# OpenBuildingControl
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# Team meeting

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# Upcoming deadlines

By Q6, demonstrate with an actual measured control response that the controls verification can signal satisfied, undecided, and violated test results.

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By Q7, release a version of the control library for primary systems, facade and lighting in Modelica on http://github.org/lbl-srg/modelica-buildings.

By Q7, release first version of the controls verification test module.

By Q8, release case study report.

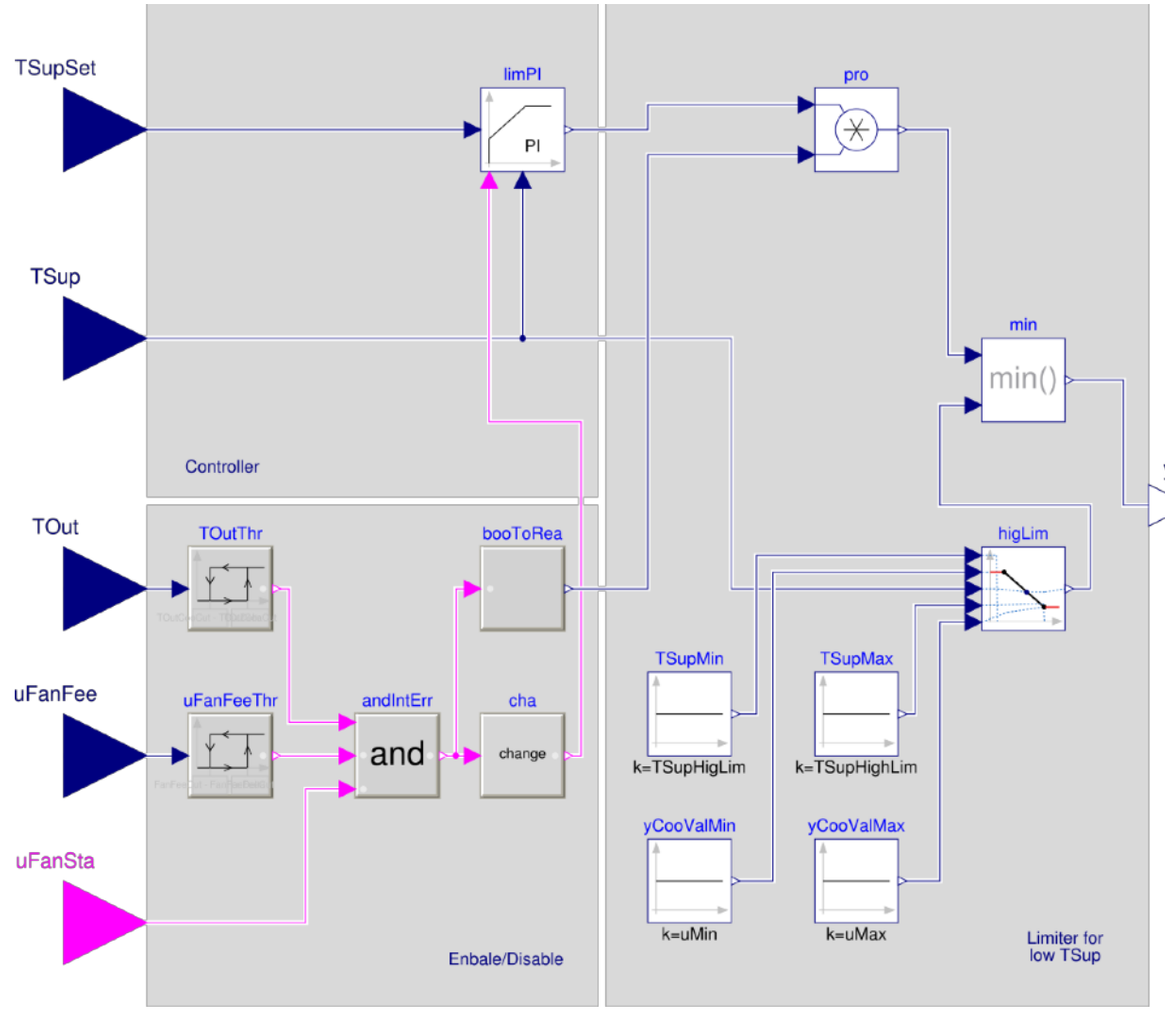
By Q8, demonstrate importing and exporting CDL in the control design tool.
Todo: Render connections that overlap or connect to the same input/output.

By Q8, write first version of commercialization and market transformation plan with the goal to show value and obtain commitment from large owners and design firms for the process.

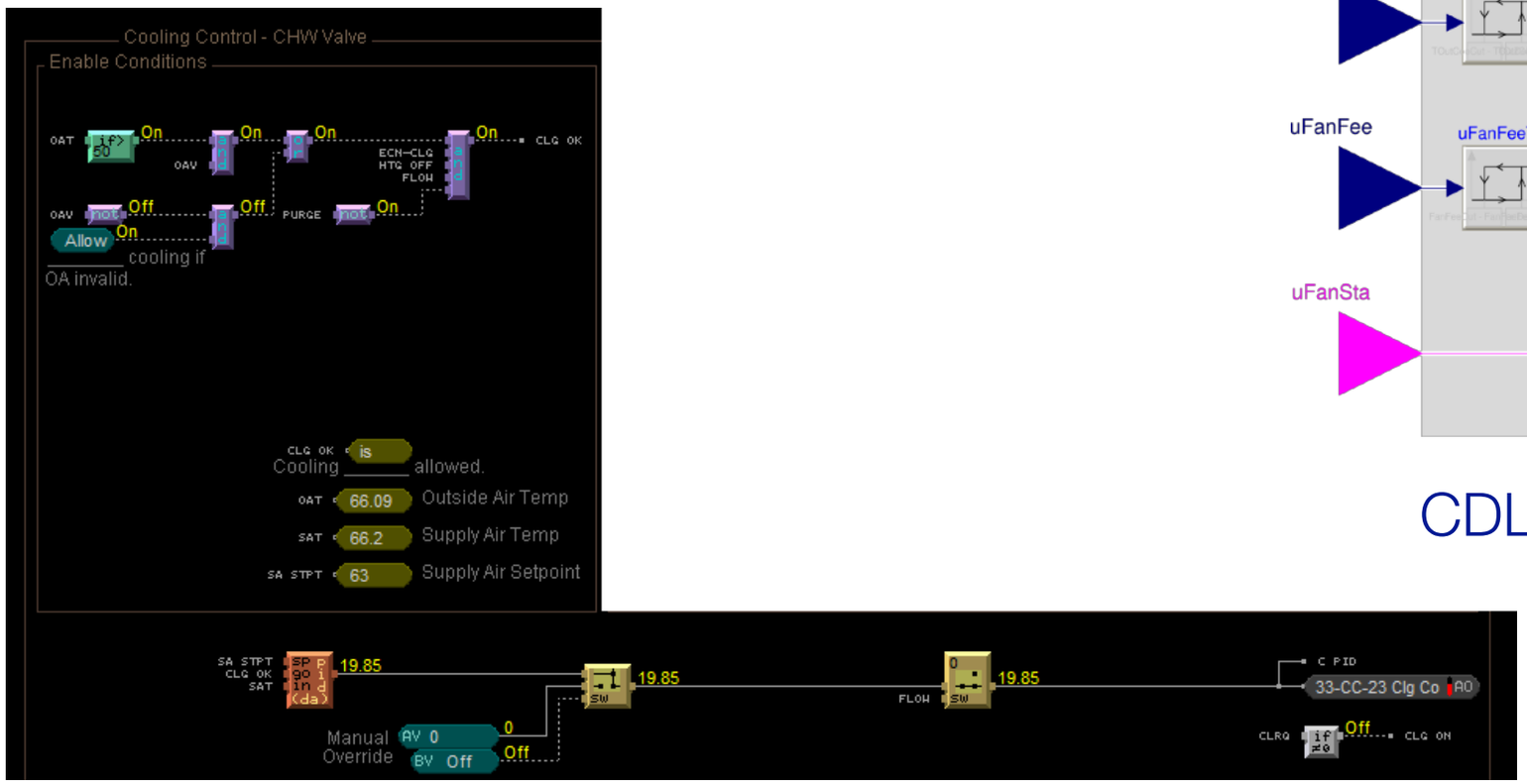
# Verification test with a measured control response - Sequence specification

We validated a **trended output** of a control sequence that defines the **cooling coil valve** position.

The cooling coil valve sequence is a part of the ALC EIKON control logic implemented in building 33 at LBNL.




CDL specification

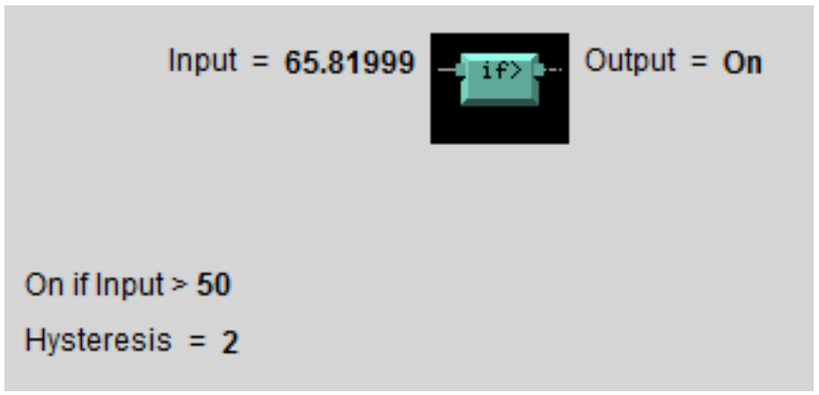



ALC EIKON specification

# Verification test with a measured control response - ALC EIKON parameter collection

We recorded ALC EIKON sequence parameters and input trends with a 5s interval:

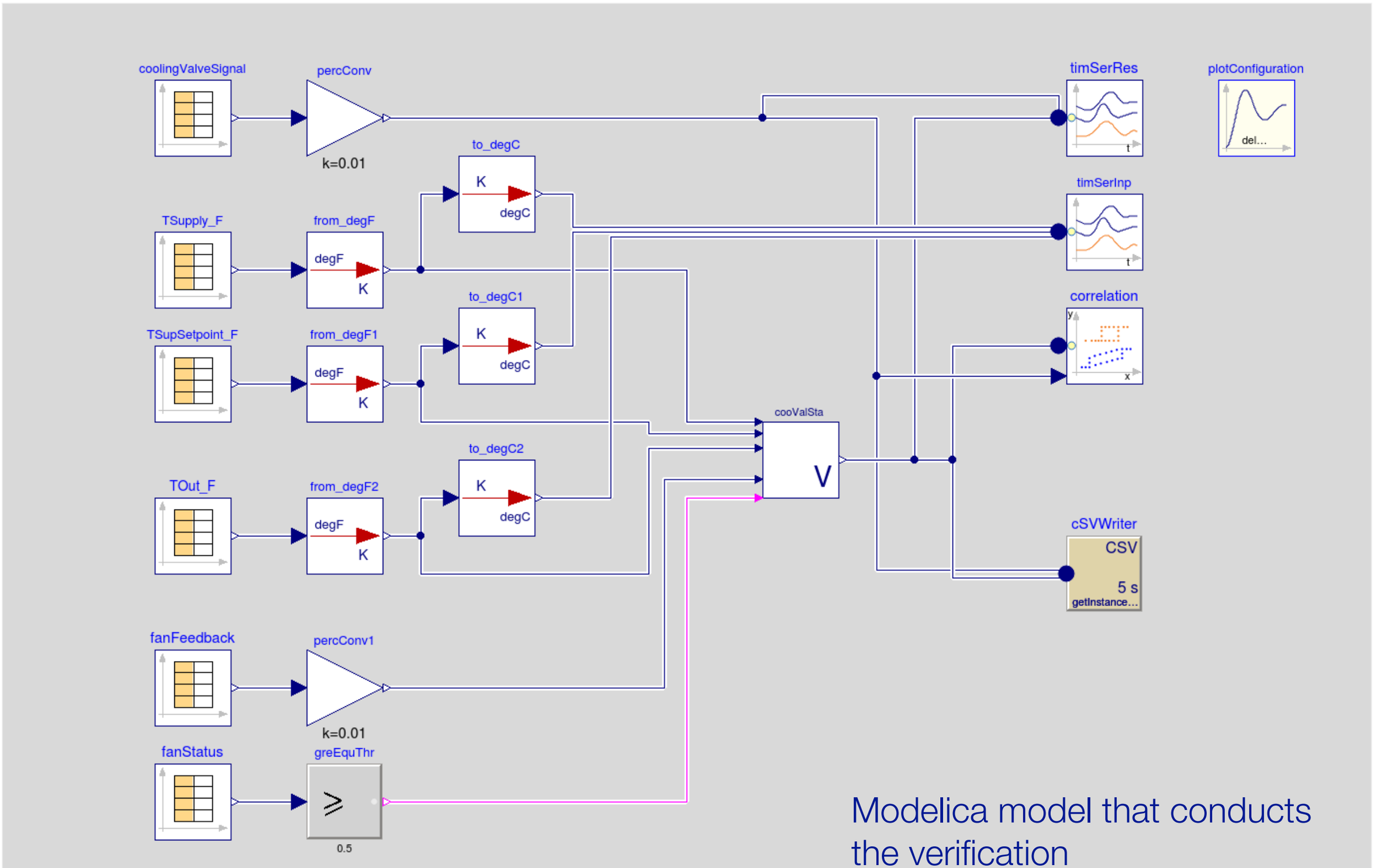
- Supply air temperature [F]
- Supply air temperature setpoint [F]
- Outdoor air temperature [F]
- VFD fan enable status [0/1]
- VFD fan feedback [%]




ALC outdoor air temperature hysteresis to enable/disable the controller


ALC PI controller parameters

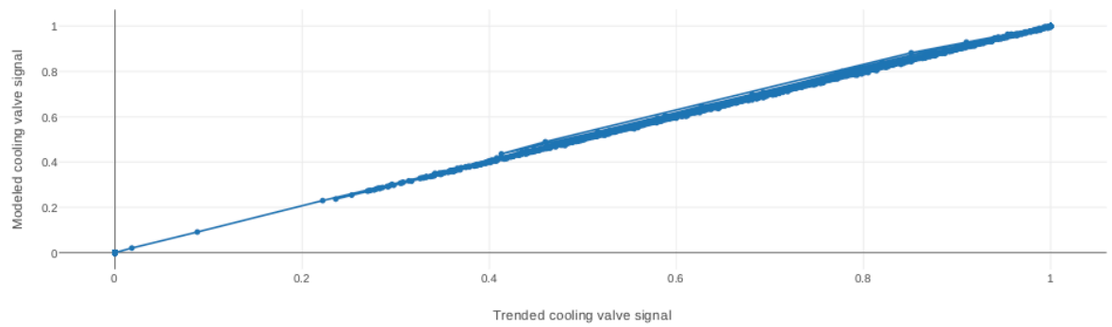
# Verification test with a measured control response - Conducting the verification



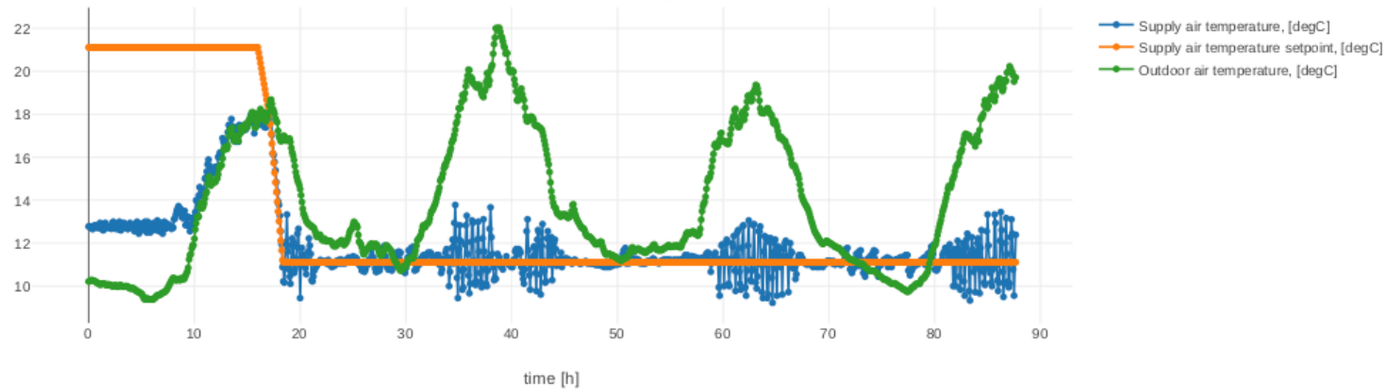

Modelica model that conducts the verification

# Verification test with a measured control response - Verification results

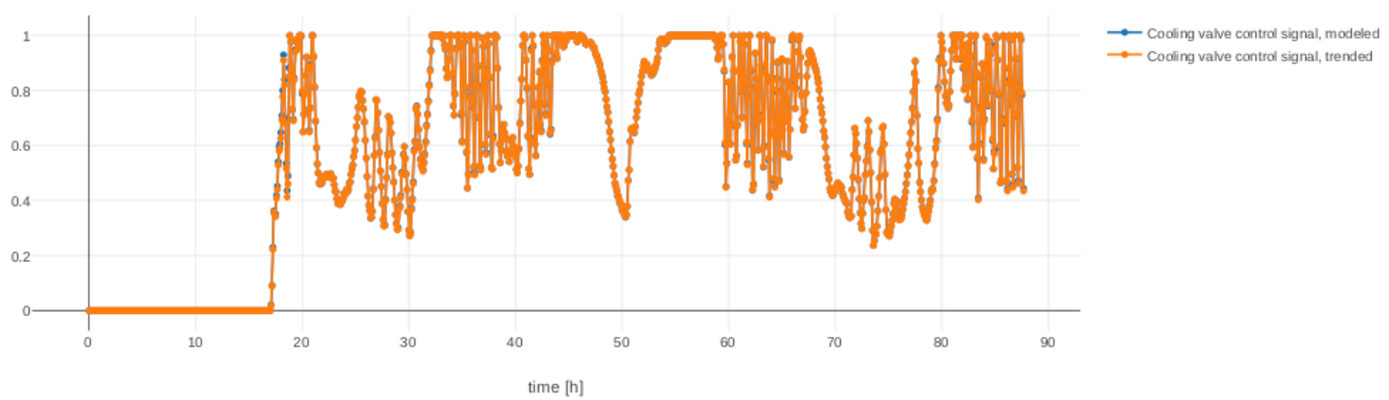
**Modeled result/recorded trend correlation**



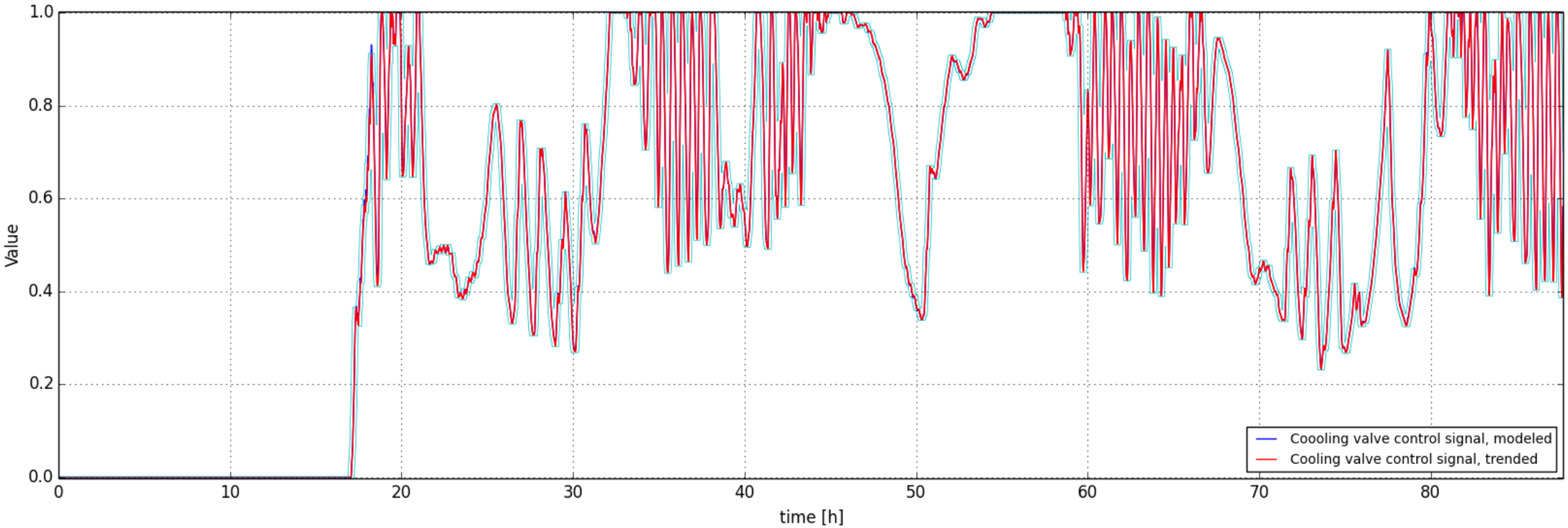

**Trended input signals**




**Cooling valve control signal: reference trend vs. modeled result**

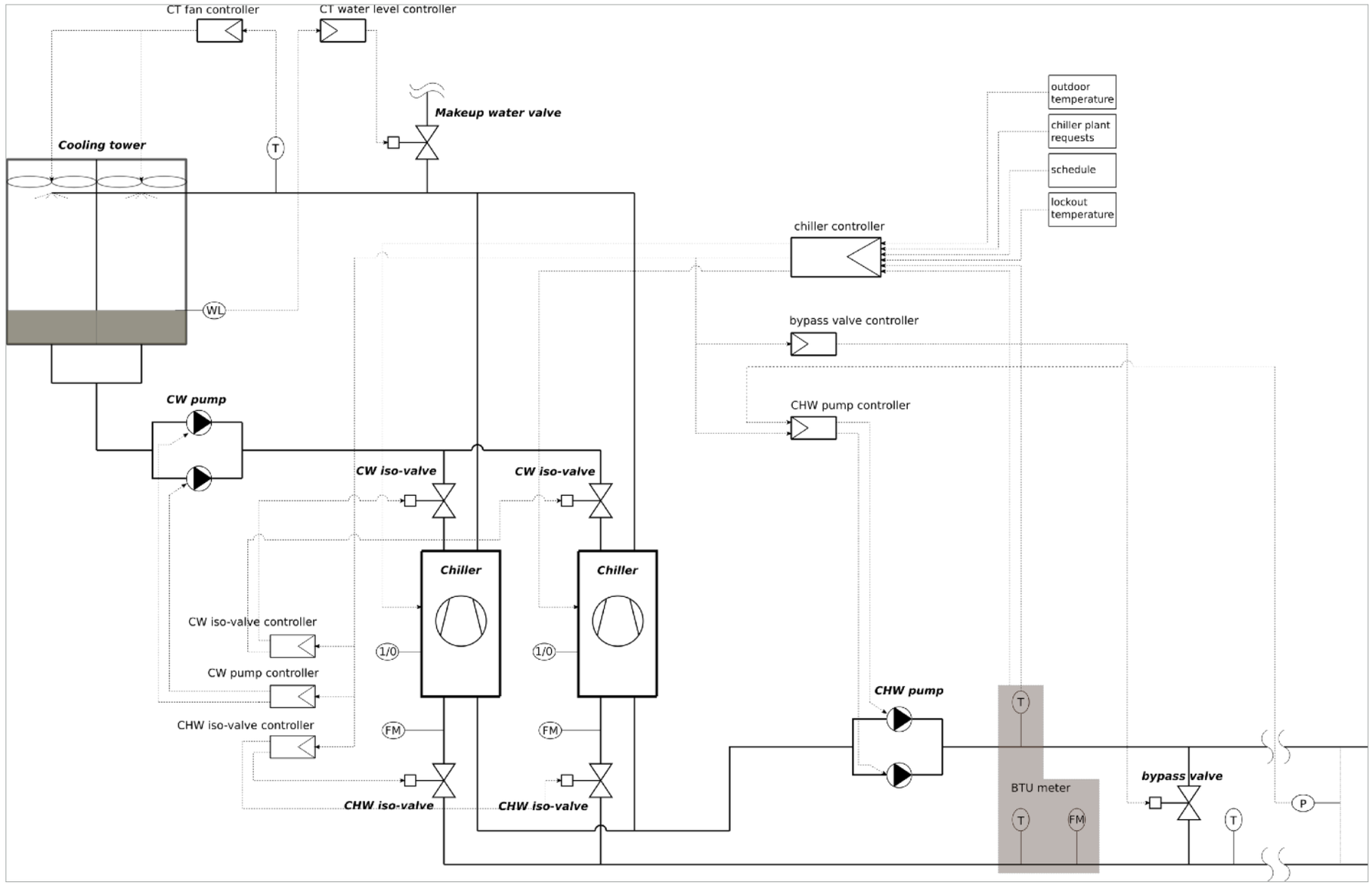


# Verification test with a measured control response - Verification results using the funnel tool



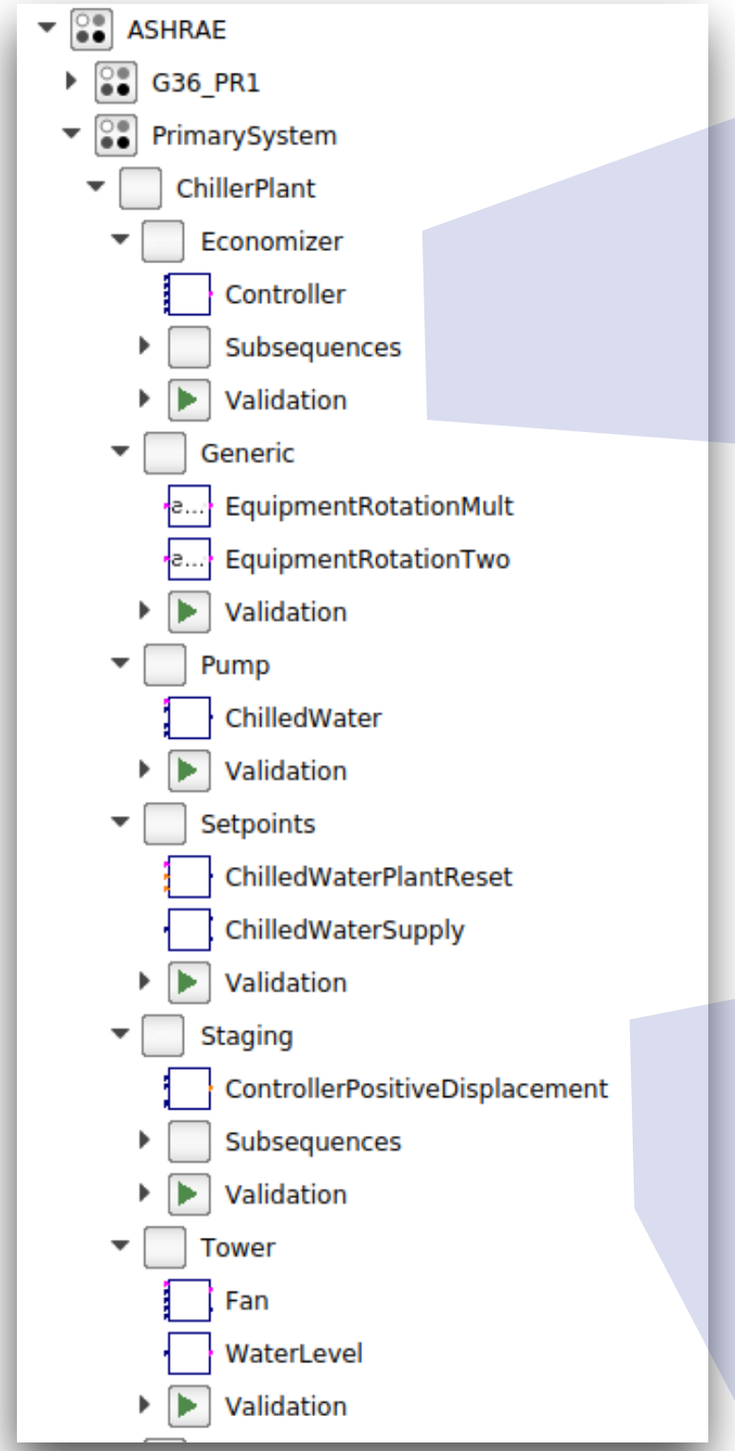
# Primary sequence implementation I

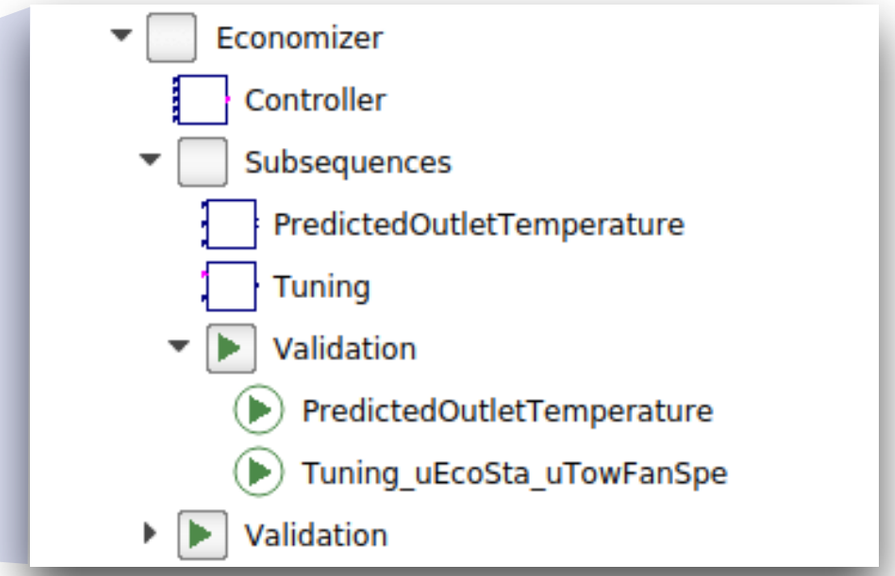
- Developed a typical plant control schematics and sequences based on “ASHRAE Fundamentals of Chilled Water Plant Design and Control SDL, Chapter 7. Controls”:
  - 2 chillers, 2 CT, 2 CHWP, 2 CWP




- Included water side economizer in the package

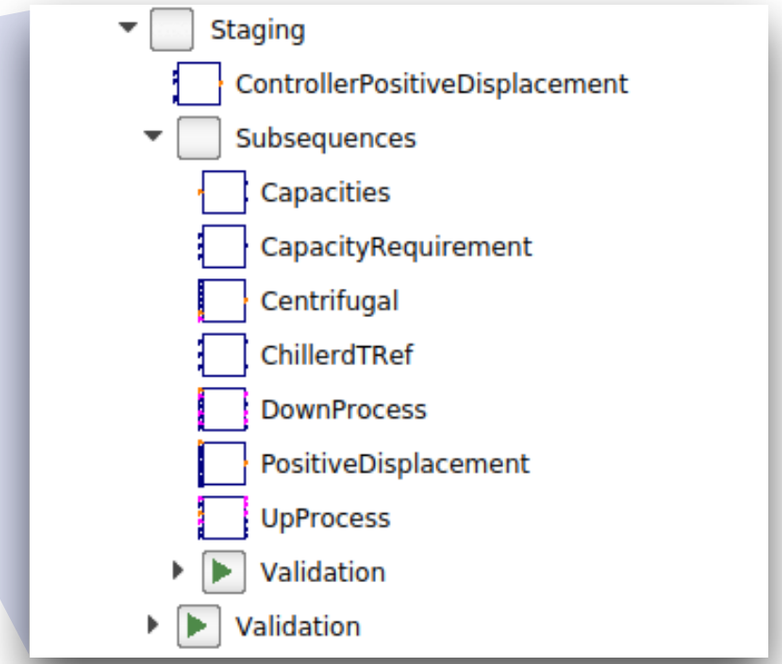
# Primary sequence implementation II




Next steps:

- Comply with latest ASHRAE RP-1711 primary sequences document
- Create top level user facing controllers
- Review the package and include in the library



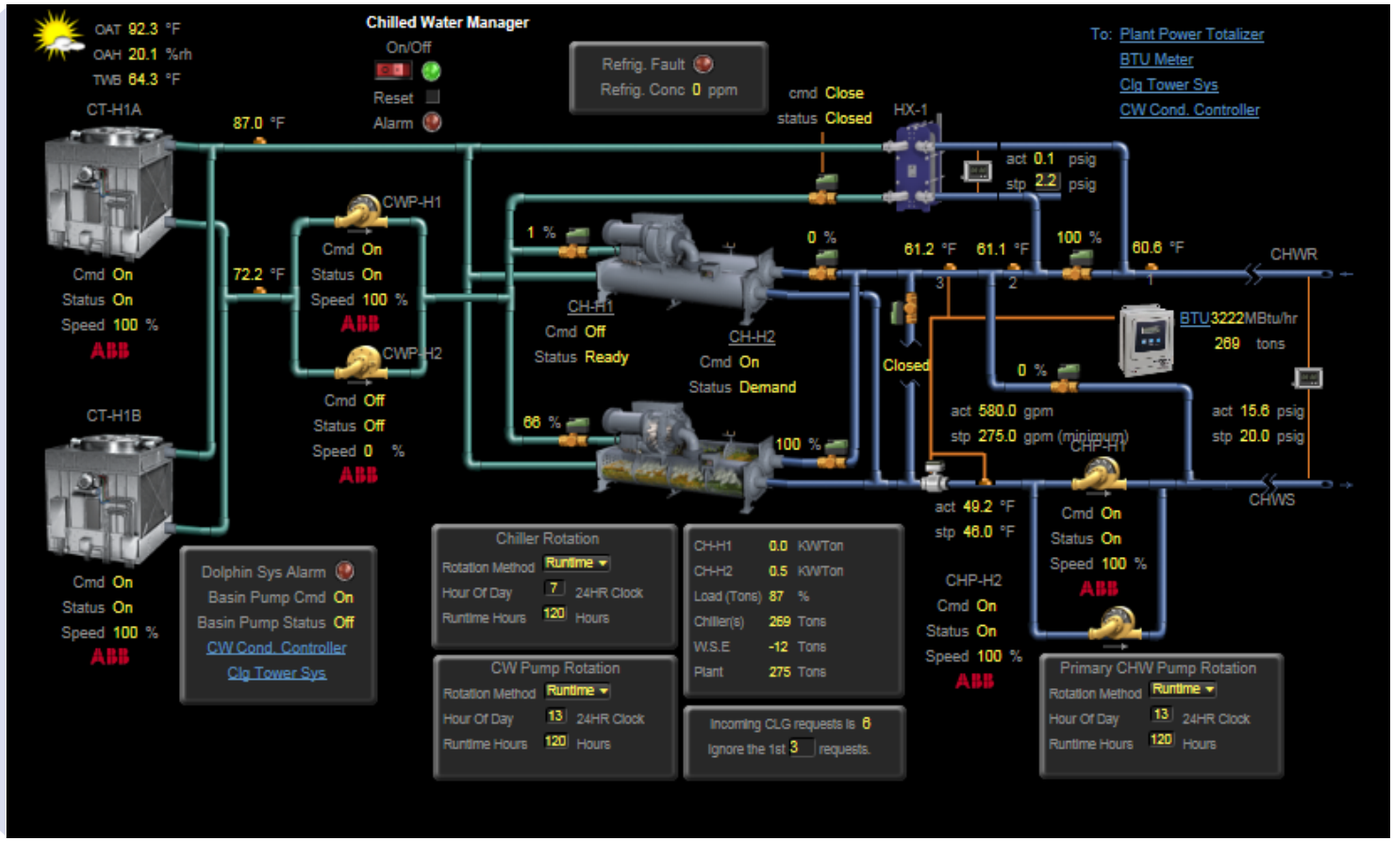
# Case study I

Chiller plant in a commercial office building in Hacienda Business Park in Pleasanton, California

Control design by Taylor Engineering

Plant consists of:

- 2 x 310 ton screw chillers
- 2 x CWP, CHP
- 2 x CT
- 1 x WS economizer HE



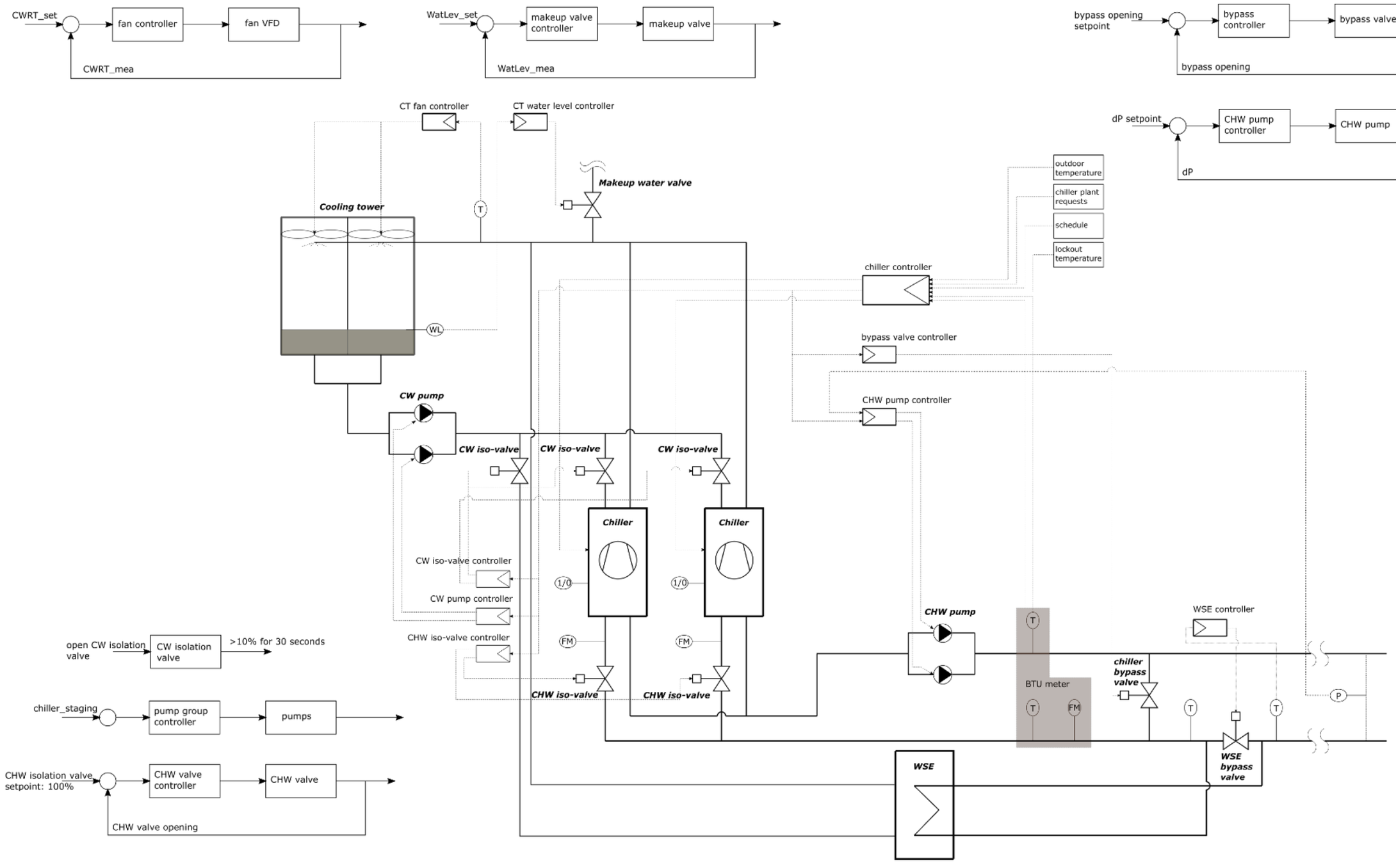

Eikon equipment view

## Trend data specs

- ~50 data points
- 1 minute interval data for Jun 22 - July 10 2018
- 5 minute interval data for Mar 11 - Jun 2 2018
- multiple operation stages

# Case study II

## Plant schematics with a WSE



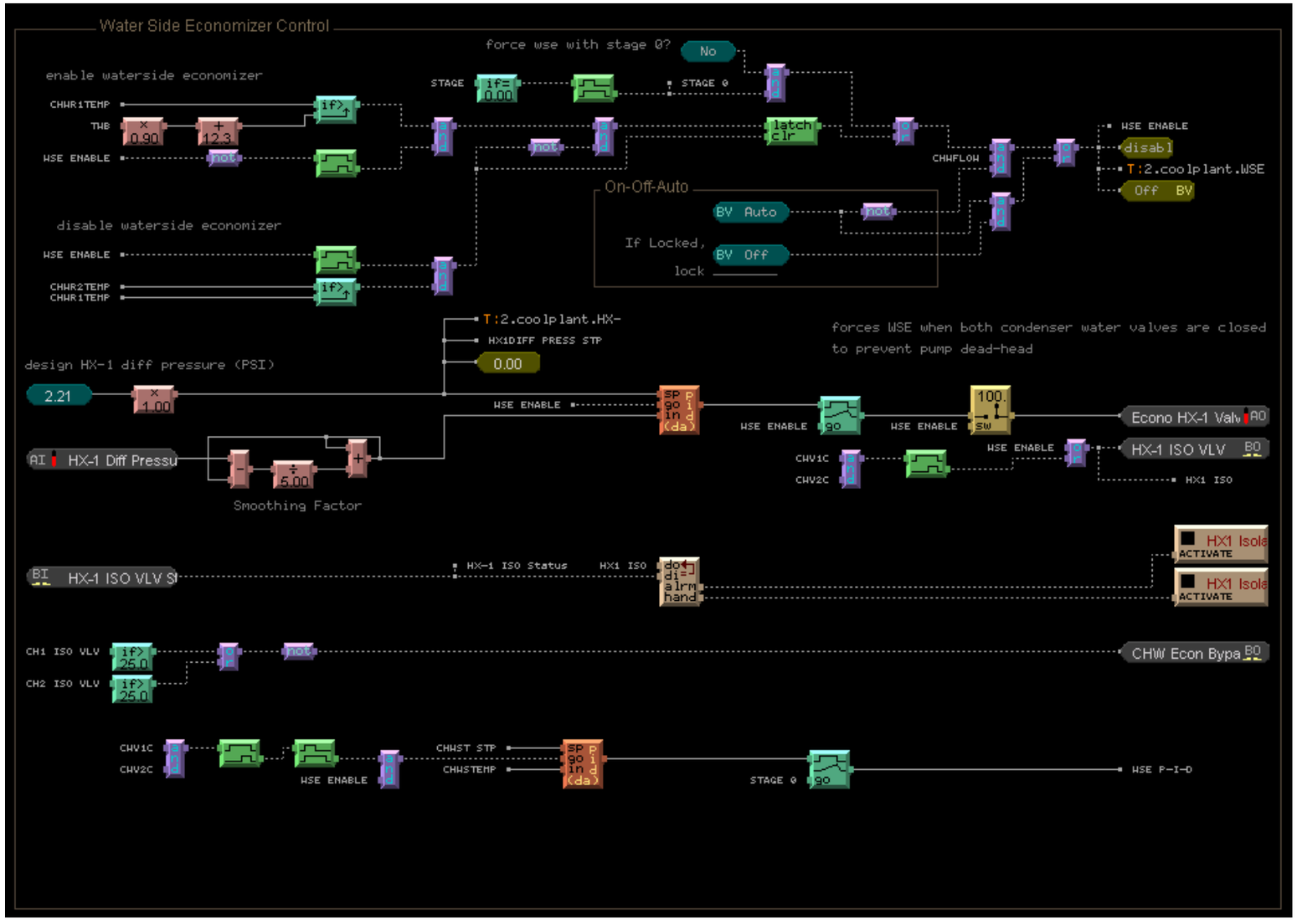
# Case study III

*Only one sequence or whole plant control?*

Approach

- Introduce case study specific edits to primary sequences
- Pick a sequence for conducting the verification test (e.g. WSE control)
- Implement sequence verification with trended data. The method is the same as used for the cooling valve verification example

ALC EIKON implementation of the WSE sequence



# Sequence translation tool

"modelica-json": parse control sequences written in Modelica to JSON, and from JSON to other format, such as html, to graphical rendering

- different parsing modes:
  - "cdl": ensure models following cdl syntax
  - "modelica": general modelica syntax

- graphical annotation
  - provide graphical layout for display in block diagram editors (Modelica or actual control platforms)
  - generate graphical diagram for inclusion in documentation (in svg format)
  - render both icon and diagram layer

```
block CustomPWithLimiter
  "Custom implementation of a P controller with variable output limiter"

  parameter Real k = 2 "Constant gain";

  Buildings.Controls.OBC.CDL.Interfaces.RealInput yMax "Maximum value of outp
    annotation (Placement(transformation(extent={{-140,20},{-100,60}})));

  Buildings.Controls.OBC.CDL.Interfaces.RealInput e "Control error"
    annotation (Placement(transformation(extent={{-140,-60},{-100,-20}})));

  Buildings.Controls.OBC.CDL.Interfaces.RealOutput y "Control signal"
    annotation (Placement(transformation(extent={{100,-10},{120,10}})));

  Buildings.Controls.OBC.CDL.Continuous.Gain gain(final k=k) "Constant gain"
    annotation (Placement(transformation(extent={{-60,-50},{-40,-30}})));

  Buildings.Controls.OBC.CDL.Continuous.Min minValue "Outputs the minimum of
    annotation (Placement(transformation(extent={{20,-10},{40,10}})));
equation
  connect(yMax, minValue.u1) annotation (
    Line(points={{-120,40},{-120,40},{-20,40},{-20, 6},{18,6}},
         color={0,0,127}));
  connect(e, gain.u) annotation (
    Line(points={{-120,-40},{-92,-40},{-62,-40}},
         color={0,0,127}));
  connect(gain.y, minValue.u2) annotation (
    Line(points={{-39,-40},{-20,-40},{-20,-6}, {18,-6}},
         color={0,0,127}));
  connect(minValue.y, y) annotation (
     Line(points={{41,0},{110,0}},
          color={0,0,127}));

  annotation (Documentation(info="<html>
<p>
Block that outputs <code>y = min(yMax, k*e)</code>,
where
<code>yMax</code> and <code>e</code> are real-valued input signals and
```

### 1. FromModelica.CustomPWithLimiter

Custom implementation of a P controller with variable output limiter

#### 1.1. Info

Block that outputs `y = min(yMax, k*e)`, where yMax and e are real-valued inp

#### 1.2. Parameters

It has the following parameters:

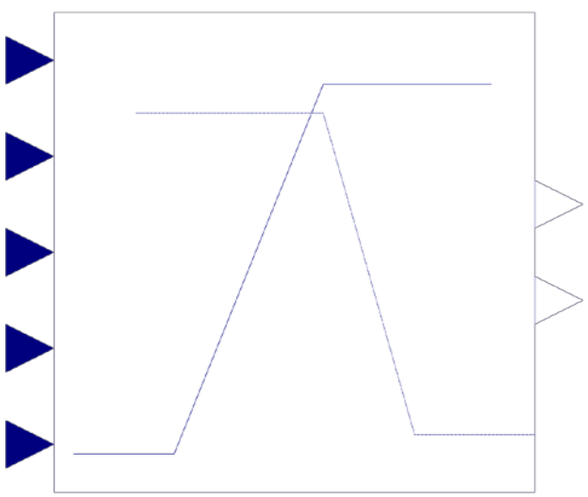
| Name | Description | Value | Unit | Display unit | Type | m |
|---|---|---|---|---|---|---|
| General | | | | | | |
| Parameters | | | | | | |
| k | Constant gain | 2 | | | Real | |

#### 1.3. Inputs

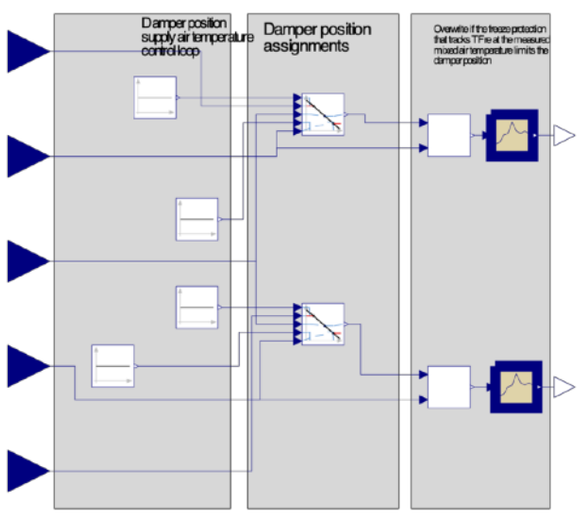
It has the following inputs:

| Type | Name | Description | min | max | Uni |
|---|---|---|---|---|---|
| Real | yMax | Maximum value of output signal | | | |
| Real | e | Control error | | | |

Icon



Diagram



# Update about commercialization plan (separate slides)