# 1 Operator interface creation using CoDeSys Visualisations

For the district heating system temperature of the boiler output must be kept as $T_{SV} = 120\ ^\circ C$. Inflow temperature is $T_{in} = 65\ ^\circ C$. Provide temperature control system if outflow of the system is a random value in the range of $F_{out} = [10 \dots 50]\ m^3/h$ and maximal power of the boiler is $P = 5\ MW$.

- Simulate the control process, calculate the power needed to keep outflow temperature level, provide controller realization.
  - with initial condition $F_{out} = 30\ m^3/h$ output of the controller is $u_o[\%] = 38\%$.
  - Assume good isolation of the boiler (no transfer into environment).
  - Assume that volume of the liquid inside boiler does not change $F_{in} = F_{out} = F$.
  - Steady-state of the process can be described as follows

$$\begin{cases} \frac{\mathrm{d}T}{\mathrm{d}t} = 0 \\ \rho V c_p \frac{\mathrm{d}T}{\mathrm{d}t} = P - F\rho c_p (T_{SV} - T_{in}) \end{cases},$$

  where $c_p = 4180\ \frac{J}{kg \cdot ^\circ C}$ is a heat capacity and $\rho = 1000\ \frac{kg}{m^3}$–liquid density.

1. Draw process components.
2. Visualize/indicate
   (a) Liquid Temperature;
   (b) Flows.
3. Provide
   (a) Numerical values of all important process parameters and necessary trends;
   (b) Used Power value using analog indicator $(0 \dots 10\ V)$ on the front panel of the PLC kit;
   (c) Possibility to manually change outflow value $F_{out}$ using potentiometer knob.
4. Provide alarm notifications
   (a) Two priority types
      i. low and high loads of the system ($F_{out} < 0.3F_{\max}$ or $F_{out} > 0.9F_{\max}$),
      ii. emergency shut down: ($F_{out} < 0.25F_{\max}$ or $F_{out} > 0.95F_{\max}$).

Use your knowledge about High Performance HMI.

✓ Create an interface.

✓ Demonstrate your work.

✓ Make changes if asked.

**Two parts of this work are evaluated separately: working algorithm on ABB PLC and HMI. Each in the range of $0 \dots 5$ points ($0 \dots 3$ with delay).**

# 2 Some notes

## Physical inputs and outputs

One of the tasks is to use Analog Output and Analog Input of the DA501 Module.

1. In the menu DA501 Configuration choose
   (a) Input 2 as Pt100(2-wire)
   (b) Output 0 as $-10 \dots +10\ V$.
2. For received/calculated signal scaling you need to know input/output ranges.
   Take a look at Measuring Ranges in DA501 help file. Download extended help for ABB controllers if needed ABB_help.
3. Select the right physical range of you equipment;
   - Find out the decimal Digital value (range) what will represent it.
   - Check what values represent Overflow and Underflow.

**Example 1** *Signal ranges*

If you use Output with range of $4 \dots 20\ mA$ then $4\ mA$ corresponds to 0; $20\ mA$ to 27648.
If given value is $> 32511$, then you have range overflow and $0\ mA$.

## Types Convertion

Do not forget to use right type of the variables!

Your analog inputs and outputs use INTeger type. If division operation is used, then result is REAL type.

Press F2 in the code window - select Convertion Operators - choose the right one.

**Example 2** *Types convertion*

$rT$ :=TRUNC(27648∗INT_TO_REAL(AI_1)/intRange);
where AI_1 is a Mapping for Analog Input 1.