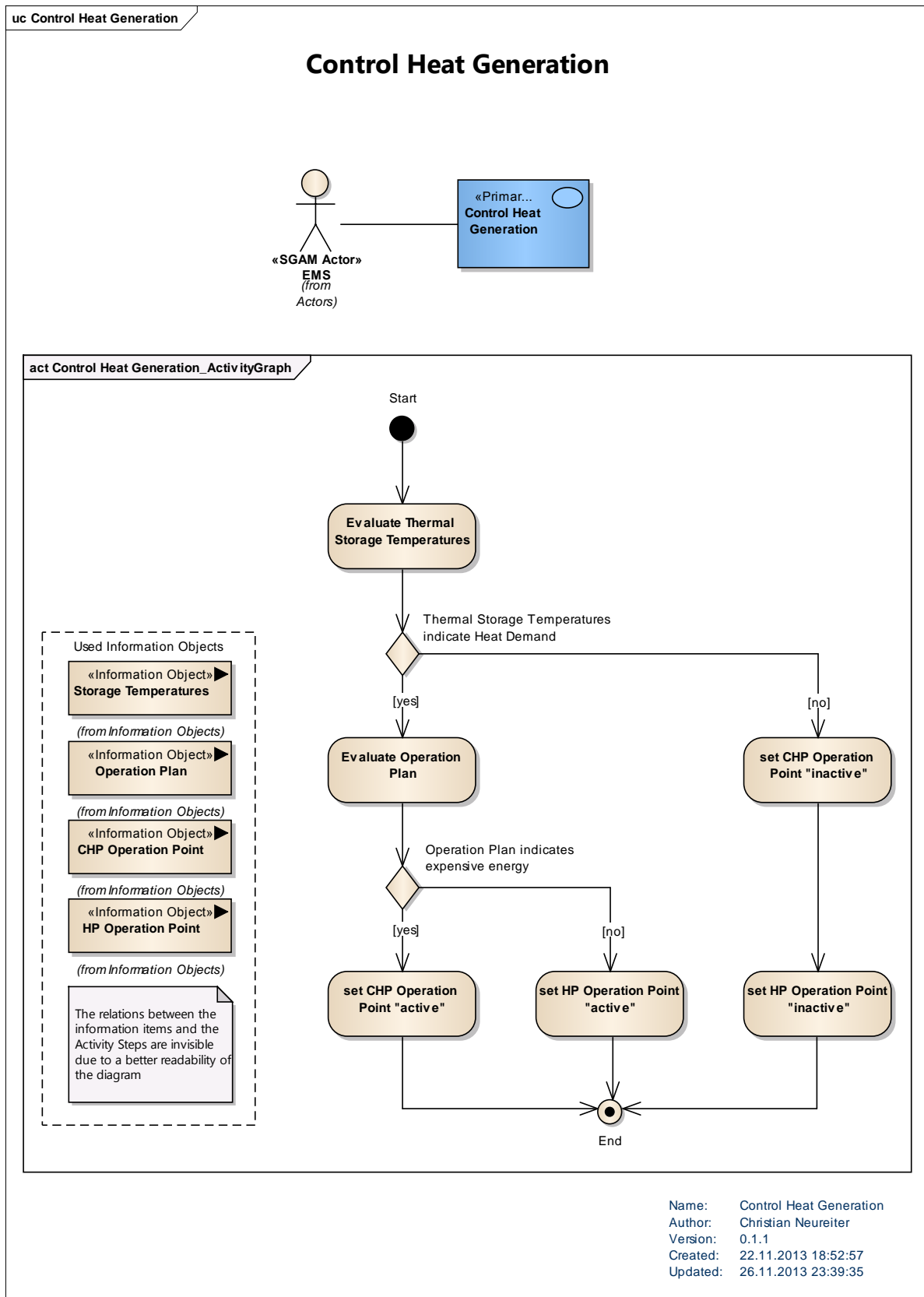| Element	Notes
«Primary Use Case» **Operation Plan**	This Use Cases aims at deriving an Operation Plan for the Facilities Heating Systems on basis of the Energy Price Table.

3.2.2 «PUC» Data Acquisition

Listing: 8 - Data Acquisition

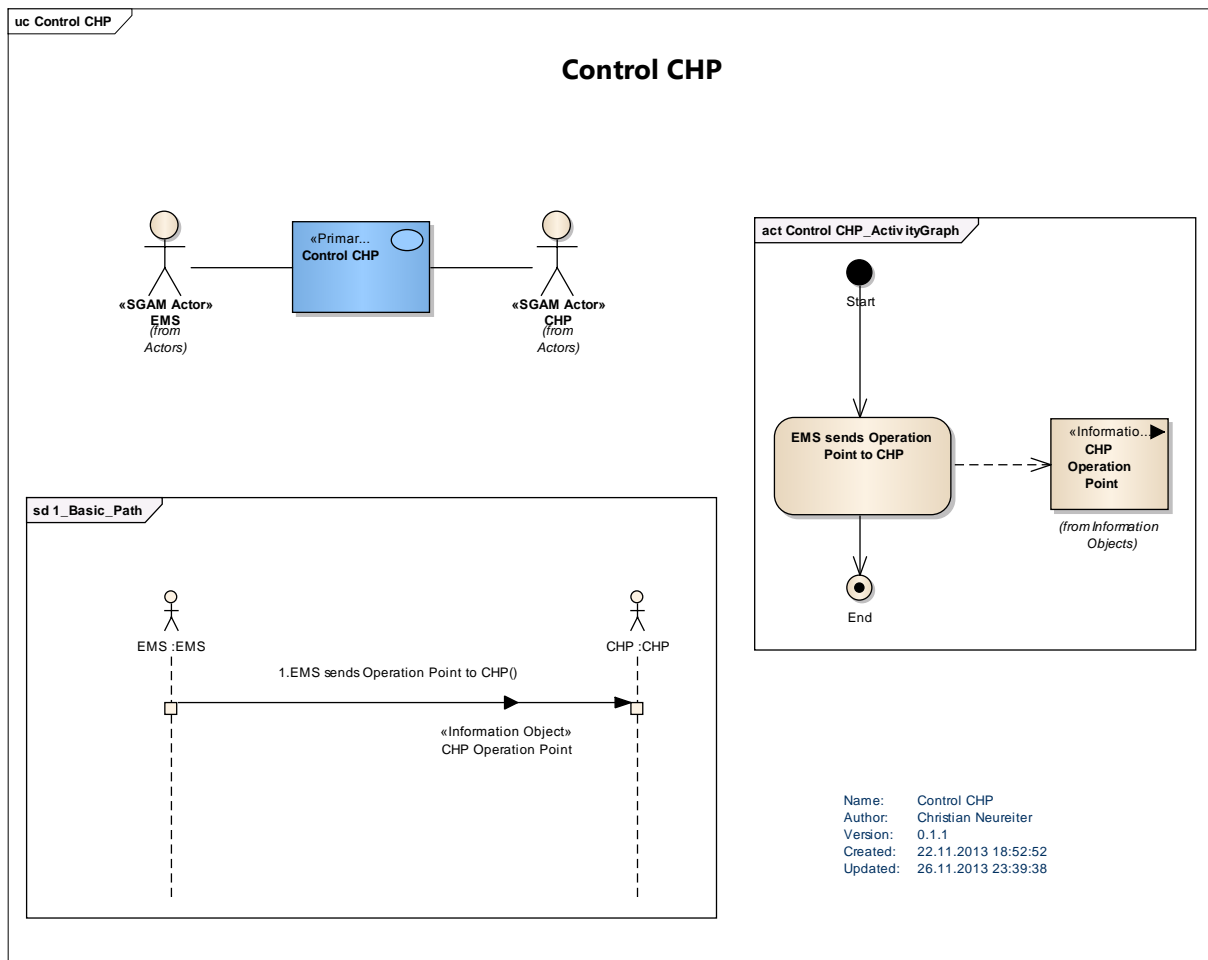| Element	Notes
«Primary Use Case» **Data Acquisition**	This Use Case focuses on the collection of various parameters that are necessary for the calculation of the Operation Points for the Facilities Heat generating Systems.

3.2.3 «PUC» Control Heat Generation

Listing: 9 - Control Heat Generation

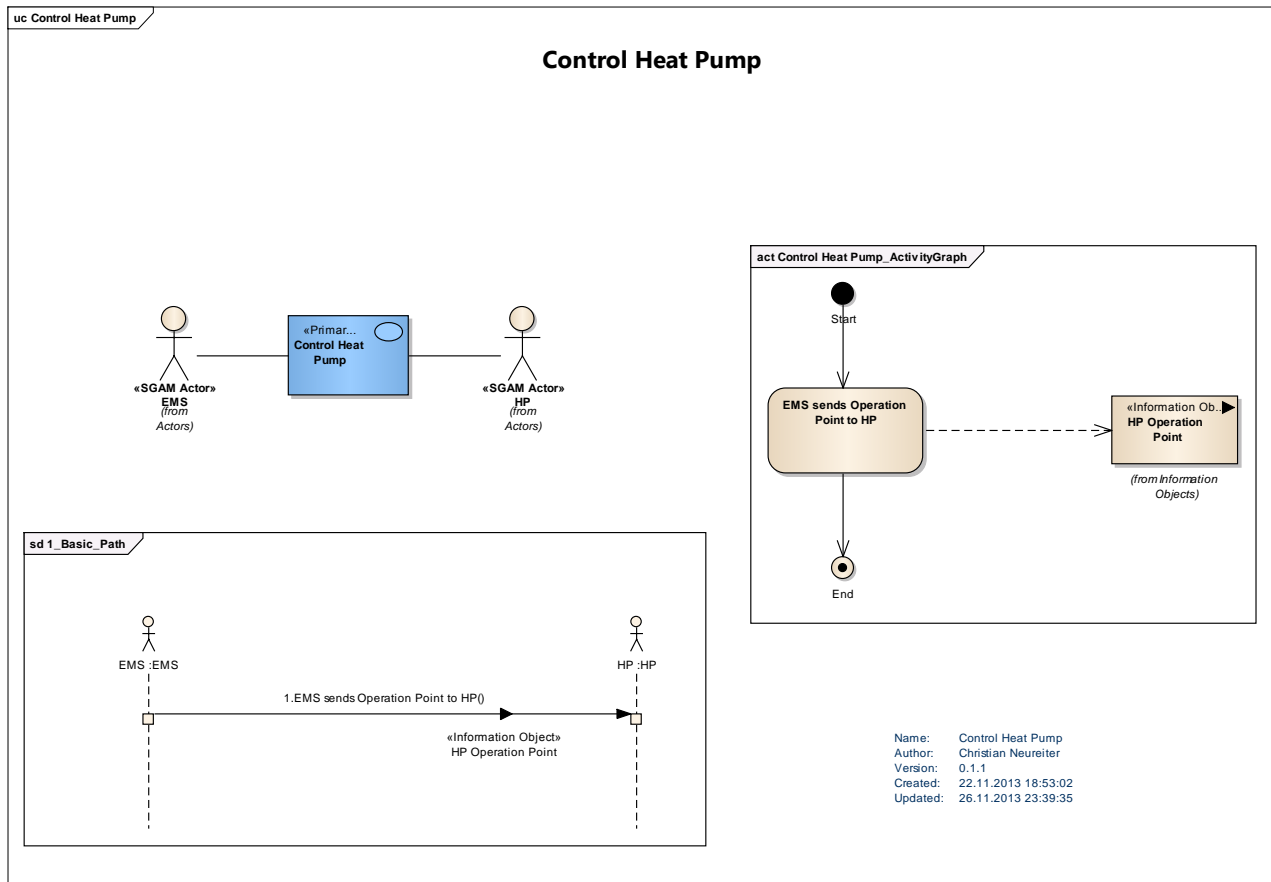| Element	Notes
«Primary Use Case» **Control Heat Generation**	This Use Case calculates the Operation Points for the CHP and the HP on basis of the Operation Plan and the actual collected System Data (Storage Temperatures)

3.2.4 «PUC» Control CHP

Listing: 10 - Control CHP

Element	Notes
«Primary Use Case» **Control CHP**	This Use Case sets the CHP to its new Operation Point.

3.2.5 «PUC» Control Heat Pump

Listing: 11 - Control Heat Pump

Element	Notes
«Primary Use Case» **Control Heat Pump**	This Use Case sets the HP to its new Operation Point.

3.3 «HLUC» Control E-Car Charging

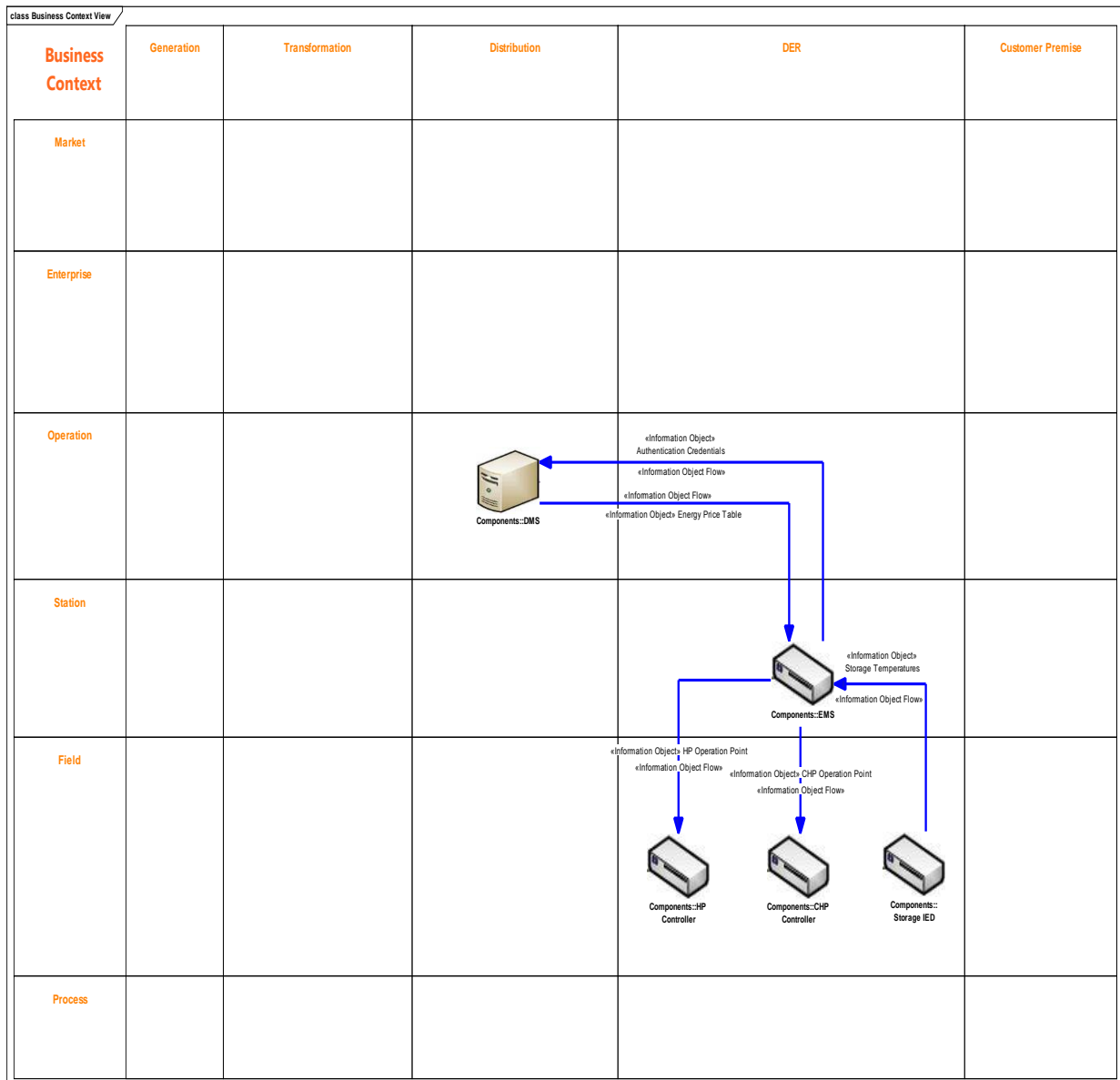| Element	Notes
«High Level Use Case» **Control E-Car Charging**	This Use Case schedules the charging process of an electric vehicle in respect to the dynamic energy prices.

3.4 «HLUC» Demand Response

Element	Notes
«High Level Use Case» **Demand Response**	This Use Case controls some Demand Response ready Home Automation equipment with respect to the dynamic energy prices.

4.   SGAM Information Layer
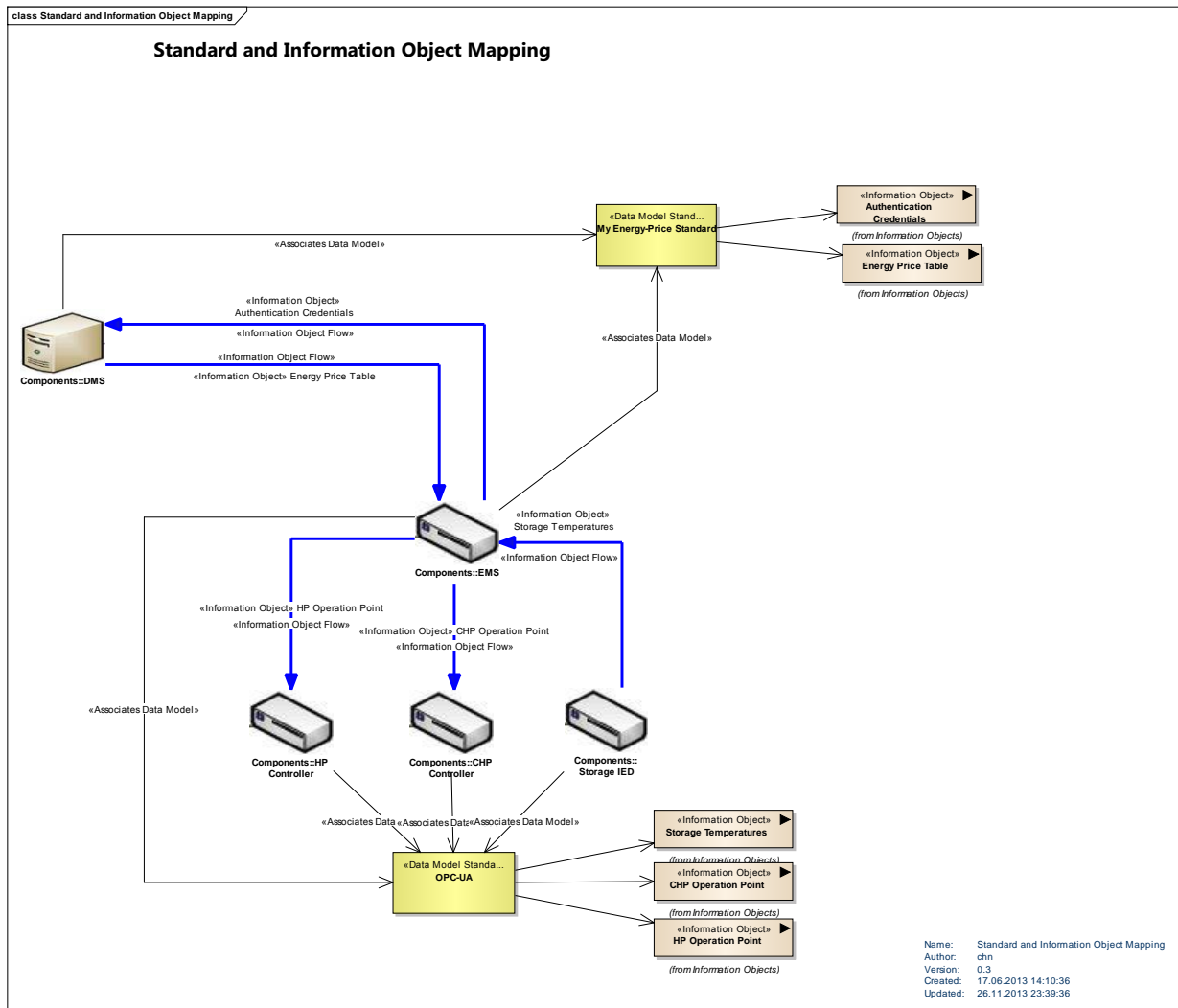
4.1   Information Objects

Element	Notes
«Information Object» **Authentication Credentials**	• User • Password • Policy....
«Information Object» **Energy Price Table**	The Energy Price Table contains information for 24 h. It has to be transmitted until a certain time, otherwise the table from the previous day is valid. It consists of prices for 30 min time slots.
«Information Object» **Operation Plan**	The operation plan marks on 30 min slots which system is to be used in case of heat-demand.
«Information Object» **Storage Temperatures**	The storage temperatures are delivered from 3 PT1000 Sensors. One at the top, one in the middle and one at the bottom of the storage. The values are delivered as °C x 100. E.G. 6250 means a temperature of 62,50°C.
«Information Object» **CHP Operation Point**	The CHP Operation point can be one of the following values: {100%, 0%}
«Information Object» **HP Operation Point**	The HP Operation point can be one of the following values: {100%, 0%}

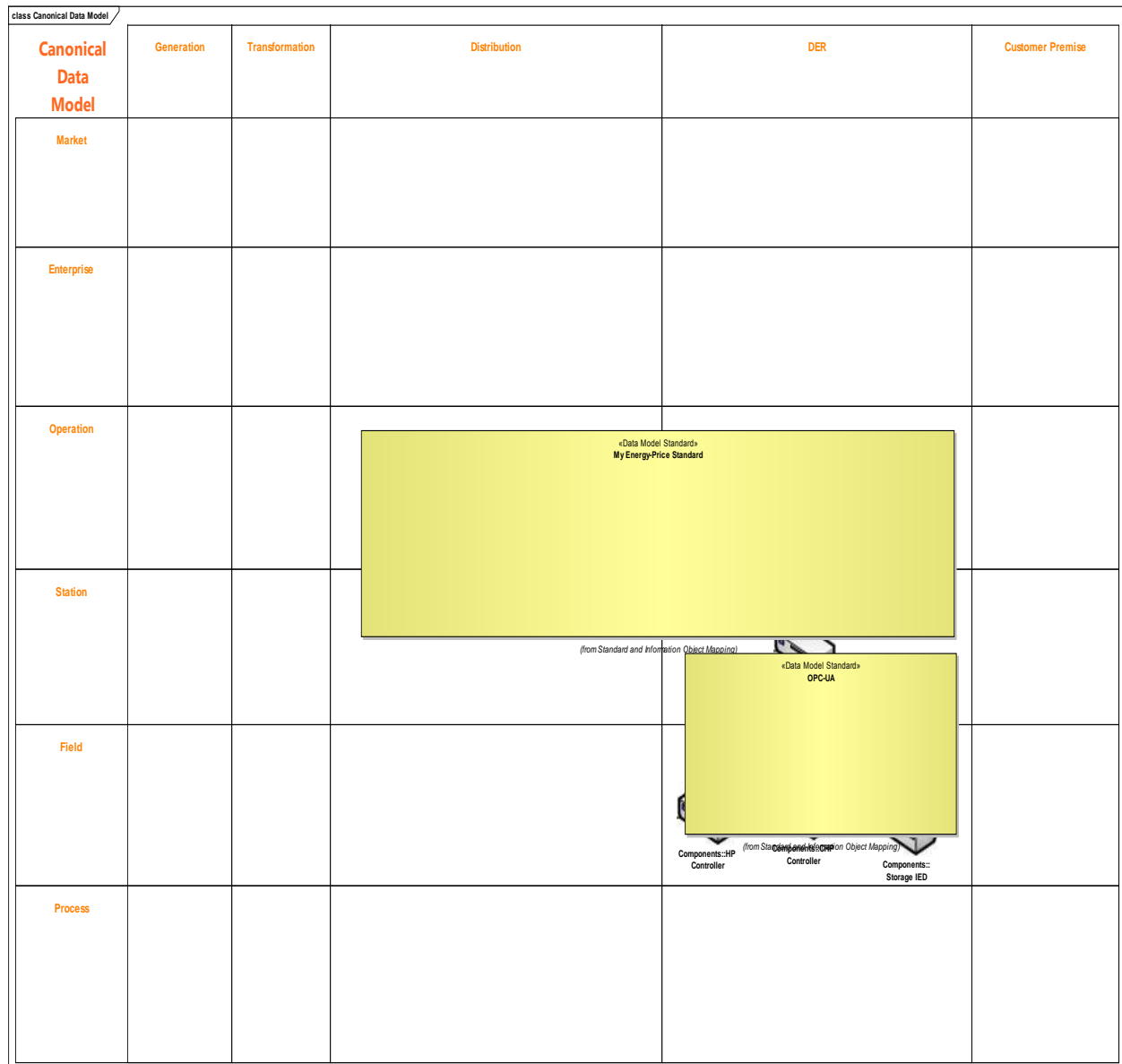## 4.2   Business Context View

Listing: 12 - Business Context View

4.3   Standard and Information Object Mapping

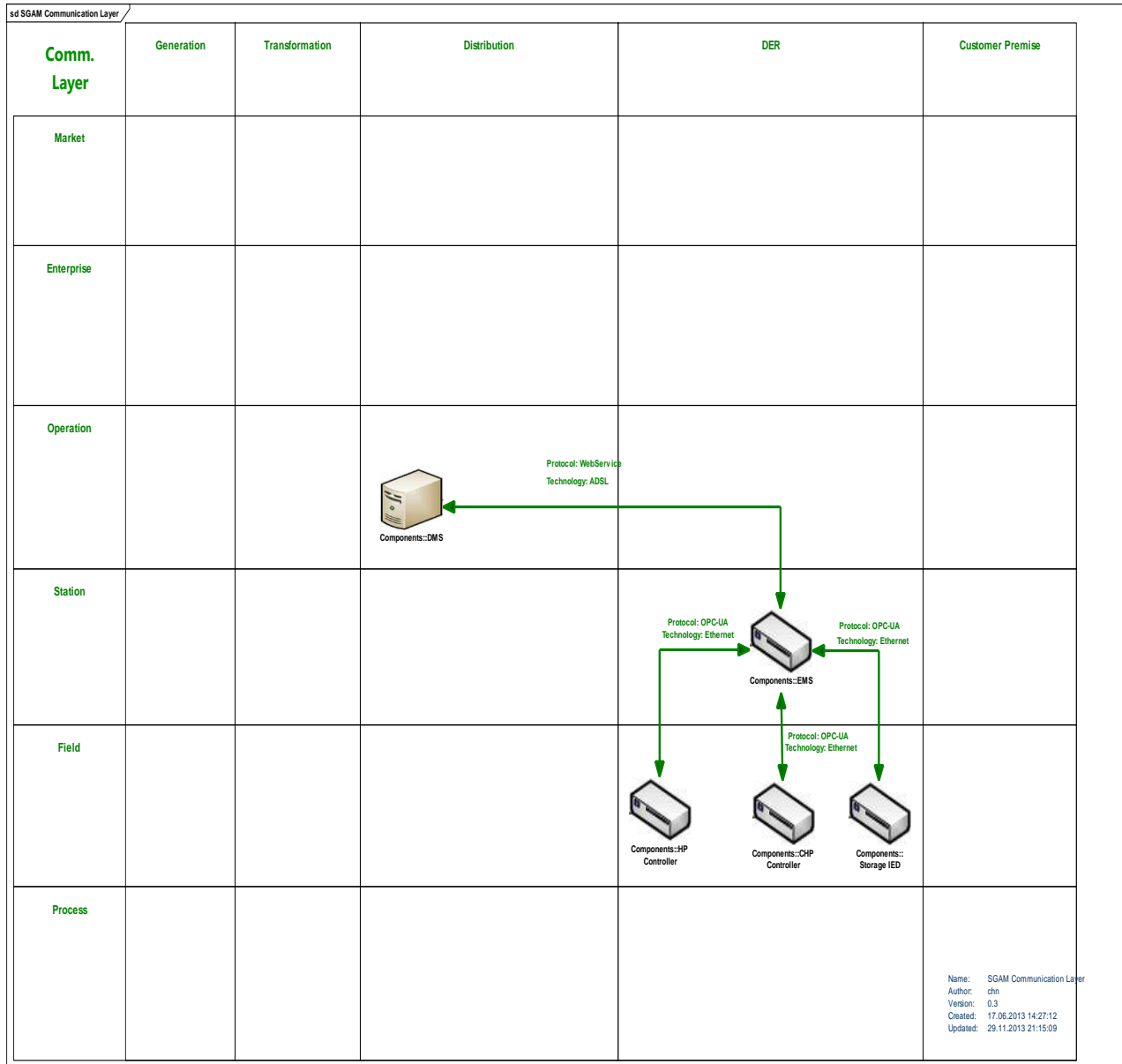
Listing: 13 - Standard and Information Object Mapping

Element	Notes
«Data Model Standard» **My Energy-Price Standard**	This format is a proprietary way of company xyz to represent dynamic energy prices for a time period of 24h.
«Data Model Standard» **OPC-UA**	The OPC-UA Standard is standard as...

4.4 Canonical Data Model

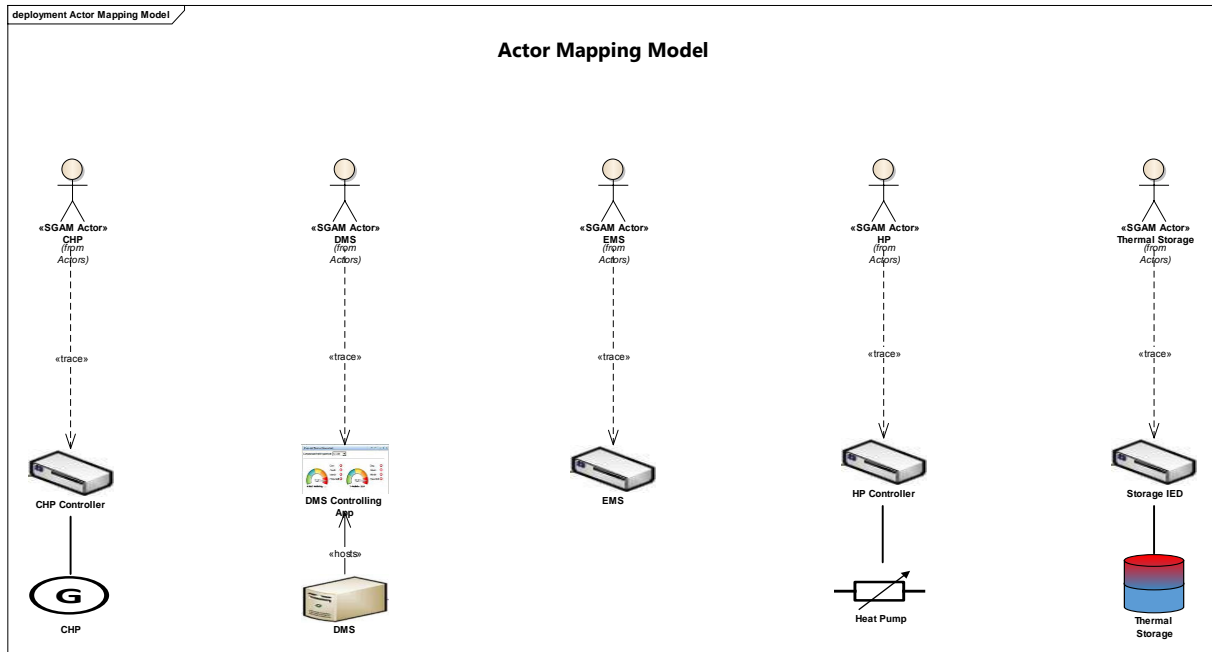Listing: 14 - Canonical Data Model

5. SGAM Communication Layer

Listing: 15 - SGAM Communication Layer
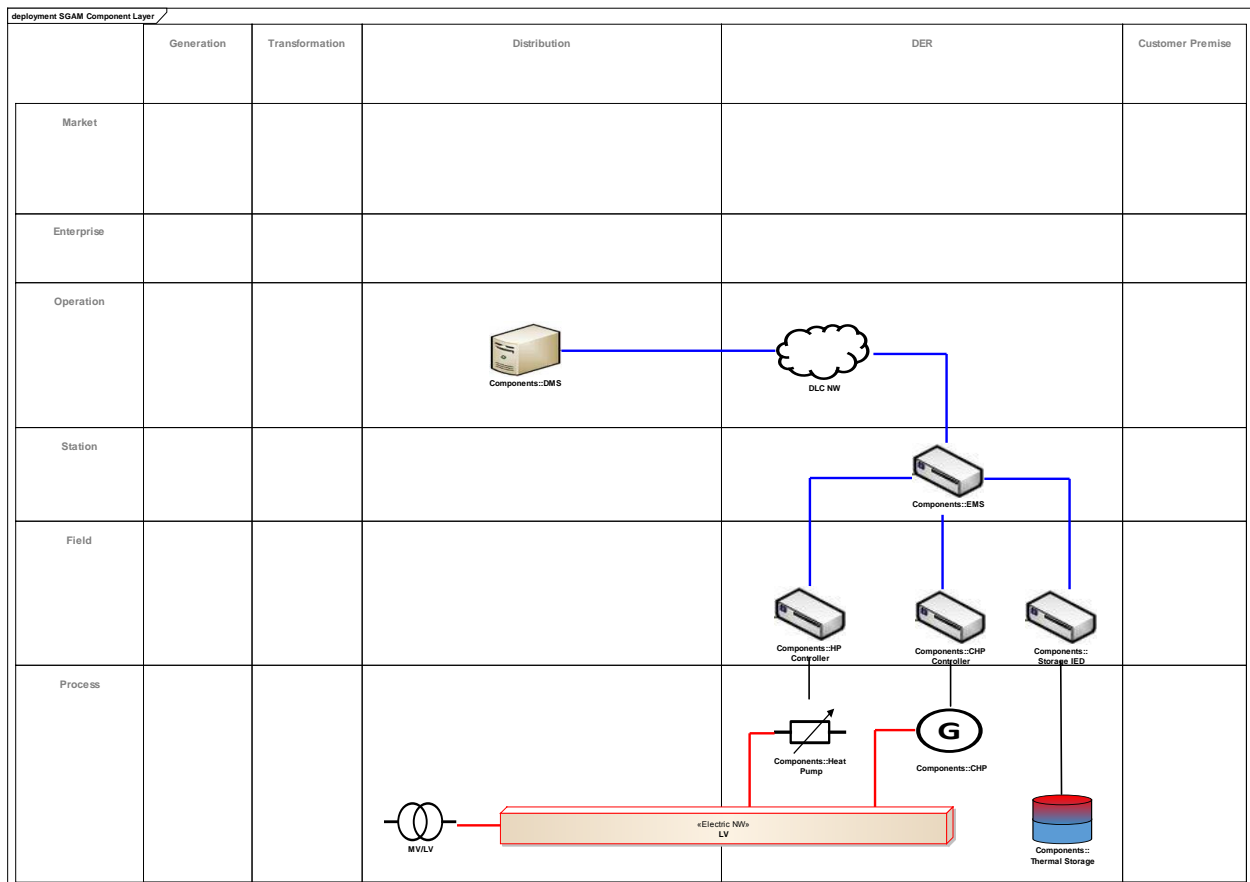
6.   SGAM Component Layer

6.1   Components

Listing: 16 - Actor Mapping Model

Element	Notes
«Generator» **CHP**	The HP is of type XYZ. It is able to produce xyz MegaWatts of electric energy.
«Device» **CHP Controller**	The CHP Controller is delivered from the CHP OEM. It is equipped with an Ethernet port and able to communicate via OPC-UA. The corresponding data-sheet can be found at www.someCHP-OEM.com
«Computer» **DMS**	The DMS computer is locatet at... It is maintained by...
«Device» **EMS**	The Energy Management System is a specific device that was developed for this specific facility. Its documentation can be found at...
«Device» **HP Controller**	The HP Controller is delivered from the HP OEM. It is equipped with an Ethernet port and able to communicate via OPC-UA. The corresponding data-sheet can be found at www.someHP-OEM.com

«*Variable Load*» **Heat Pump**	The HP is of type XYZ. It has a nominal load of one million MegaWatts...
«*Device*» **Storage IED**	The storage IED is a small Programable Logic Controller (PLC) of type... It fetches the temperature values of three PT1000 Sensors and supplies them as variables via OPC-UA.
«*Thermal Storage*» **Thermal Storage**	The thermal storage has a capacity of 800l. It is equipped with three PT1000 temperature sensors, one at the top, one in the middle and one at the bottom. The Temperature at the top must not deceed 42°C.
«*SW Application*» **DMS Controlling App**	The DMS controlling application realizes the functionality of the DMS SGAM Actor. It is hosted by the DMS Computer.

6.2 Heating System

Listing: 17 - SGAM Component Layer

Element	Notes
«ICT Network» **DLC NW**	Dynamic Load Communication (DLC) Network. This Network is a VPN Network under supervisory of the DSM.
«Electric NW» **LV**	Electric Low Voltage Network
«Transformer» **MV/LV**	MV/LV Transformer. This Transformer is located next to the facility. The facility is the only LV Network segment that is connected to this transformer. The transfomer is of type xyz and has a nominal power of xyz.