

CONTROLLER PROTOTYPING AND VALIDATION FOR PHOTO-VOLTAIC COMFORT COOLING

FUTURE ENERGY SYSTEMS MARCH 8, 2018

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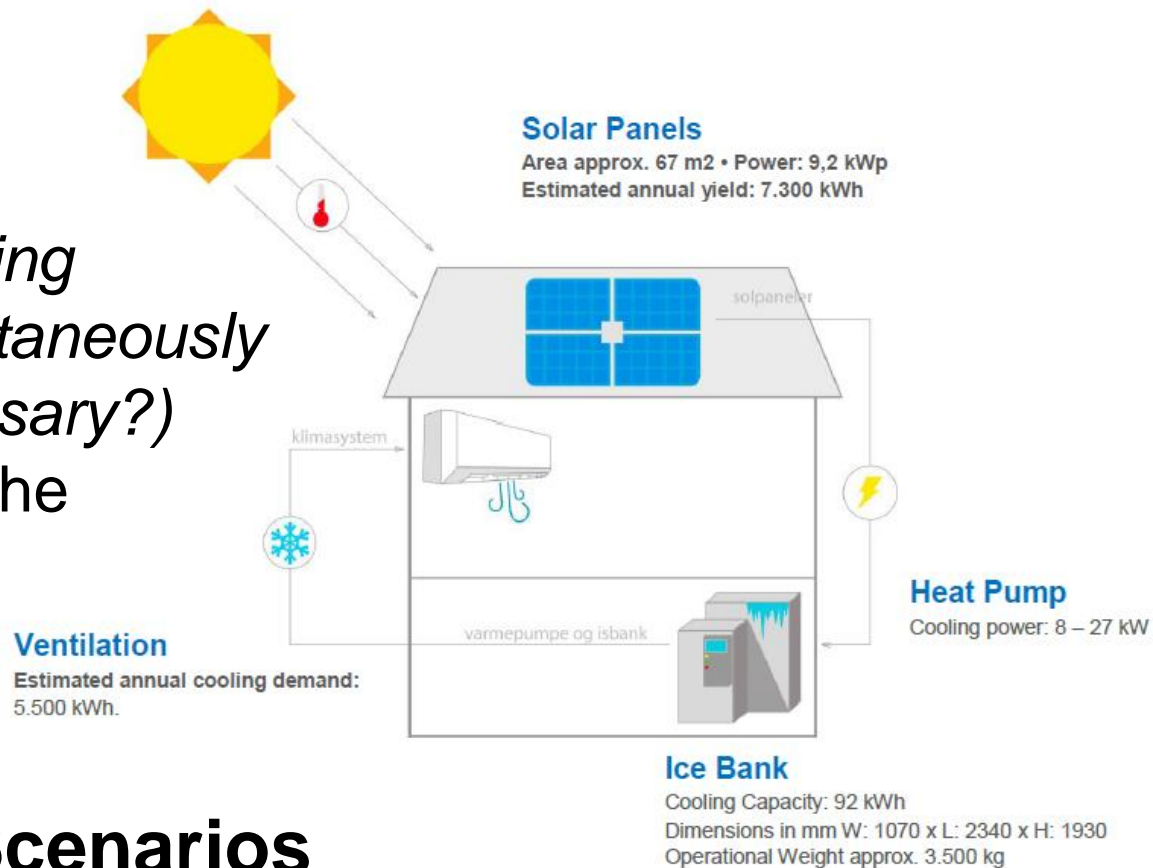
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Introduction

- **The basic idea**

Sun implies a cooling demand and simultaneously provide (the necessary?) energy to provide the cooling.



- **Demonstrator Scenarios**

– On/off grid



Photo Voltaic Comfort Cooling

- **Project consortium**

- One university
 - CISS/Aalborg University
- Four industrial partners
 - Electrical energy company
 - PV, heat pump and sensor supplier
- Building owner (Demo site)

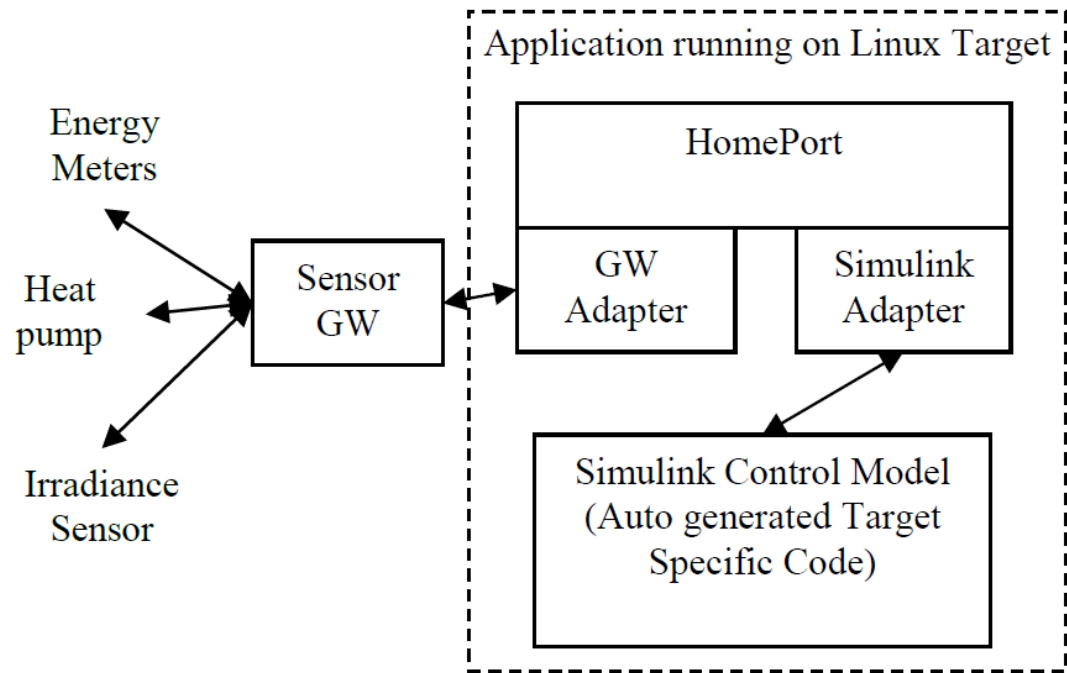
- **Project funding (2013-2016)**

- Danish EUDP research grant no. 64013-0134



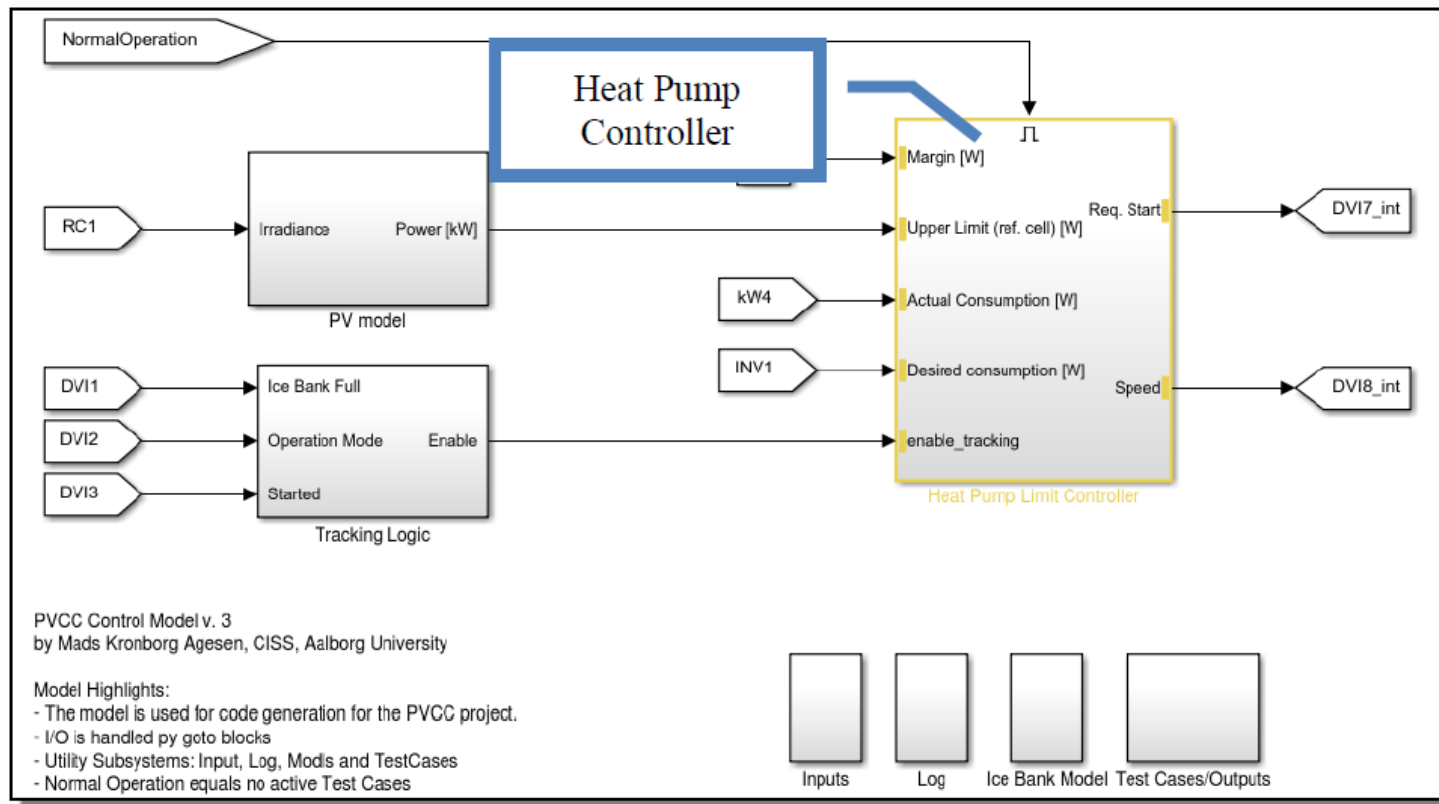
Demonstrator Architecture

- **Sensors and actuators**
 - Temperatures, power consumption,
 - solar irradiance etc.
- **Simulink Model**
 - Plant model
 - Control model
- **HomePort**
 - Home automation
 - Protocol abstraction

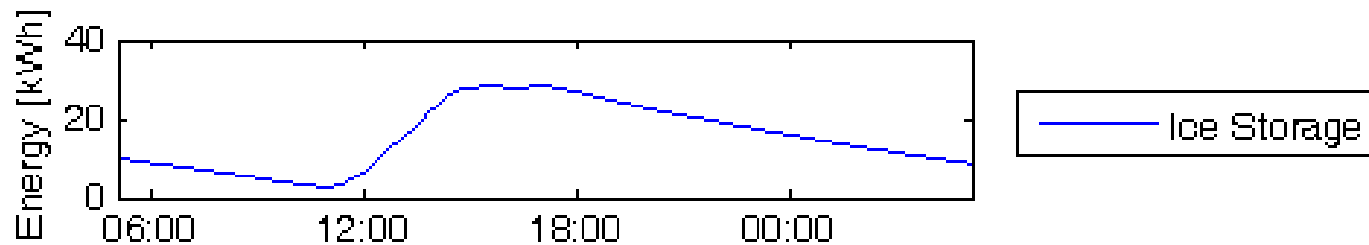
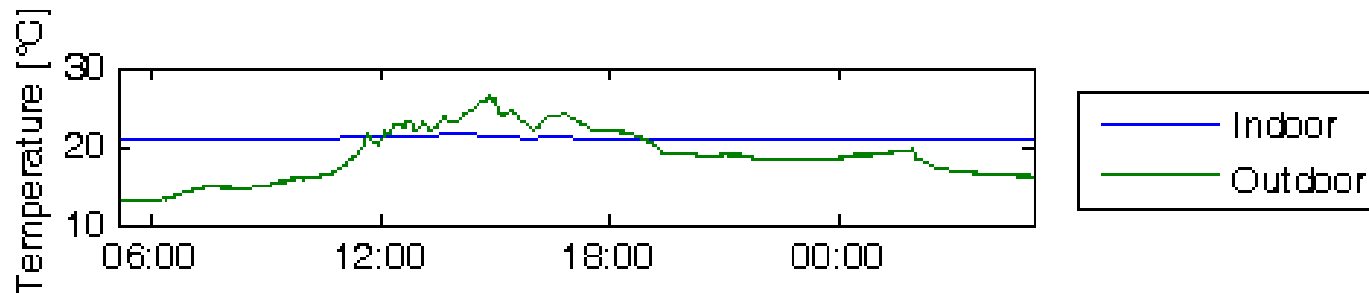
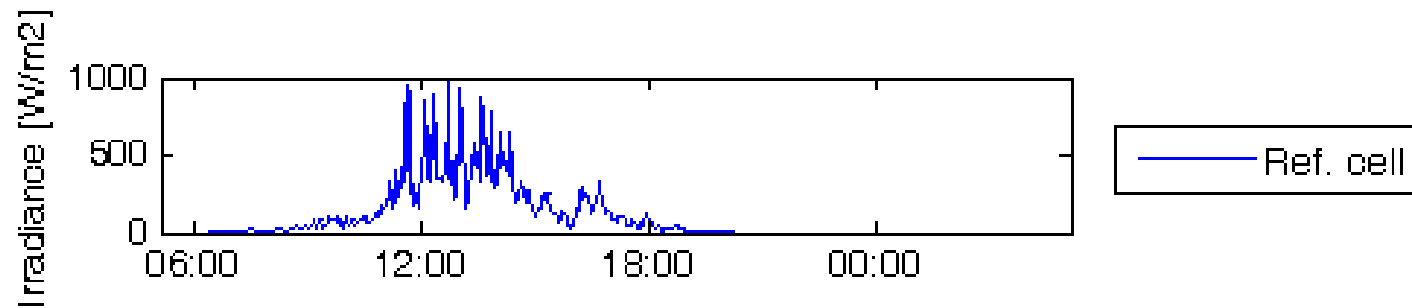


Controller Prototyping

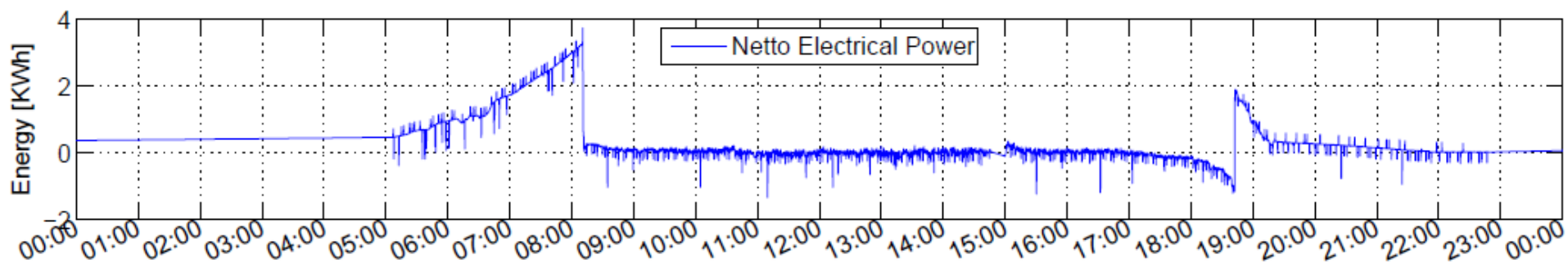
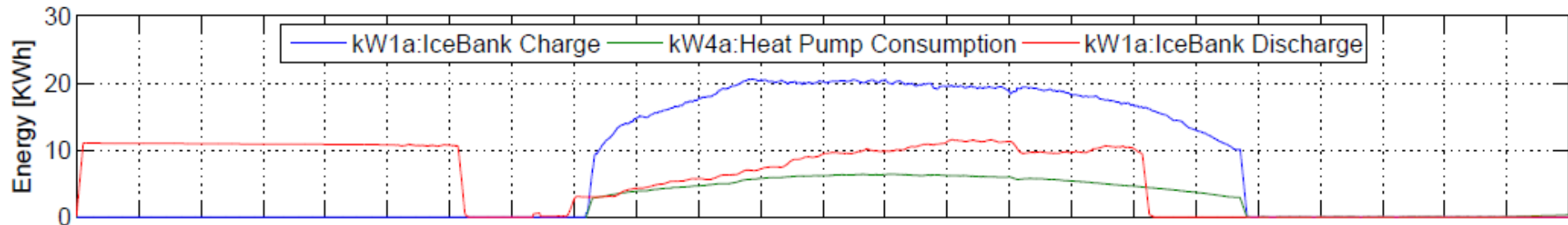
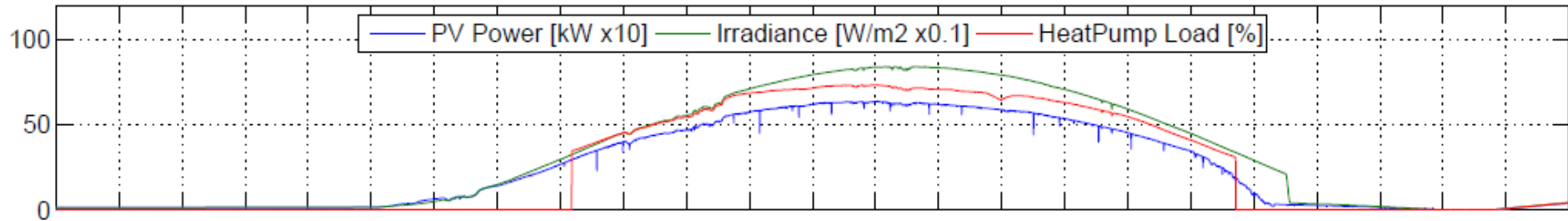
- Plant model included in control model
- Behavioral simulation and verification



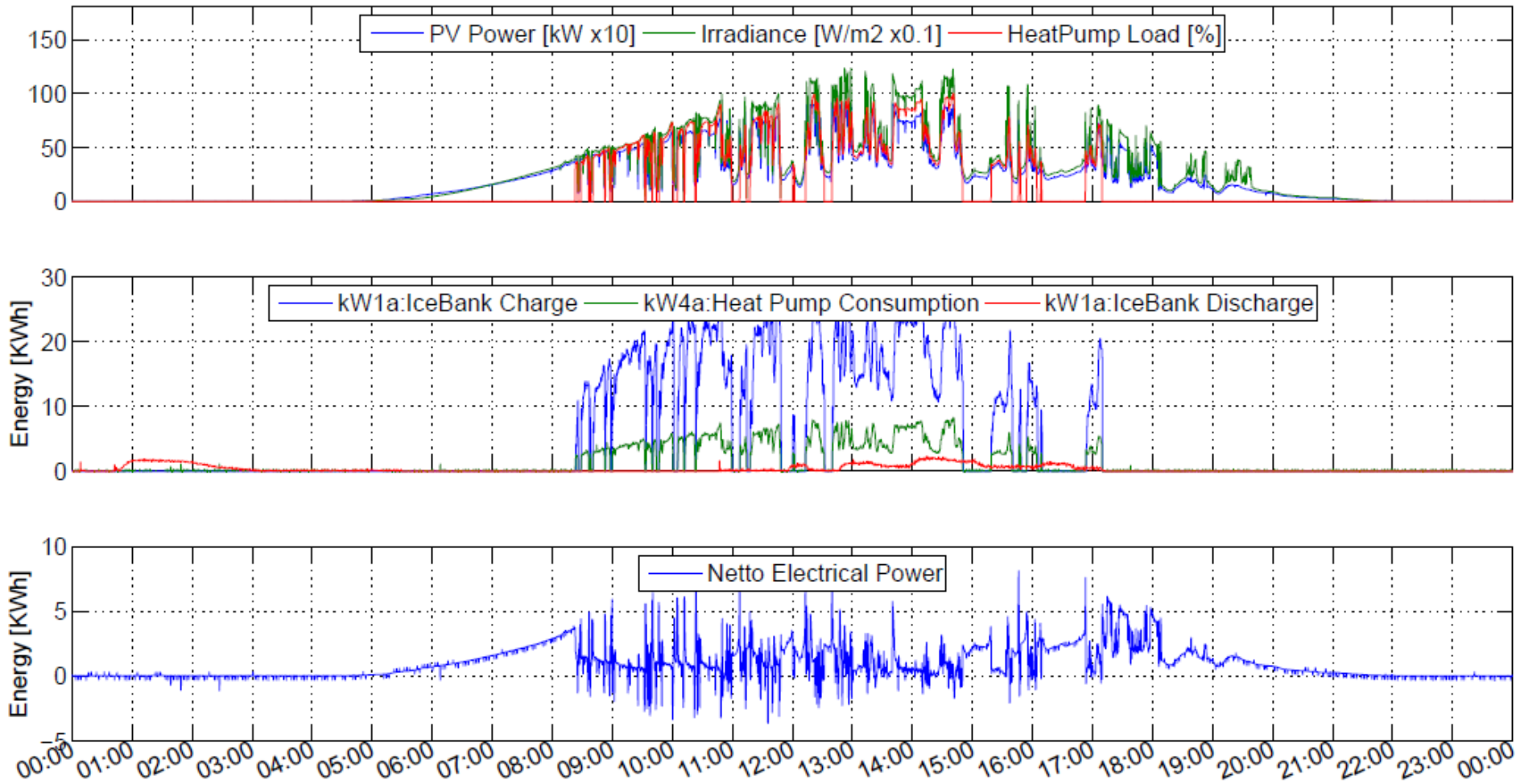
Simulation Results



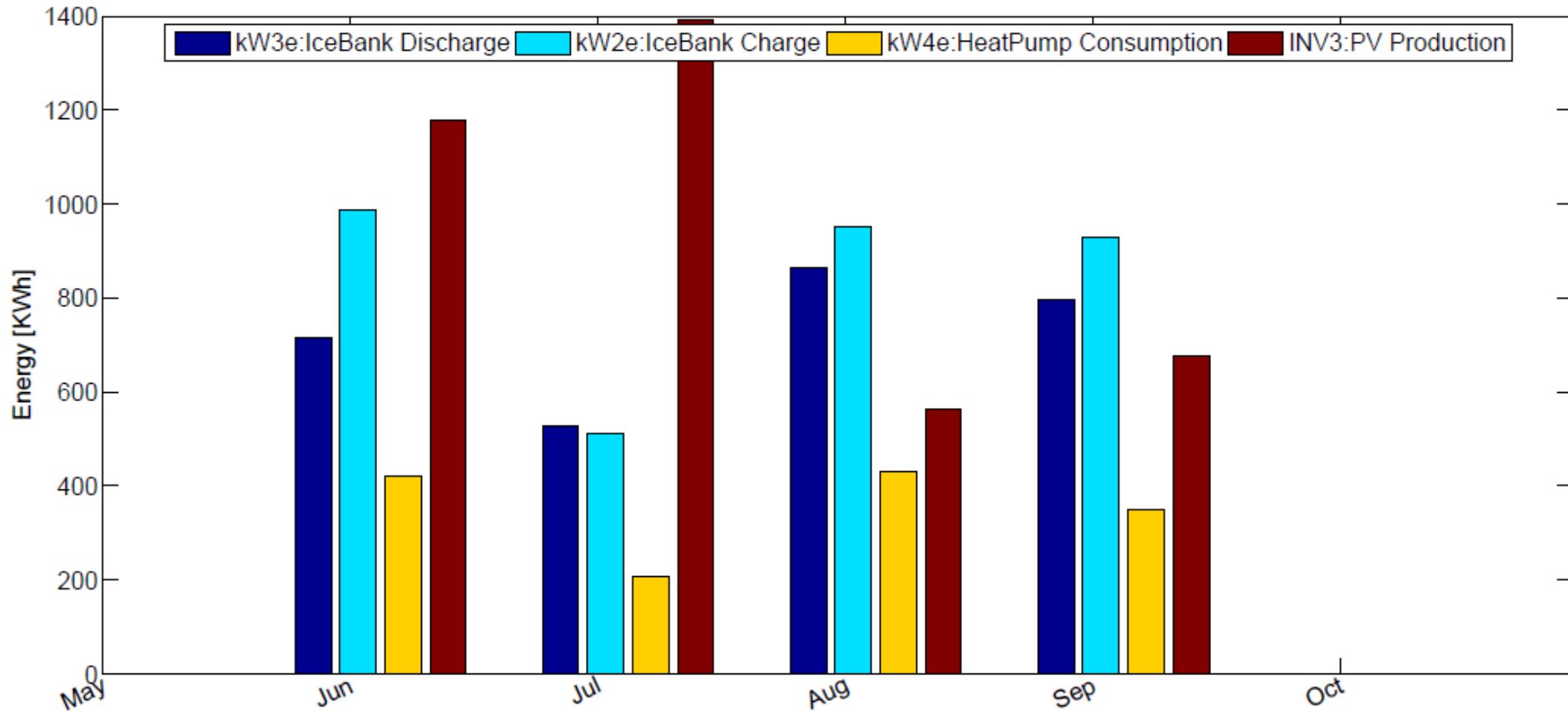
PVCC Sunny Day (June 3, 2016)



PVCC Partly Cloudy Day (June 28, 2016)



PVCC monthly energy 2016

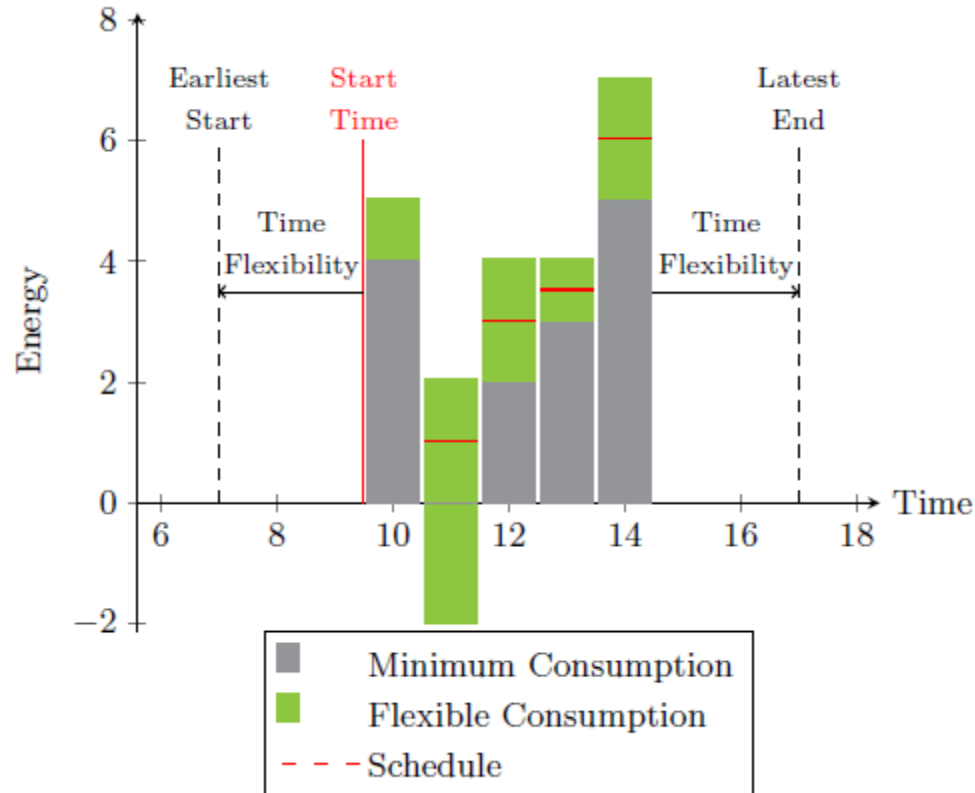


PVCC in a future energy system?

- How to generate flex-offers?
- How to generate schedules?
- How to model uncertainty?
- Ideas:
 - Encode as Stochastic Hybrid Game
 - strategy minkWh = minE (kWh) [$\leq H$]: $\langle \rangle$ time == H
 - E[$\leq H; N$] (min:kWh) under minkWh
 - strategy maxkWh = maxE (kWh) [$\leq H$]: $\langle \rangle$ time == H
 - E[$\leq H; N$] (max:kWh) under maxkWh
 - strategy schedule = minE (error) [$\leq H$]: $\langle \rangle$ time == H
 - Pr[$\leq H$] ($\langle \rangle$ (kWh < schEnd - delta || kWh > schEnd + delta))
under schedule



FlexOffer example



Probabilistic FlexOffer

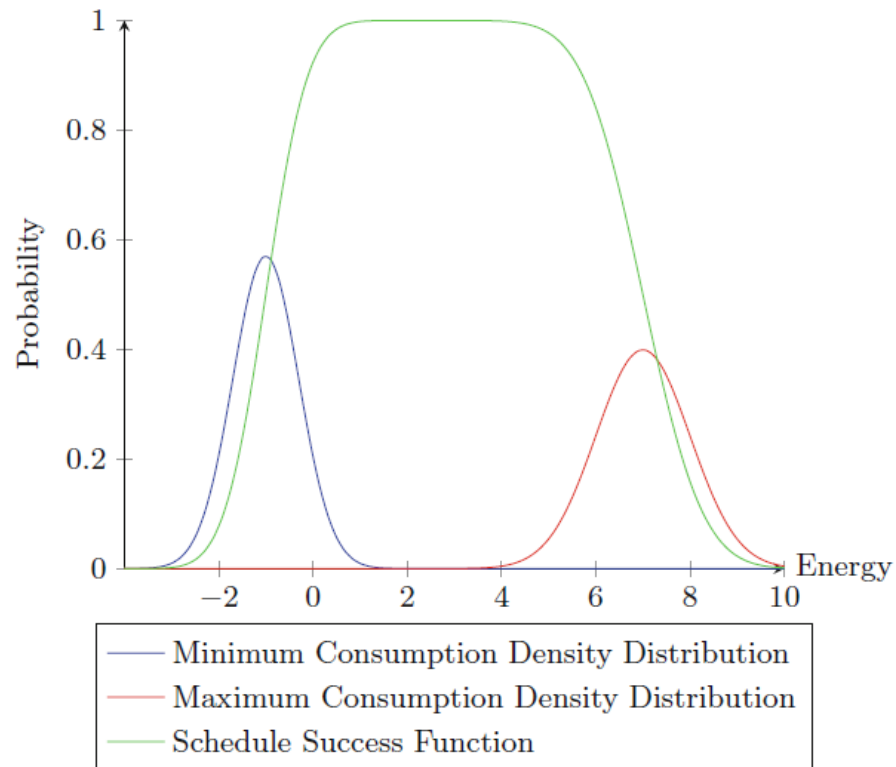
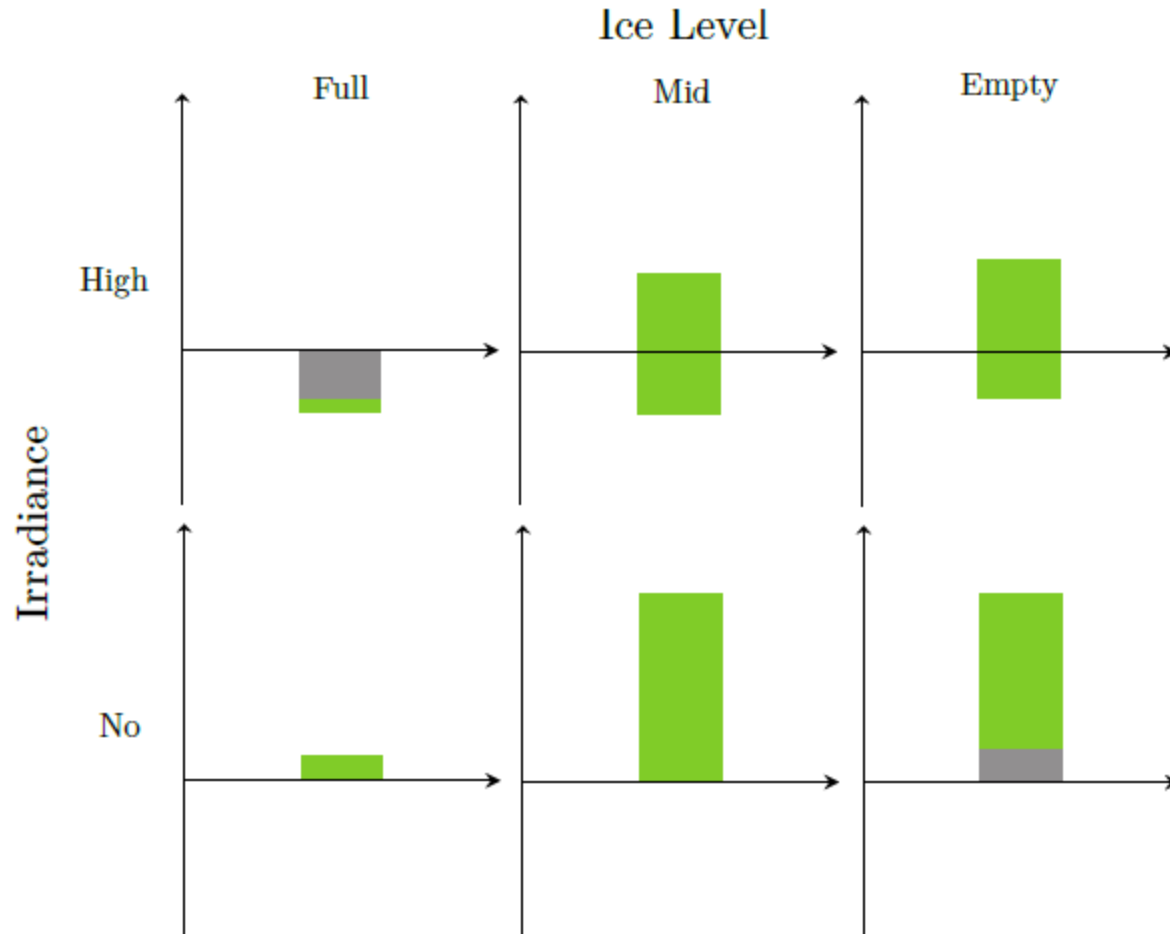


Fig. 2. Example of a slice of a probabilistic FlexOffer.



Future flexibility scenarios



Success functions

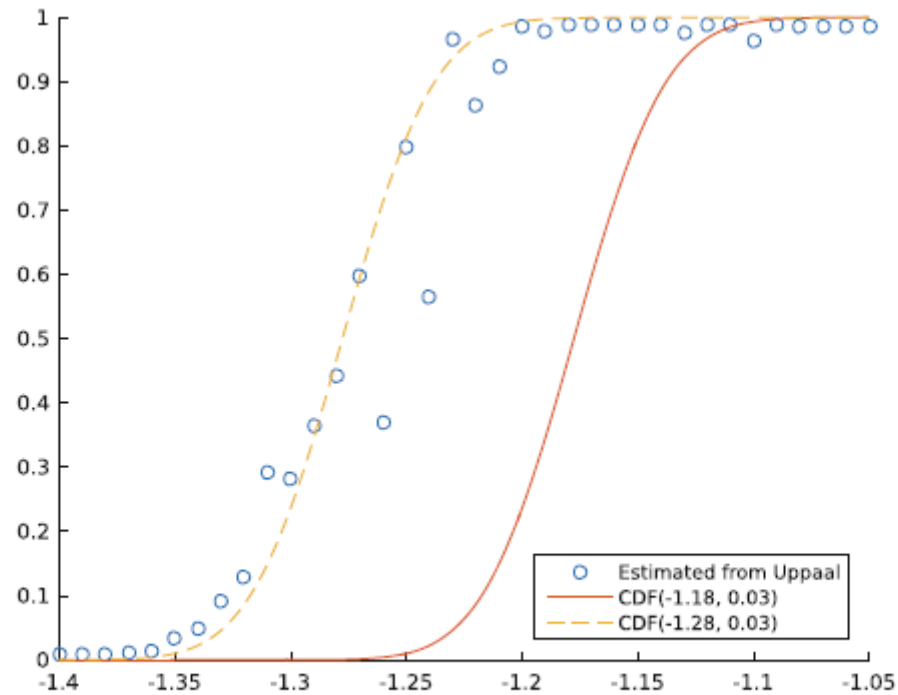


Fig. 7. Probability of being able to follow an assigned schedule. (Color figure online)



Future System Architecture

