OpenModelica Annual Workshop 2021

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BuildSysPro library on OpenModelica: a compatibility case study

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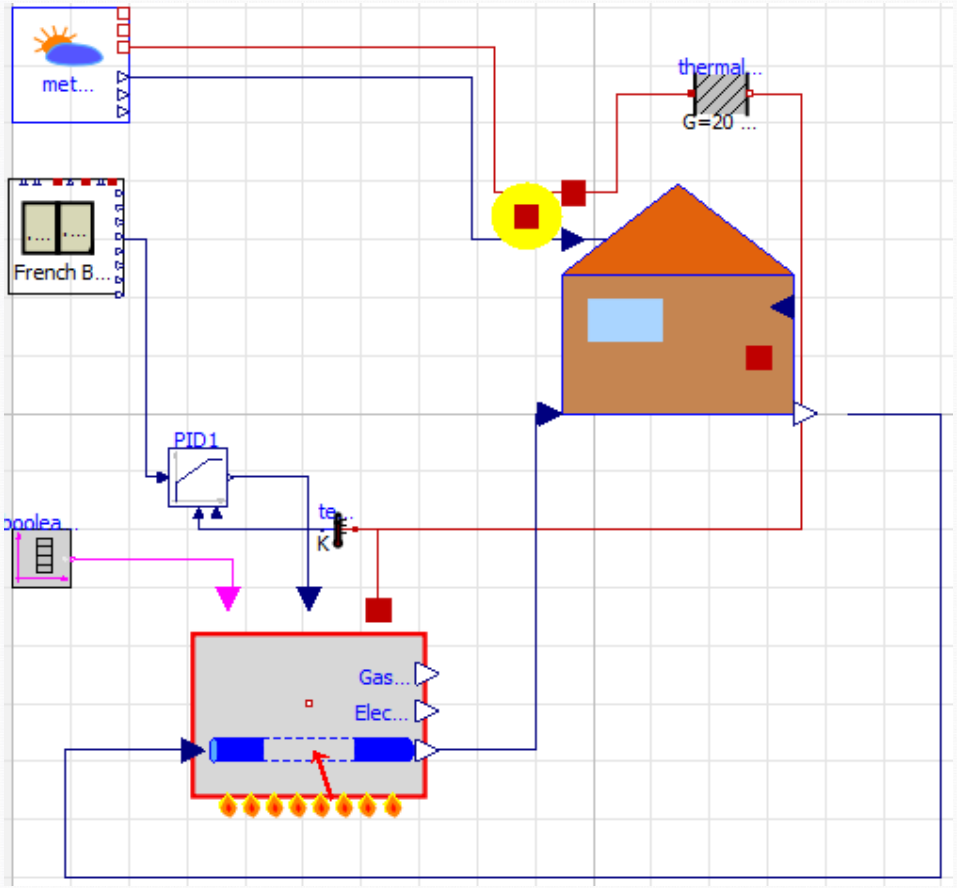
Background

- EDF developed two open source Modelica libraries: ThermoSysPro and **BuildSysPro**
- Make BuildSysPro accessible on OpenModelica
- **User point-of-view** who wants to use a library developed on Dymola on another Modelica tools => **library developers** impacts

Our methodology

- Use the example models of the library to:
  - detect incompatibilities
  - observe graphical difference
  - verify results consistency

- On OpenModelica 16.0 with BuildSysPro 3.3.0



OpenModelica tools

libraries.openmodelica.org/branches/master/BuildSysPro/BuildSysPro.html

BuildSysPro test using OpenModelica

Total	Frontend	Backend	SimCode	Templates	Compilation	Simulation	Verification
491	458	453	453	453	448	413	0

Total time taken: 1:52:34

System info: Intel(R) Core(TM) i7-6900K CPU @ 3.20GHz, 126 GB RAM, Ubuntu 18.04.5 LTS

OpenModelica Version: OMCompiler v1.17.0-dev.353+g116b44059e

Test started: 2021-01-20 22:58:08

Tested Library: 3.4.0

Links are provided if getErrorString() or the simulation generates output. The links are coded with red if there were errors, yellow if there were warnings, and normal links if there are only notifications.

Model	Verified	Simulate	Total buildModel	Parsing	Frontend	Backend	SimCode	Templates	Compile
BuildSysPro.BaseClasses.HeatTransfer.Examples.ValidationLWRLinear (sim)		2.94	3.34	3.18	0.15	0.11	0.03	0.06	2.99
BuildSysPro.BoundaryConditions.Scenarios.Examples.ComparisonDHWScenario (sim)		3.13	2.77	3.13	0.14	0.04	0.02	0.06	2.52
BuildSysPro.BoundaryConditions.Scenarios.Examples.StepFunctionExample (sim)		0.28	2.84	3.11	0.14	0.03	0.01	0.03	2.63
BuildSysPro.BoundaryConditions.Scenarios.ScenarioAliquote (sim)		0.02	2.59	3.22	0.15	0.02	0.01	0.03	2.37
BuildSysPro.Building.BuildingEnvelope.HeatTransfer.Examples.DynamicTestLightedWall		0.00	0.94	3.33	0.17	0.21	0.37	0.08	0.12
BuildSysPro.Building.BuildingEnvelope.HeatTransfer.Examples.IlluminanceExample (sim)		13.74	4.55	3.09	0.18	0.23	0.46	0.09	3.59
BuildSysPro.Building.BuildingEnvelope.HeatTransfer.Examples.WindowExample (sim)		2.06	3.57	3.18	0.18	0.16	0.03	0.07	3.13
BuildSysPro.Building.Examples.HeatRecoveryVentilation (sim)		0.03	2.61	3.23	0.14	0.02	0.01	0.02	2.42
BuildSysPro.Building.Examples.OneZone		0.00	2.58	3.51	0.31	1.67	0.11	0.32	0.17
BuildSysPro.Building.Examples.TestZoneNWalls		0.00	0.36	3.24	0.36	0.00	0.00	0.00	0.00

Libraries referenced on openmodelica.org are tested and a verification report is accessible online

+ Page *"Writing libraries compliant to the Modelica specification"*
trac.openmodelica.org/OpenModelica/wiki/WritingCompliantLibraries

Some code incompatibilities

Variable declaration of a function

```
function CalculPs "Compute the saturation pressure"
    parameter Real Tmin=273.16;
    parameter Real Tmax=647.3;
    output Real ps;
    input Real T;

protected
    Real tk;

algorithm
    tk:=min(Tmax,max(Tmin,T));
    ps:=exp(a/tk + b*log(tk) + c*tk + d);

end CalculPs;
```

Accepted by Dymola,
understandable by a user
BUT
not Modelica standard,
error in OpenModelica

Some code incompatibilities

Modelica_LinearSystems2

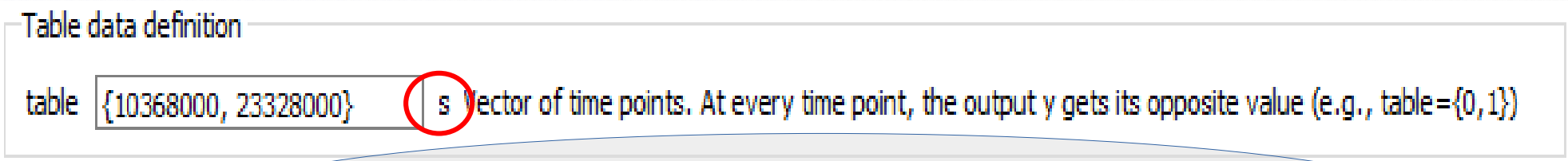
```
parameter Modelica.Units.SI.Time sampleTime = 1
```

corrected in Modelica_LinearSystems2 by

```
parameter Modelica.SIunits.Time sampleTime = 1
```

Only Dymola-compatible library

Modelica.Blocks.Sources.BooleanTable

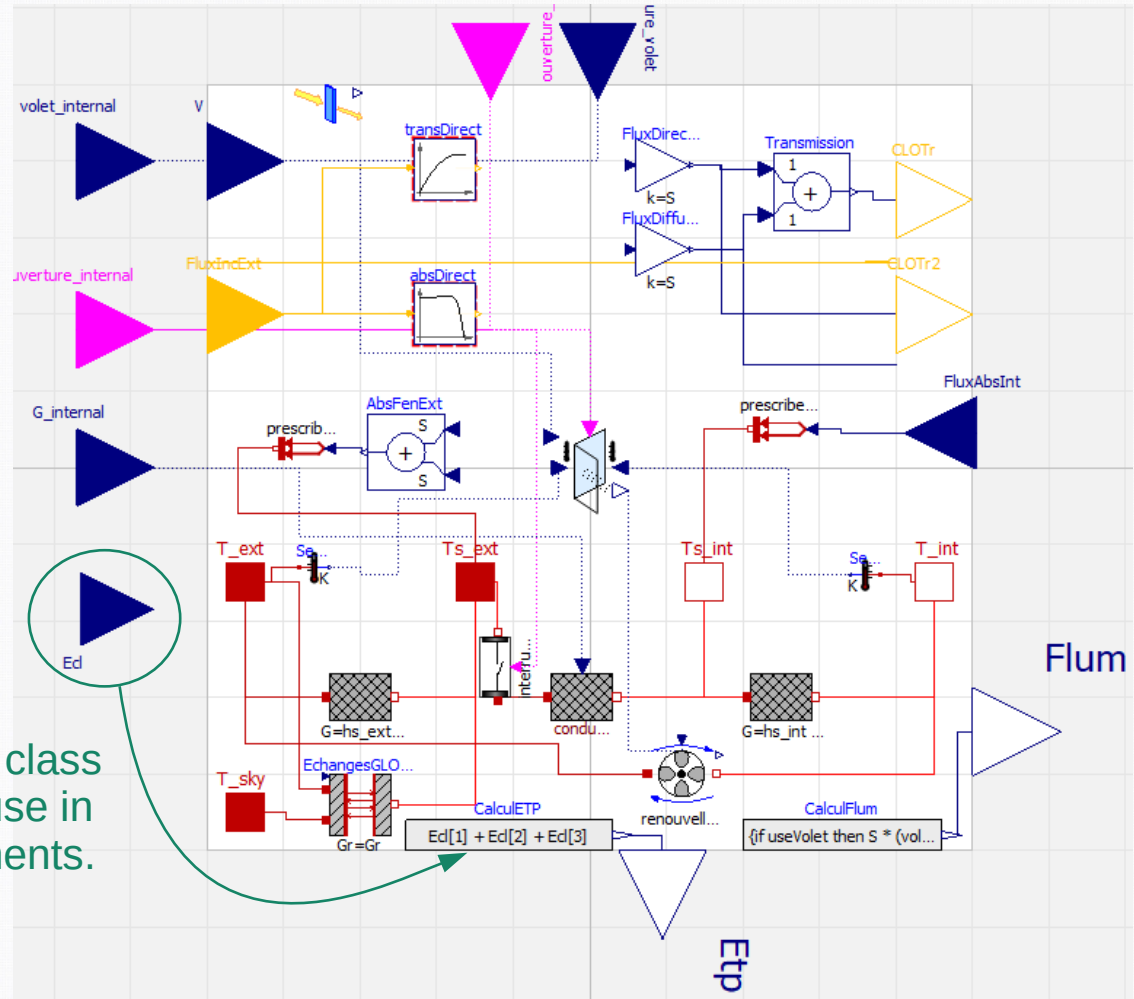


Dymola allows to change unit and save it as “displayUnit=” in the code but that gives error message in Open Modelica

Some code incompatibilities

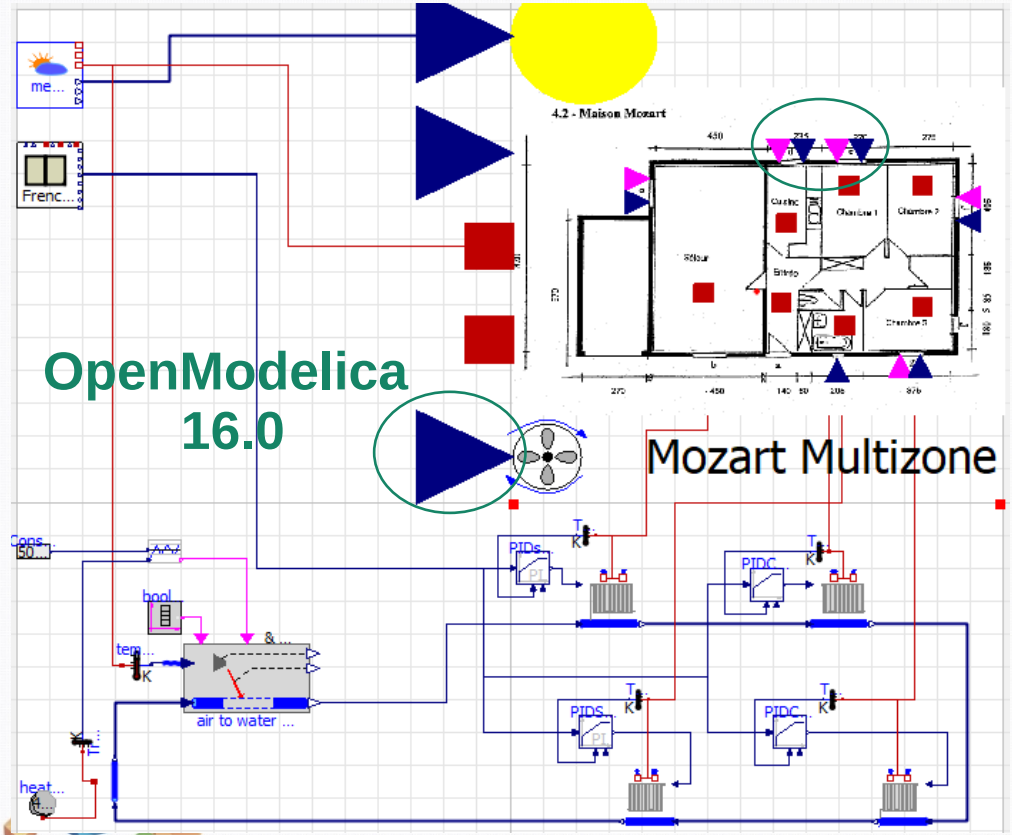
Conditional classes

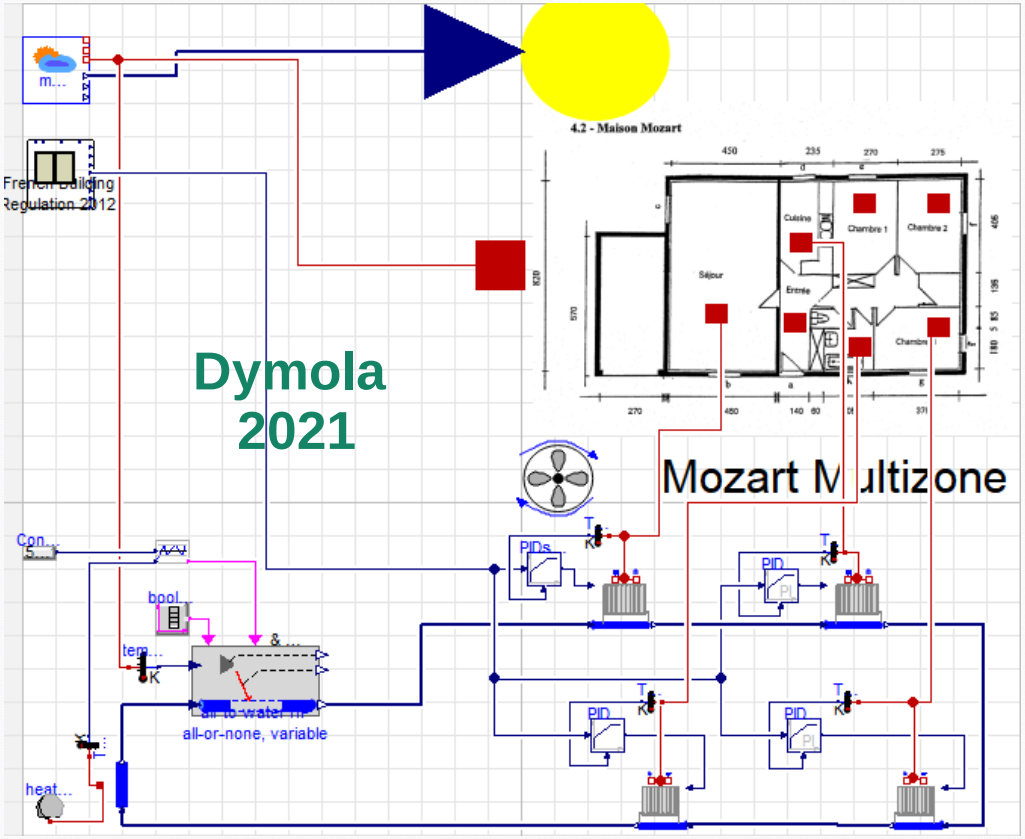
Accepted by Dymola,
understandable by a user
BUT
not Modelica standard,
warning on OpenModelica,
error on Modelon Impact



Ecl is a conditional class that shall be only use in connection statements.

Some graphic interface differences?



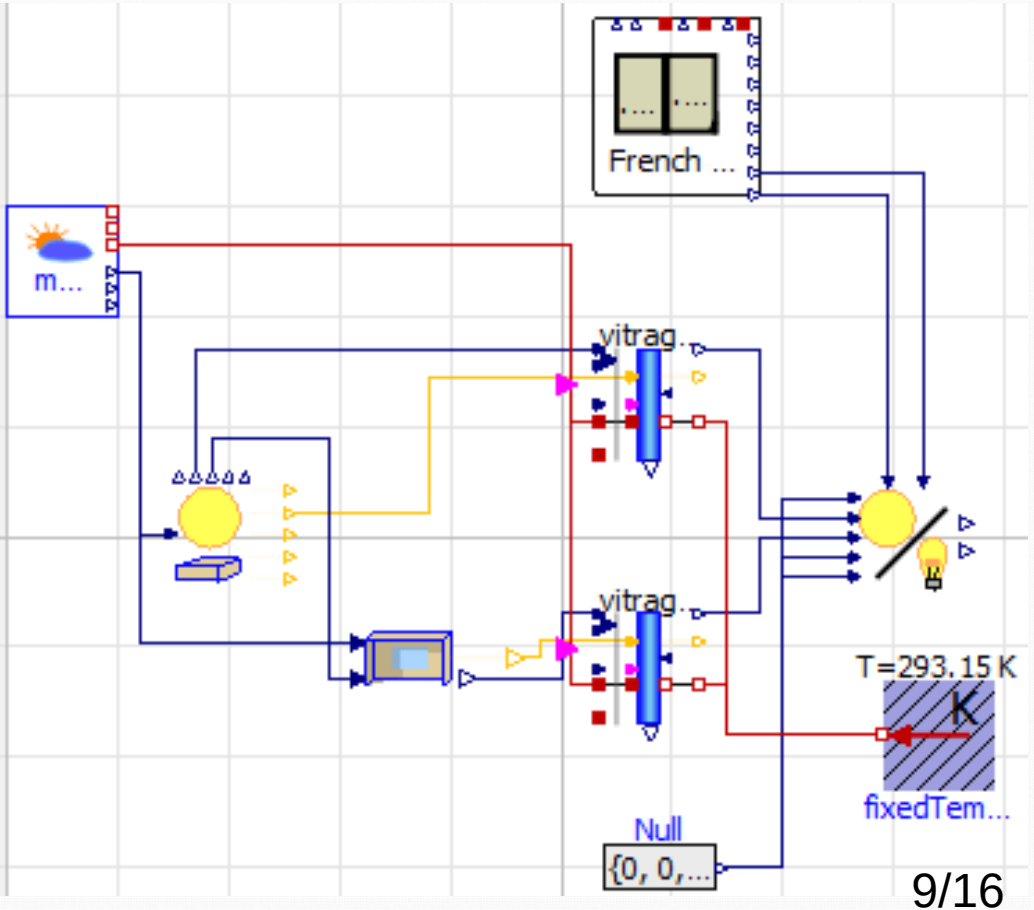


Except concerning conditional classes, a final user on OpenModelica sees the graphic interface the model developer has created.

Results consistency

BuildSysPro.Building.BuildingEnvelope.
HeatTransfer.Examples.IlluminanceExample

Two windows lighting a room
Assessment of electric lighting needed
following french regulations

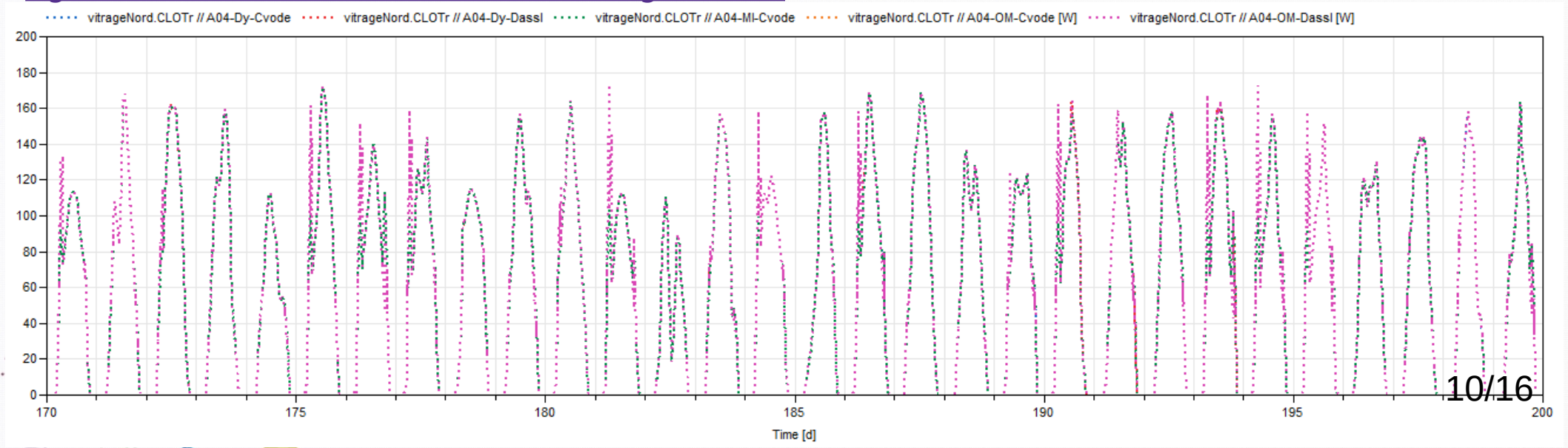


Results consistency

Observation on dynamic representation and overall key indicator: insignificant gap

Lighting electric consumption [kWh]	
OpenModelica-Dassl	323,47
OpenModelica-Cvode	323,44
Dymola-Dassl	323,46
Dymola-Cvode	323,45
ModelonImpact-Cvode	323,45

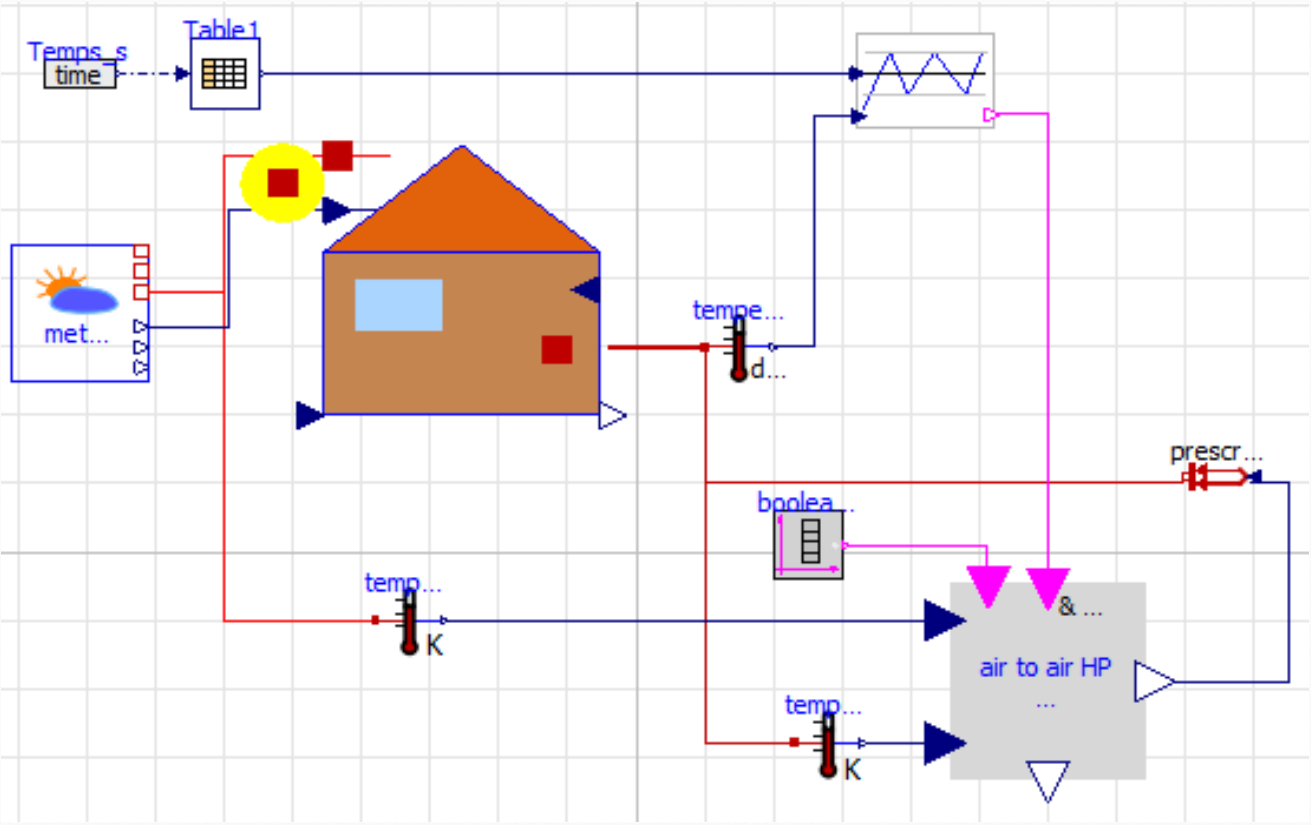
Light transmission [W] (North window) during 1 month



Results consistency

BuildSysPro.Building.BuildingEnvelope.HeatTransfer.Examples.IlluminanceExample

Low energy building
Air conditioner for heating only
On/off closed loop control
Simulation for 1 year



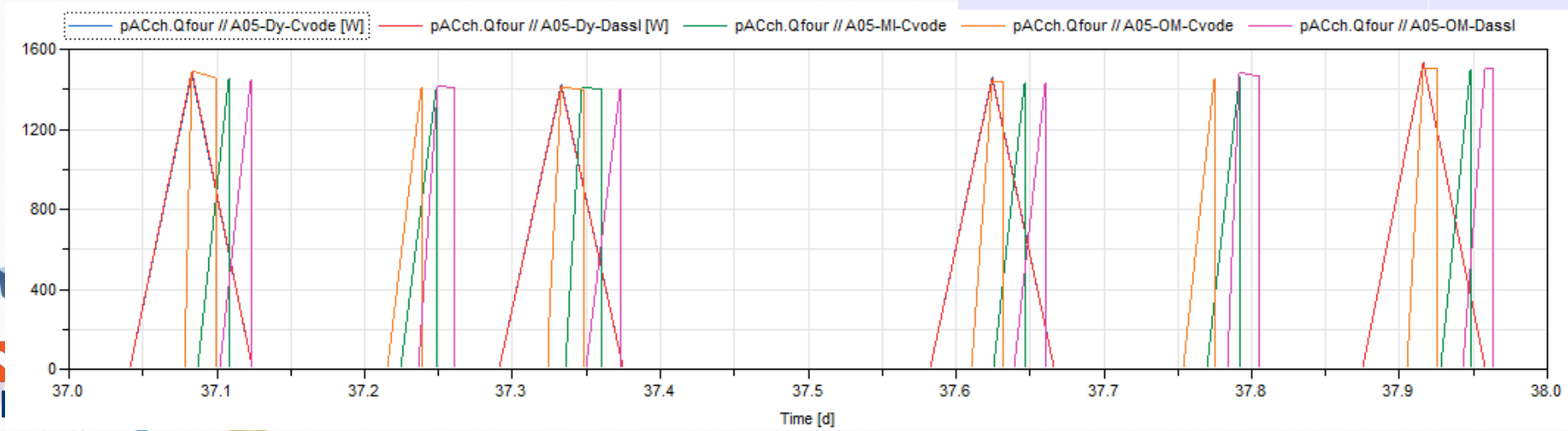
Results consistency

About dynamic, closed loop control leads some time shift. Correct for an annual observation.

Max 0,81 % gap on the annual consumption.

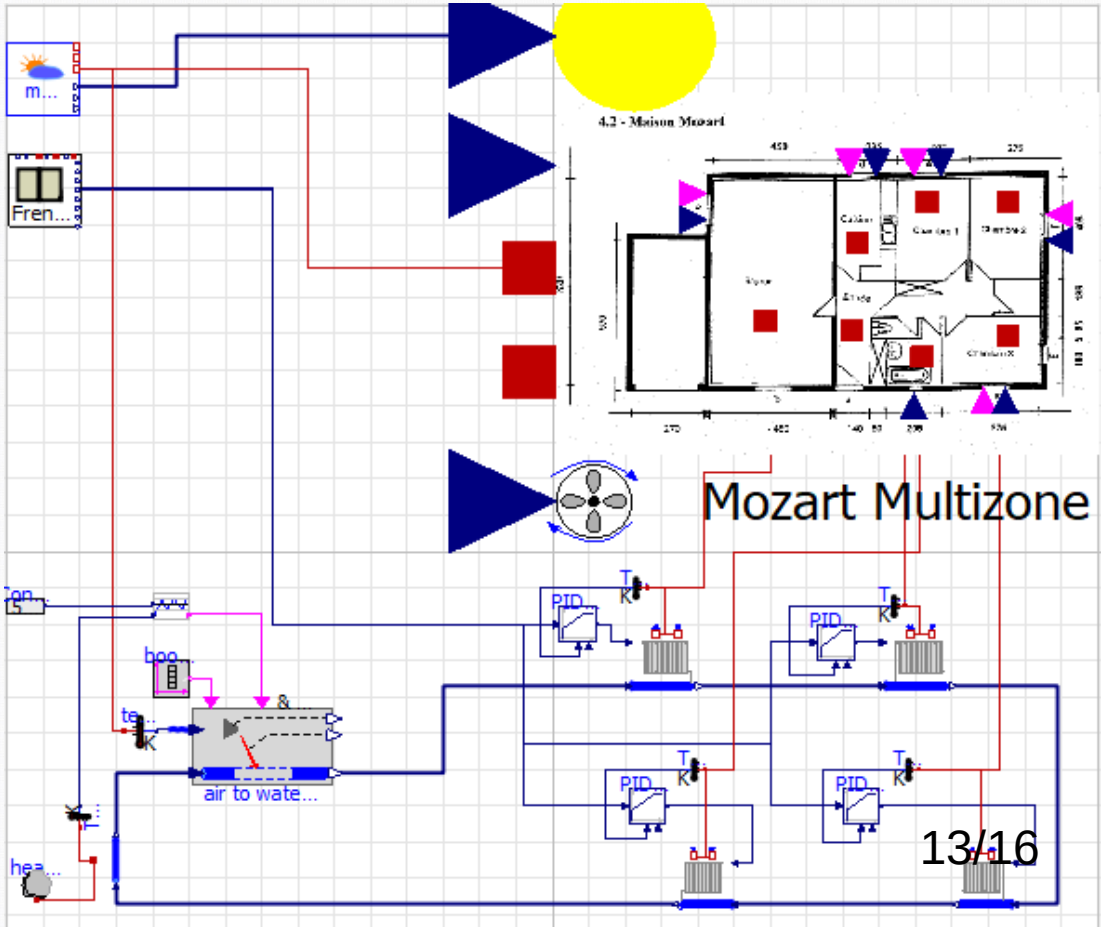
Conditioner electric consumption for heating [kWh]	
OpenModelica-Dassl	166,0
OpenModelica-Cvode	166,4
Dymola-Dassl	167,3
Dymola-Cvode	167,2
ModelonImpact-Cvode	166,0

Air conditioner heating power [W] during 1 day



Results consistency

A new model developed to represent a more complex case:
- seven-rooms house
- four hot water heaters with PI controller
- hydraulic distribution network
- on/off air-to-water heat pump with 50°C$^{+/-3}$ control



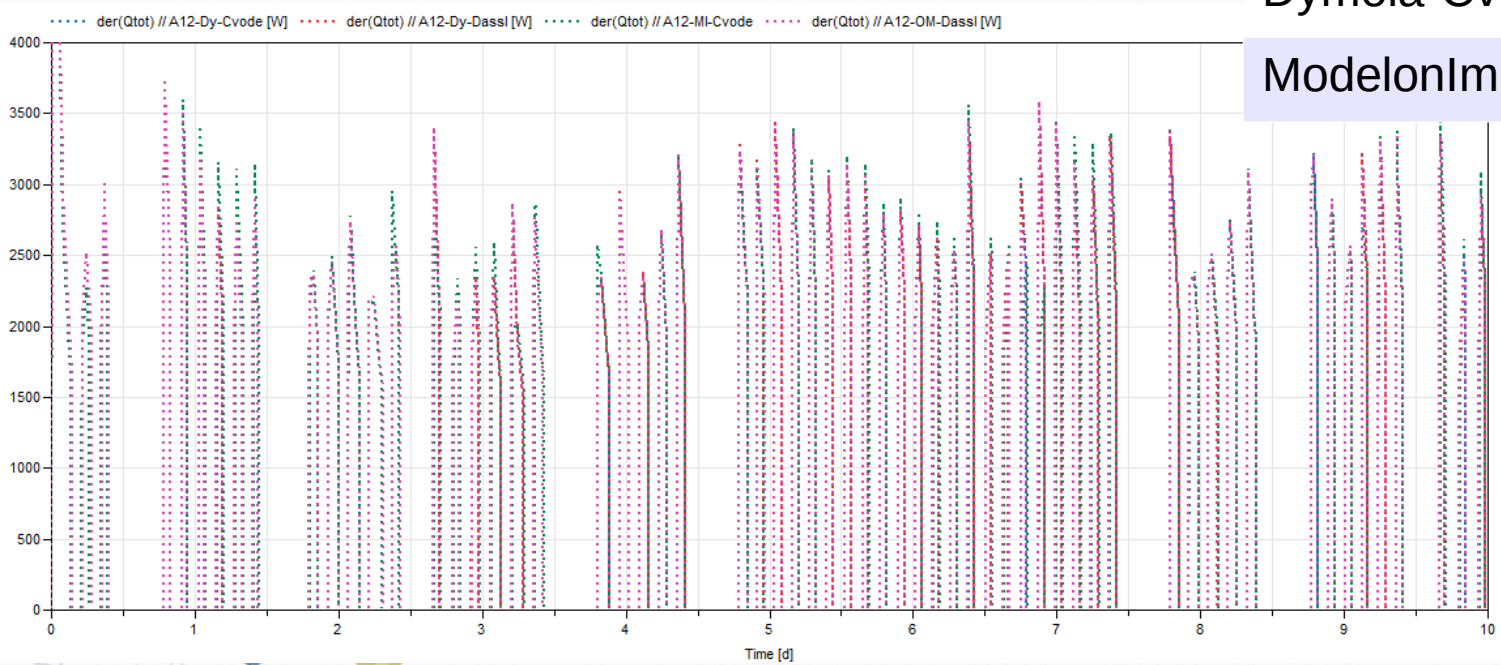
Results consistency

For a complex (multi-control/dynamic/physics) model, the gaps are still very limited.

Heat pump electric consumption for heating [kWh]	
OpenModelica-Dassl	1030,3
OpenModelica-Cvode	-
Dymola-Dassl	1030,2
Dymola-Cvode	1030,2
ModelonImpact-Cvode	1028,8

Max 0.15% difference

Heat pump heating power [W] during 10 days



Conclusion

Modelica is a non-proprietary equation based language used in several modeling tools.

Those modeling tools allows different flexibility levels with Modelica standard that could create some incompatibilities.

Modelica standard is and needs to remain an under-development language. The tools offered some flexibility to facilitate the modeling and simulation. It should not be restricted. It may be useful that those extra-features can be saved outside the Modelica code.

On this study, 12 BuildSysPro models have been simulated with very good results consistency (<0.5%). The highest gap (1.7%) was on two solvers from a same modeling tool. The results consistency is not related to the tools but to the solver implementation.

Thank you for your time