

BIM/GIS and Modelica Framework  
for  
building and community energy system  
design and operation

Task 1

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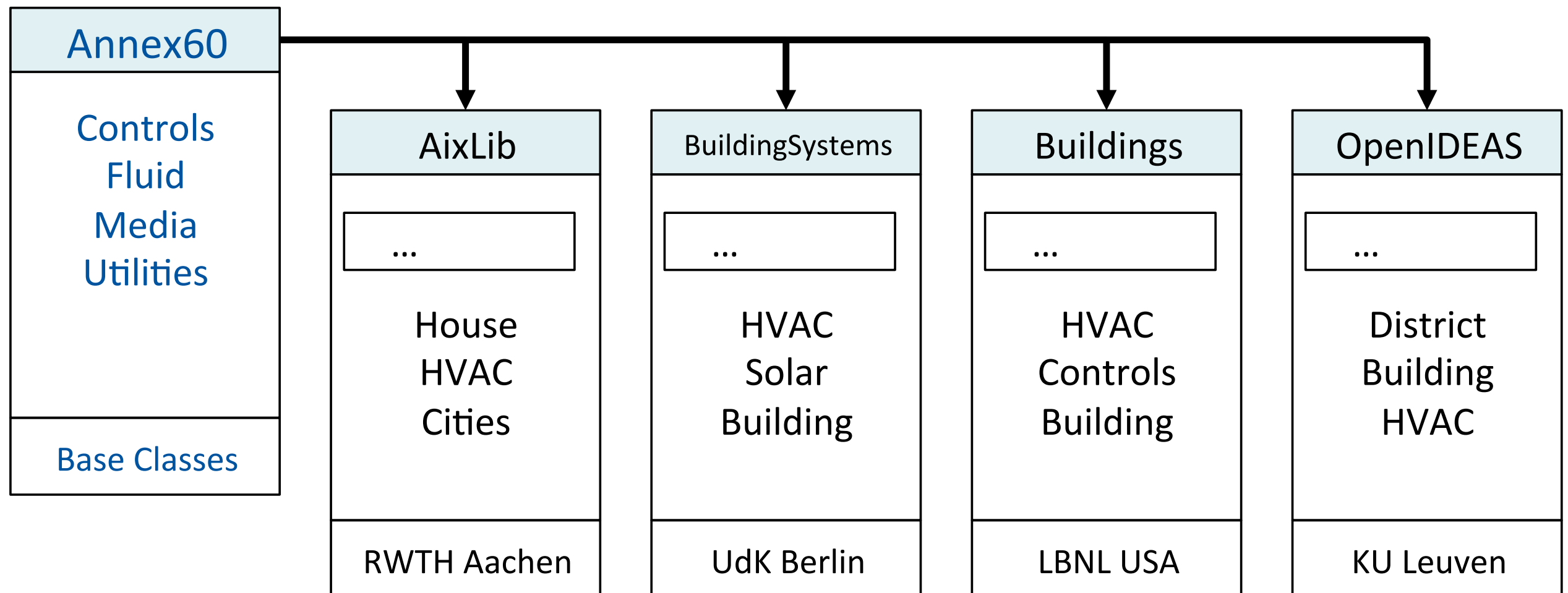
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# Activity 1.1- Modelica library

## Scope

Scope:

Develop and distribute a well documented, vetted and validated open-source Modelica library that serves as the core of future building simulation programs.



# Modelica libraries for design and operation (WP 1.1); and for Model Predictive Control (WP 1.2)

## Modelica IBPSA library

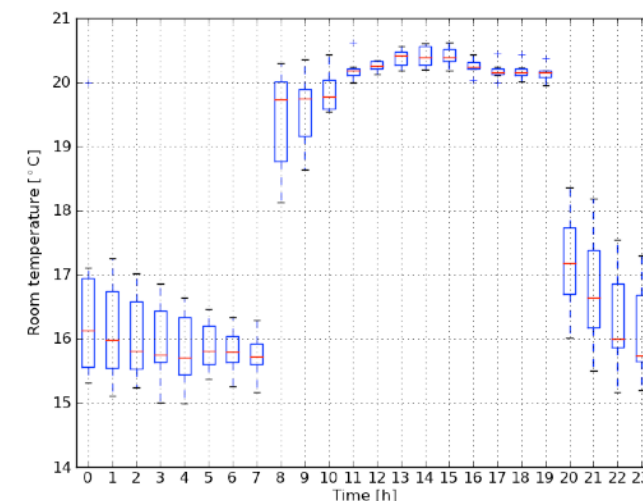
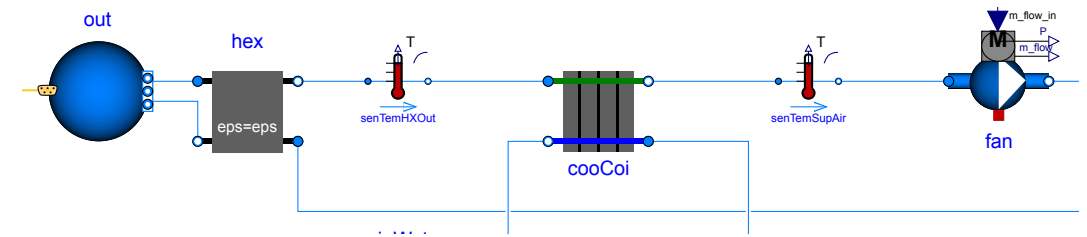
Continue and expand collaboration from Annex 60, Activity 1.1

Restructure library into IBPSA.Air and IBPSA.Water for more intuitive use.

Work on scalability to large system models.

Add

- components (borefield, combined heat and power, absorption chiller, ...)
- template HVAC systems
- control sequences



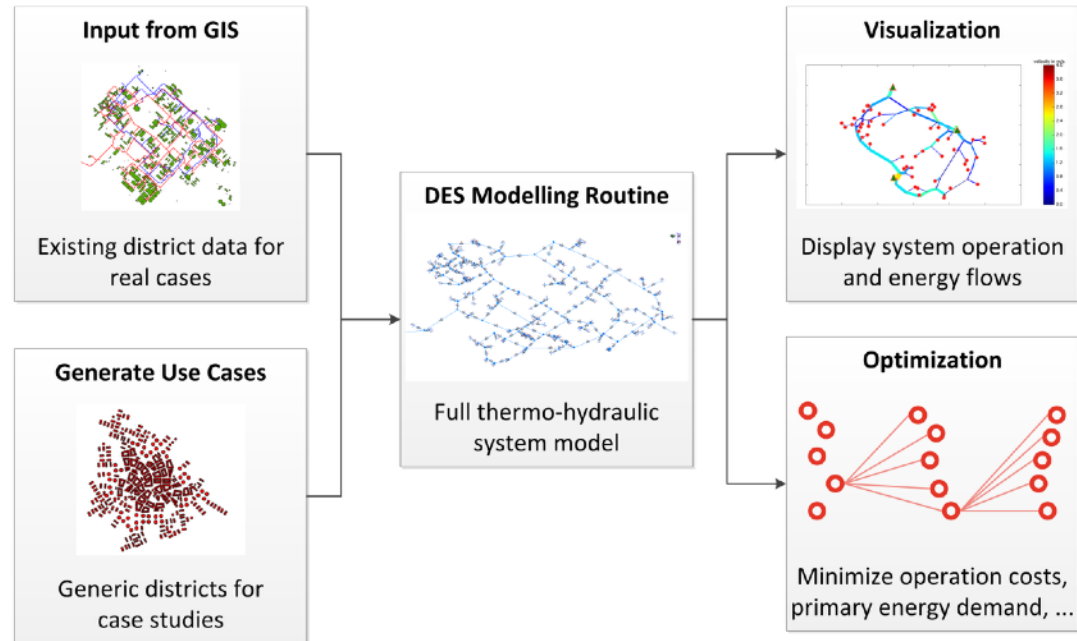
# Activity 1.1- Modelica library

## Approach

- **standardize** how component and system models are **represented**, both as data-model and as mathematical models that formalize the physics, dynamics and control algorithms,
- agree upon the **physics** that should be included in components for whole building simulation
- Conduct distributed development through <https://github.com/ibpsa/modelica-ibpsa>, following style guide at <https://github.com/ibpsa/modelica-ibpsa/wiki>

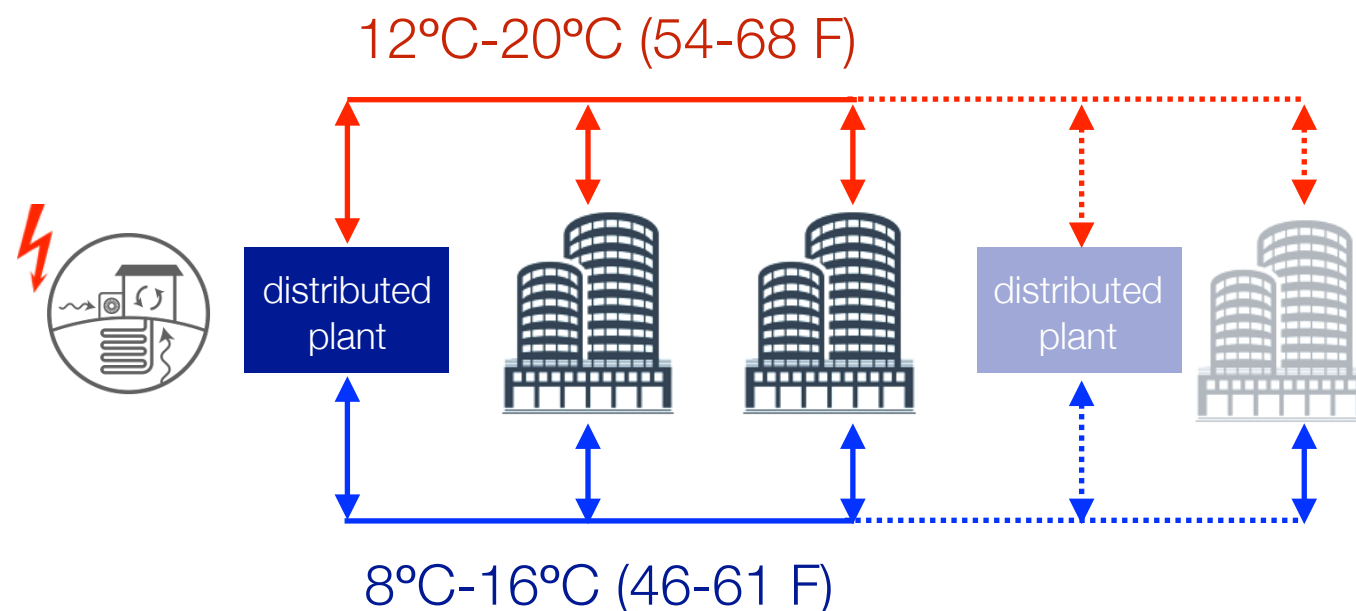
# Selection of use cases

# District energy systems — building tools needed by urban developers and cities to prioritize investment and policy decisions



Source: RWTH Aachen

GIS to Modelica for performance analysis, visualization and optimization of district energy systems.



Analysis of novel, modular extensible energy networks with decentralized energy hubs and bi-directional flow networks that share heating, cooling and waste heat among energy hubs and buildings.

Source: LBNL

# Spawn of EnergyPlus — Modularize EnergyPlus based on open standards to address complexity of design & operation



Links design and operation

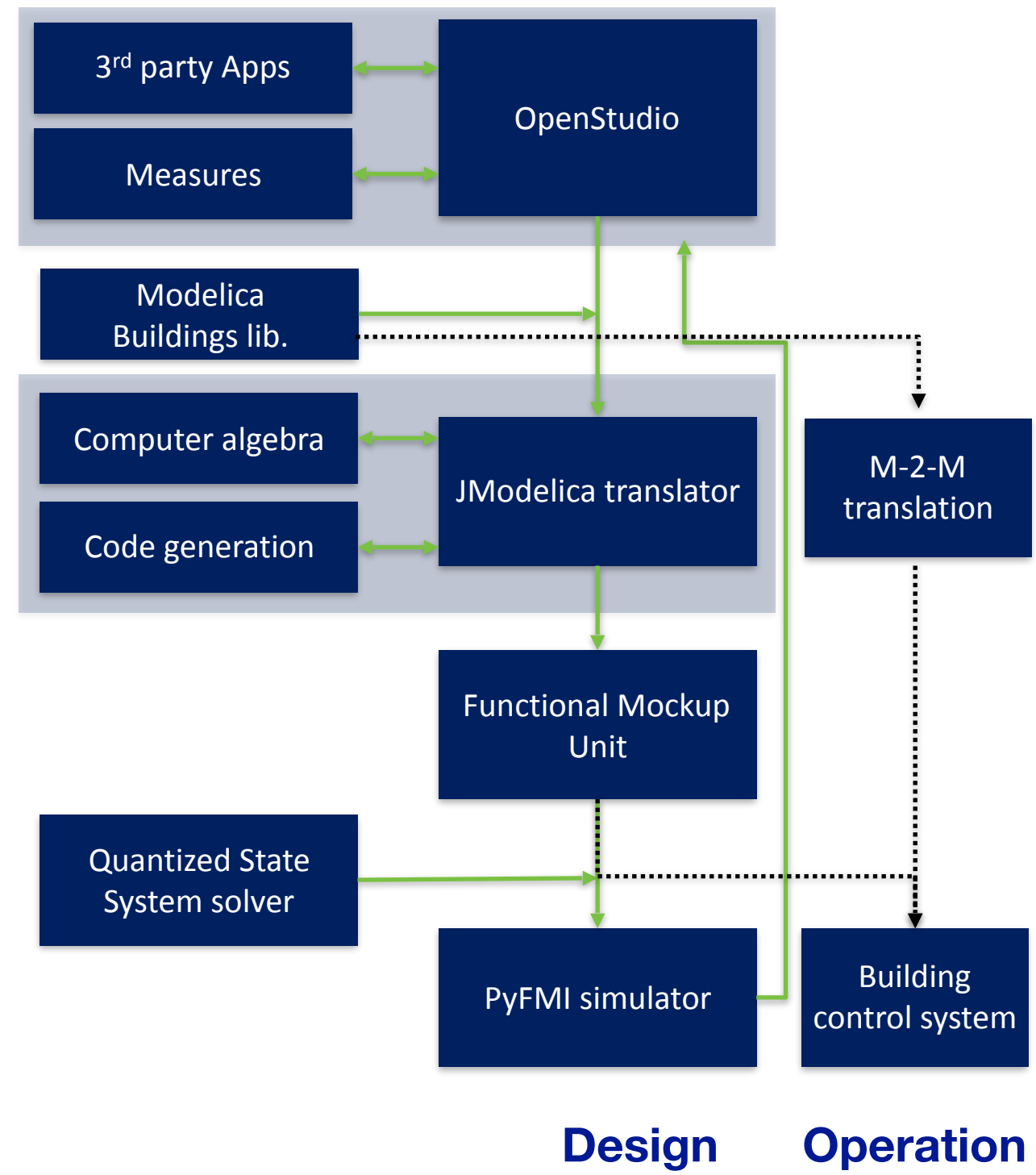
Supports insertion of custom models and computing modules

Inter-operability with control workflows and product development

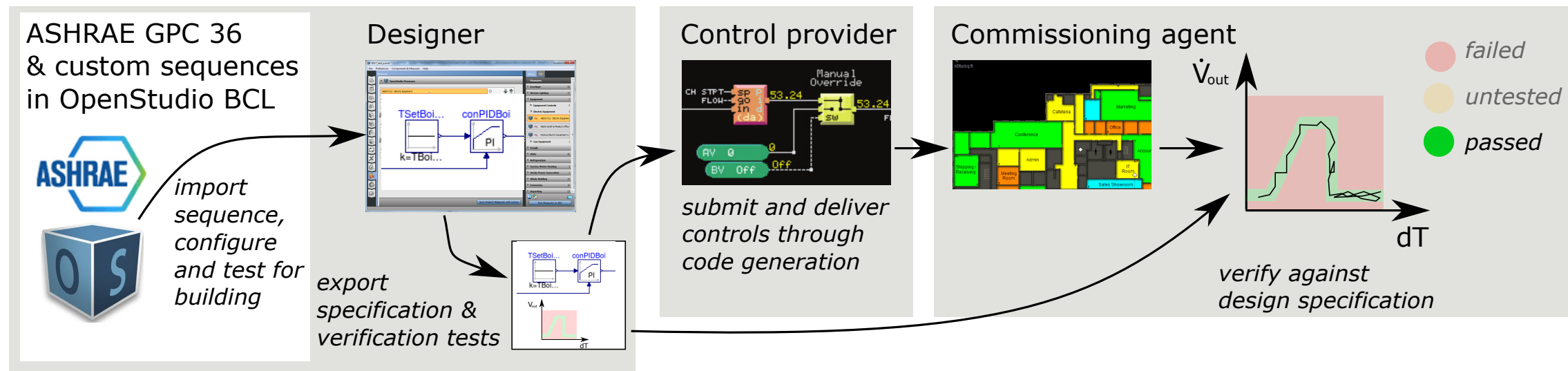
Reduces technology lag

Built on open standards (Modelica and FMI)

Modular design allows component-wise upgrades



# OpenBuildingControl — Design and implement control sequences error-free and at lower cost to owner



Codify best practice

Design

Implement

Verify against original design intent

**BACnet** standardizes communication.

**OpenBuildingControl** will standardize

- basic functional building blocks that are used to compose sequences and tests,
  - expressing control sequences,
  - expressing functional verification tests,
- for bidding, automatic implementation and automated functional testing.



# Key requirements for all of these uses cases

Robust, comprehensible library.

Good, well tested and robust template models.

Ability to generate system models from third party applications

- BIM/GIS
- OpenStudio
- Schematic diagram editors

# Modelica libraries for design and operation (WP 1.1)

## How to contribute

Follow the style guide and the workflow for code changes on <https://github.com/ibpsa/modelica-ibpsa/wiki>

In summary:

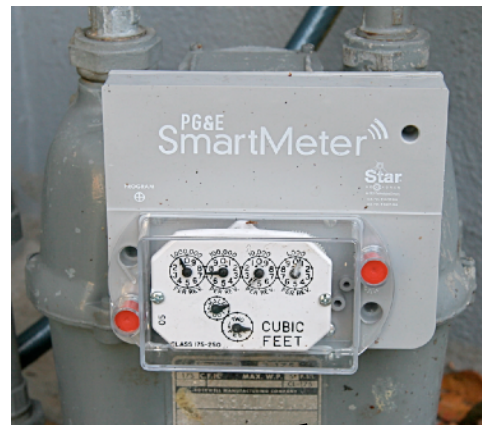
- Additions are done if they are useful for typical users — no experimental code will be released.
- Discussions will be done primarily through the issue tracker and conference calls.
- Each feature needs a validation test.
- Every class needs documentation.
- Follow the style guide.
- All code must be reviewed and approved by a core developer.
- All development happens on development branches  
(the master branch must always be ready for release, or for others to base their library on).

# WP 1.2: Modelica approaches and library for MPC

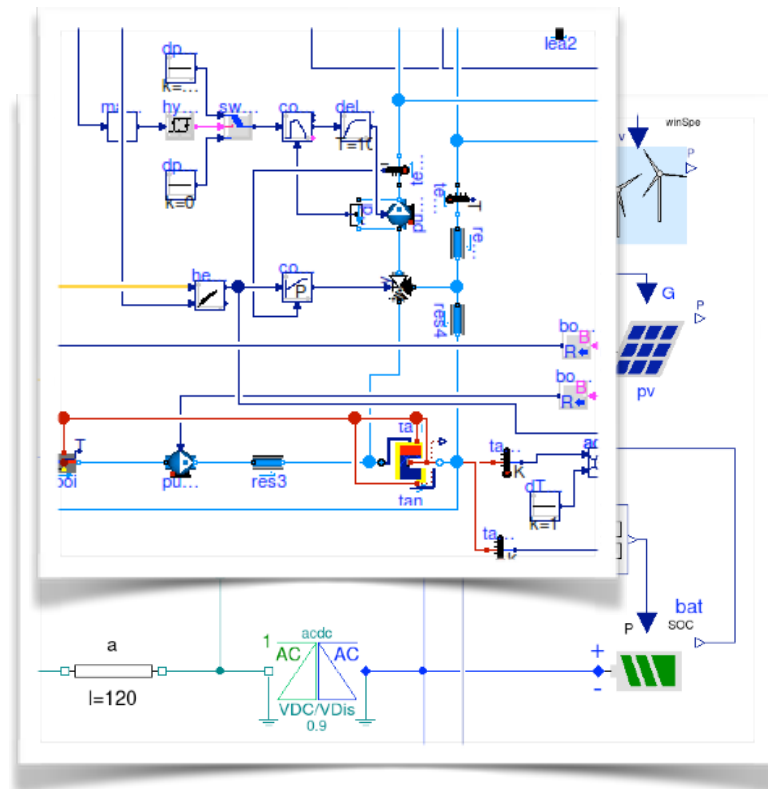
Goal:

Enable MPC for buildings and district energy systems at scale.

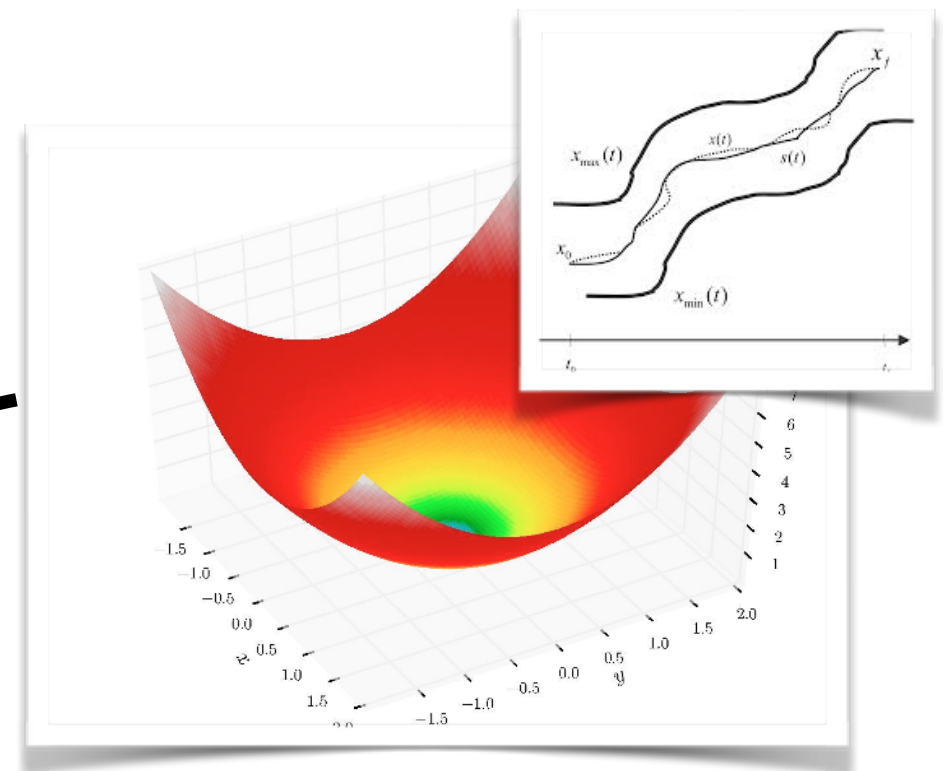
Data streams



Repository of models



Repository of optimization algorithms



Framework for  
combining models  
and optimization



# WP 1.2: Modelica approaches and library for MPC

New activity that emerged from Annex 60 collaboration.

## Key questions

1. How to best conduct MPC for building and district energy systems, and for providing services to the electrical grid, in a way that scales industry-wide.
  1. Linear, piece-wise linear, non-linear?
  2. If design model is present, how can it be reused?
  3. White-box, grey-box, black-box model?
  4. Deterministic vs stochastic optimization?
  5. How to conduct state and parameter identification?
2. How to encode models in a library that supports 1)?
3. How to develop frameworks that allow 1)?
4. How to benchmark different approaches — need “BESTEST” for MPC that covers set up requirements, model identification and MPC.

?