# Use of Weather and Occupancy Forecasts for Optimal Building Climate Control
(*OptiControl*)

## Project Presentation

The OptiControl Team

http://www.opticontrol.ethz.ch/

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# *OptiControl* – Overview

**Aims:**

Development of methods to exploit weather forecasts and occupancy-related information aiming at

- improving the energy efficiency and comfort of buildings;
- reducing peak electricity demand.

**Expected Results:**

- Methods
- Software/tools
- Benefit-cost analyses
- Application to demonstrator

# *OptiControl* – Approach

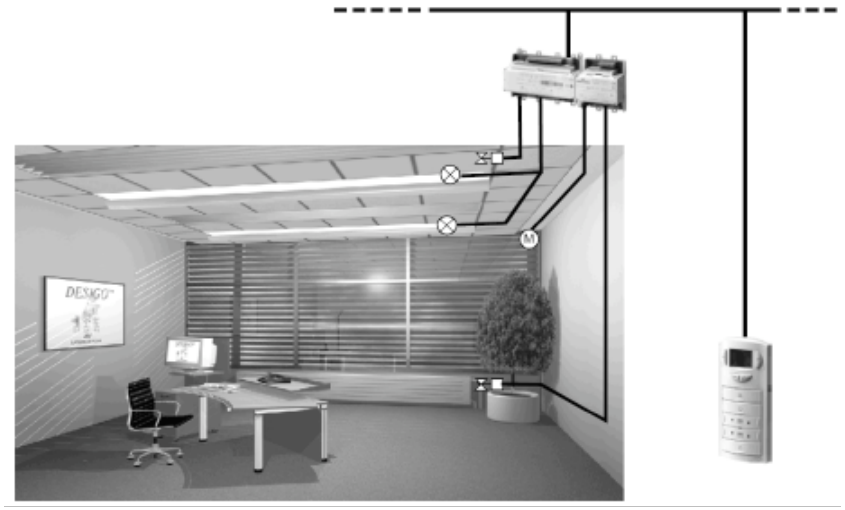
- **Case studies**
  (Selected “Applications”, typical buildings, representative sites etc.)
- Extensive use of **computer-based modeling & simulation**
  (Controller development, potential assessment, tests etc.)
- Emphasis on **Model Predictive Control** (MPC)
- **Stepwise refinement & simplification** of methods and models
- **Field tests** of the new control approaches in demonstrator object(s)

# *OptiControl* – Research Partners

- **ETH Systems Ecology Group**
  Modeling and simulation; project management
- **ETH Institut für Automatik**
  Control theory; controller development & tools
- **EMPA Building Technologies Laboratory**
  Building physics, HVAC & energy systems, modeling, field tests
- **MeteoSwiss**
  Meteorological data and predictions (Europe–local)
- **Siemens Building Technologies**
  BAC research and product development

# *OptiControl* "Applications"

1. **Integrated Room Automation** (IRA)



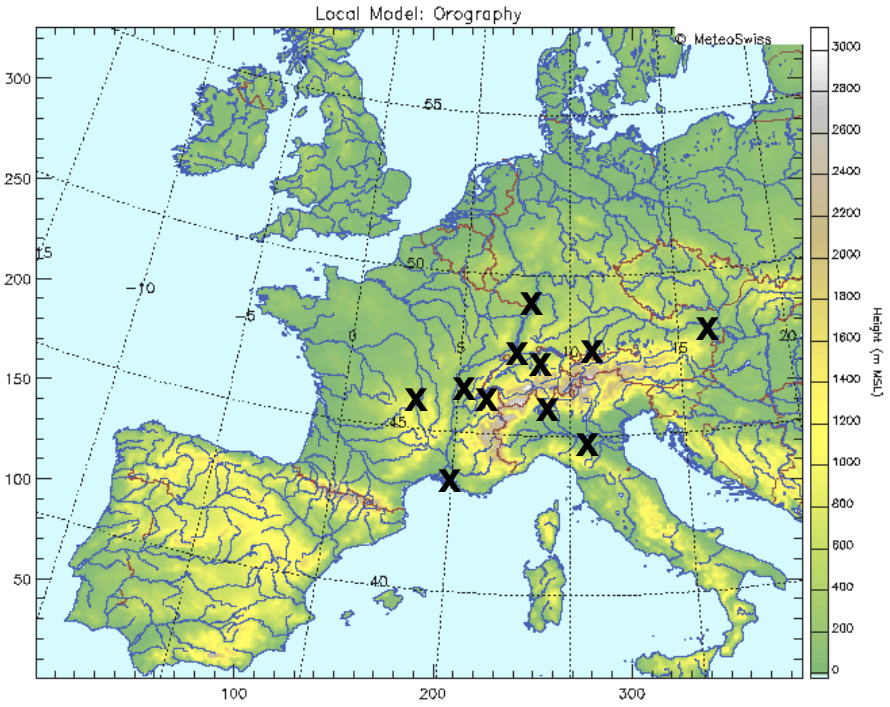
Integrated automation of
light, blind, heating, cooling and
ventilation

(including TABS and floor heating
subsystem variants)

In preparation:

2. **Cooling by night-time ventilation**
3. **Energy Recovery**
4. **Generic Energy Flux Control**

# Case Study Sites




Zürich

Basel-Binningen

Genève-Cointrin

Lugano

Modena

Marseille-Marignane

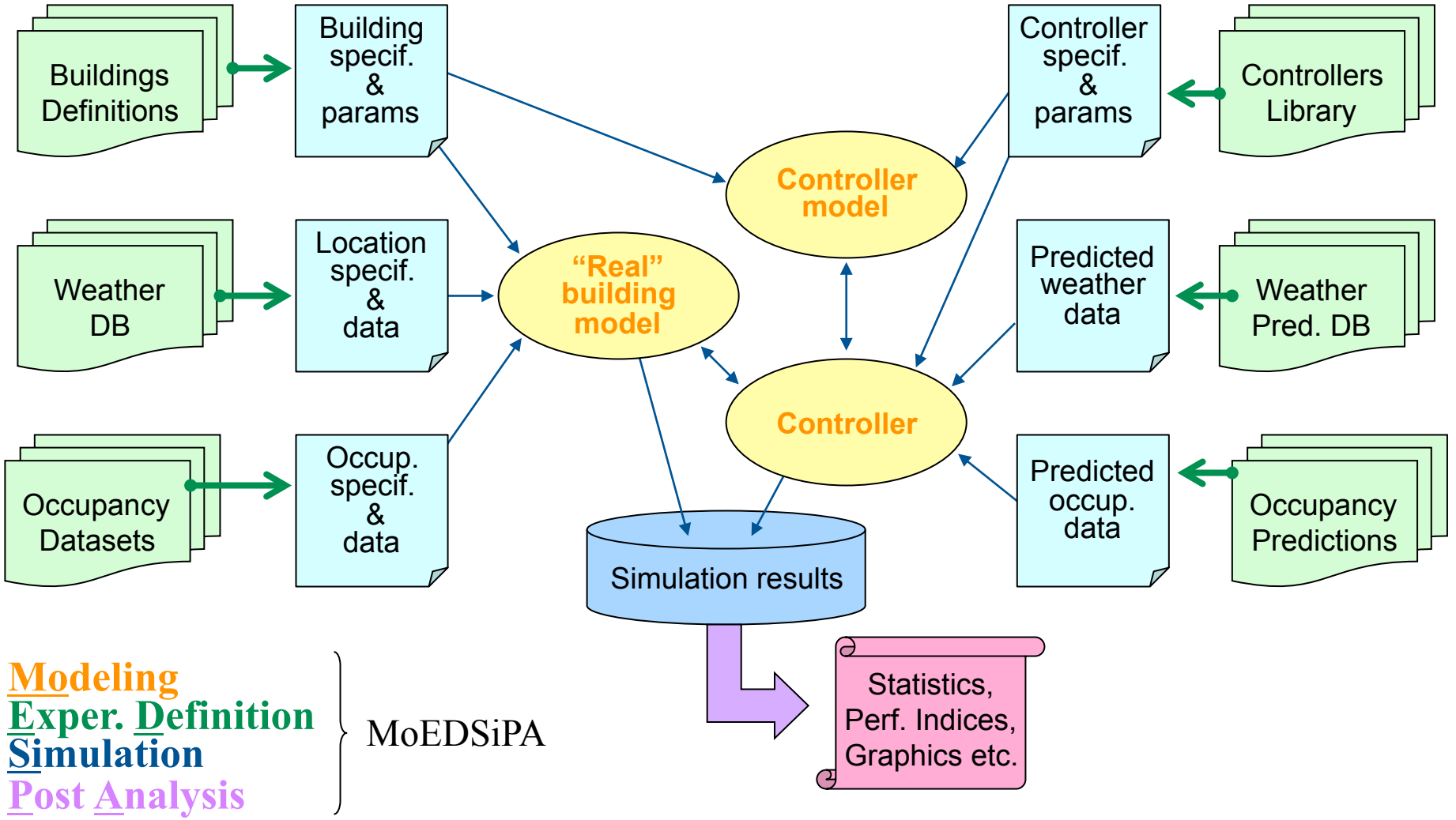
Clermont-Ferrand

Mannheim

Hohenpeissenberg

Wien Hohe Warte

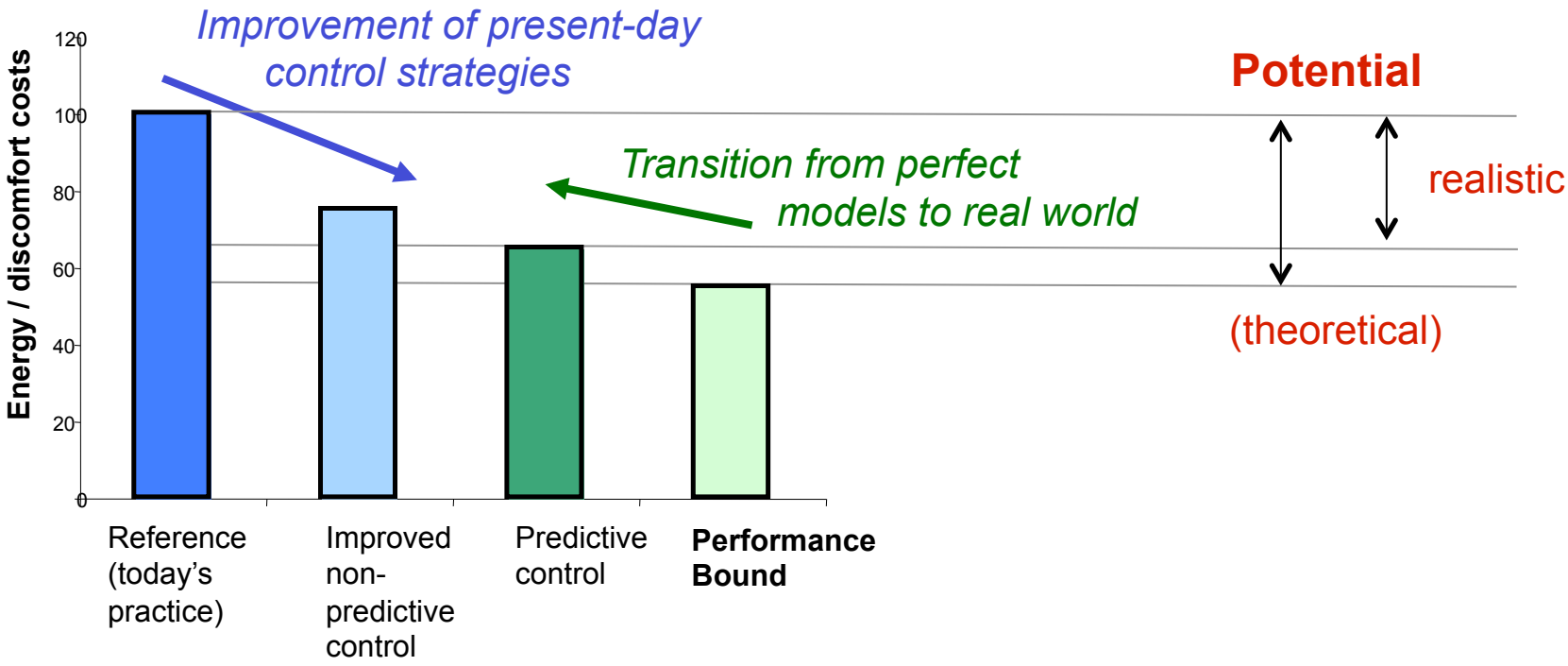
# Modeling & Simulation Environment



# Controller Assessment

Information Levels:

1. "perfect world – we know everything"
2. "real world, no weather forecasts"
3. "real world, with weather forecasts"



# Sample Results: Definition of Simulation Experiments

## 8 building zone types:

| | | |
|---|---|---|
| **Façade orientation** | Southwest | |
| **Thermal insulation level** | Swiss average | Passive house |
| **Construction type** | Heavyweight | Lightweight |
| **Window area fraction** | 30% | 80 % |
| **Internal gains level** | low | high |

## HVAC System (OptiControl System #01):

- Blinds
- Electric lighting
- Heating: radiators
- Cooling: slow ceiling
  - mechanical chiller
  - free cooling with wet tower

# Sample Results: Control Strategies Considered

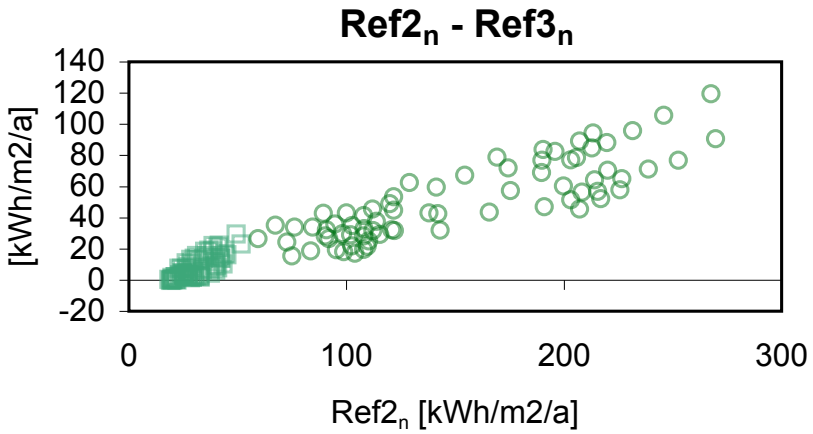
- **Ref2** State-of-the-art rule based control
- **Ref3** Improved rule based control (new)
- **MPC-CE** MPC-Certainty Equivalent control *)
- **PB** Performance Bound

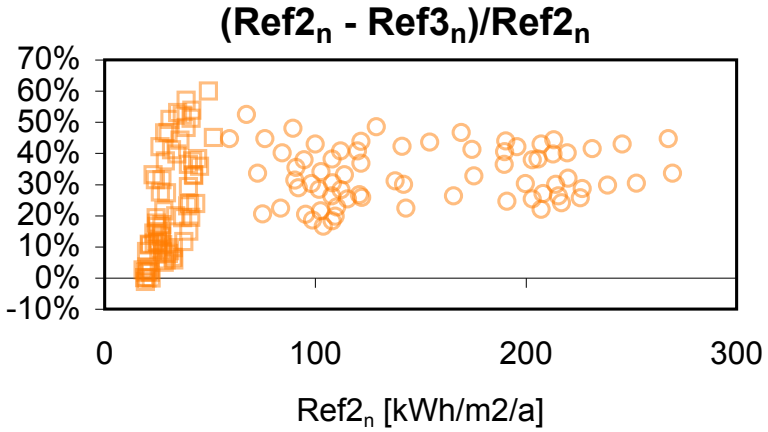
*n* = Narrow thermal comfort range

*w* = Wide thermal comfort range

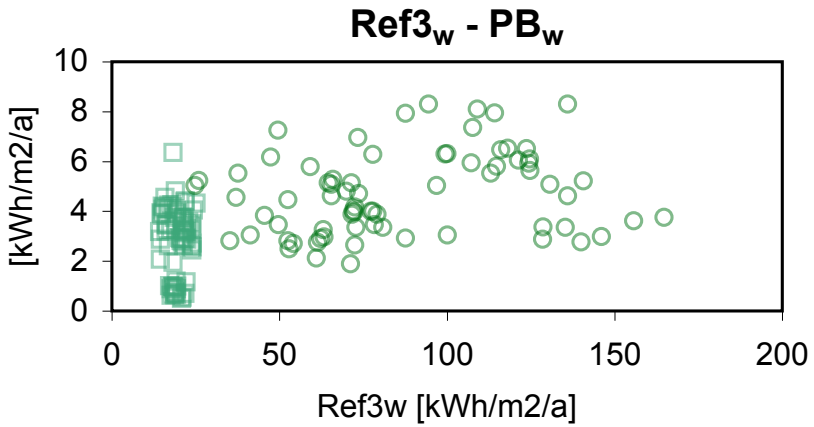
*) Using “COSMO-7” weather forecasts by MeteoSwiss, preliminary results.

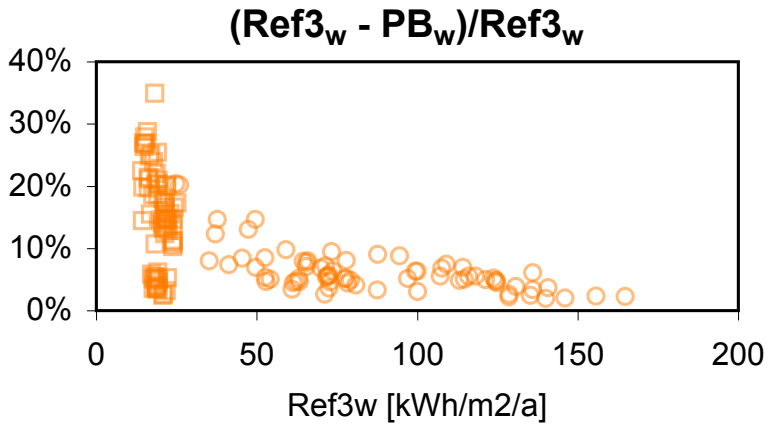
# Results (1) – Improved Non-Predictive Control



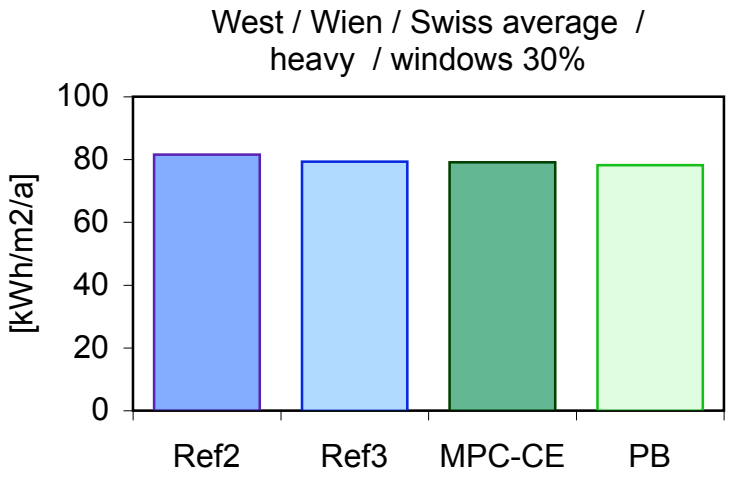



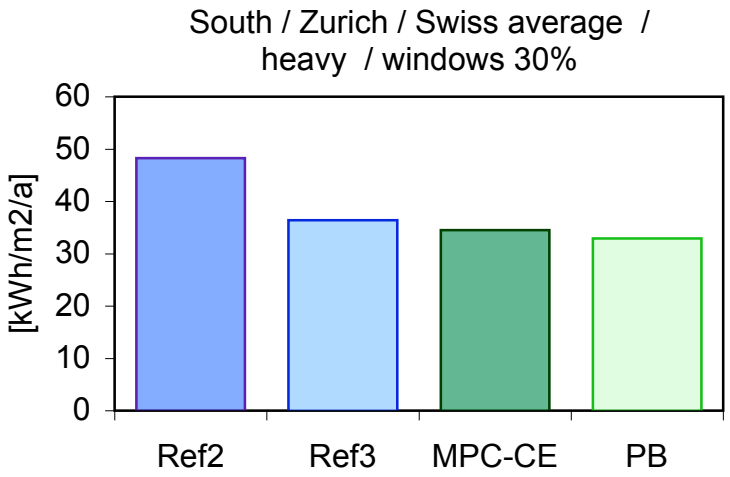
# Results (2) – Potential of Weather Forecasts

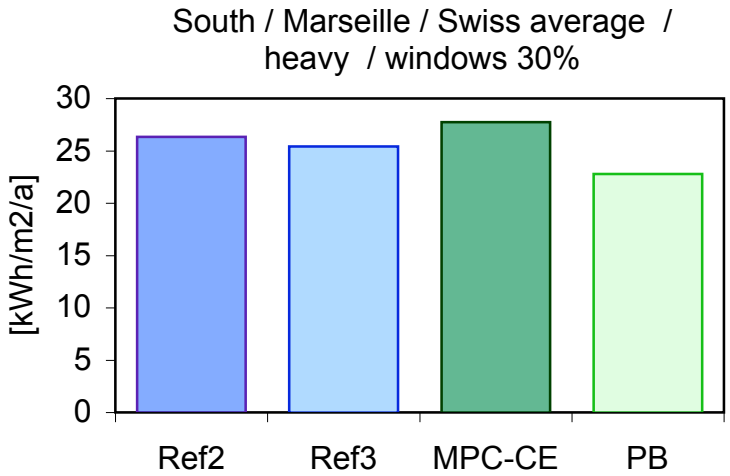


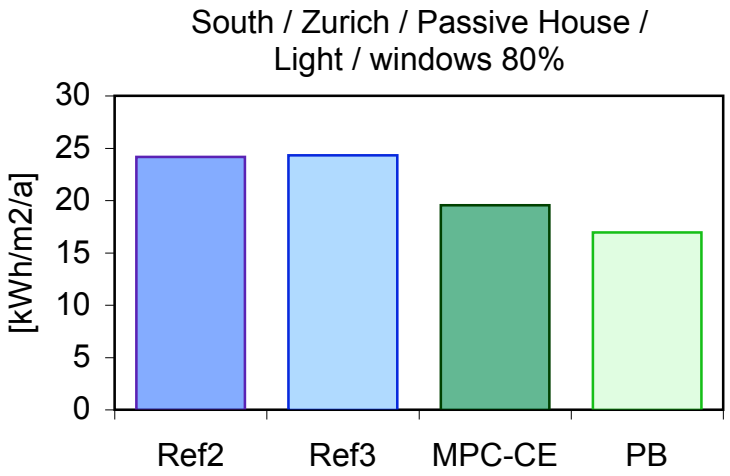



# Results (3) – Comparison of Control Strategies



# Conclusions

- First results are promising
- Benefit of weather predictions varies strongly from case to case
- Appropriate tools are important
- Our sophisticated studies can be useful for identifying simple, improved control strategies