



CALIBRATION OF AN ENERGYPLUS BUILDING ENERGY MODEL TO ASSESS THE IMPACT OF DEMAND RESPONSE MEASURES

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Contextualization

> Hydro-Québec

- Principal utility in Québec, Canada
- Total installed capacity of 35,829 MW in 2012
- HQ is interested in additional power sources for the network's future requirements

Demand Response in CI Buildings

- > **Represents a potential**
- > **Power peak demand in CI buildings attributed mostly to:**
 - Ventilation
 - Air conditioning and heating
 - Plug loads and lighting
 - Domestic hot water
- > **Identify appropriate measures for different building categories and HVAC configurations:**
 - Modeling several buildings (Pilot project)
 - Applying measures on calibrated models
 - Assessing the impact on real buildings

3

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This presentation...

- > **Focuses on one case study**
- > **Gives an overview of:**
 - The modeling methodology and the tools used
 - The analysis of the measured and simulated data
 - The calibration/parameterization process and the tools used to calibrate the model

4

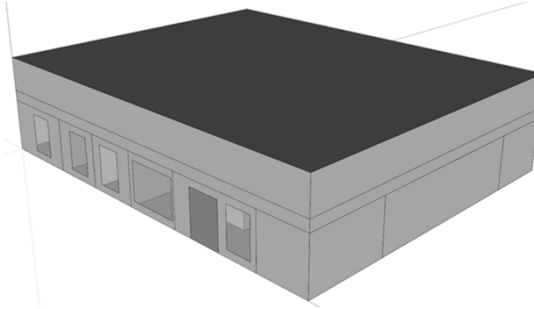
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Case study

- > Commercial building located in Quebec
- > Built in 2009
- > ~25 kWh/pi²
- > 3 rooftop units
- > Heating source: electricity



5

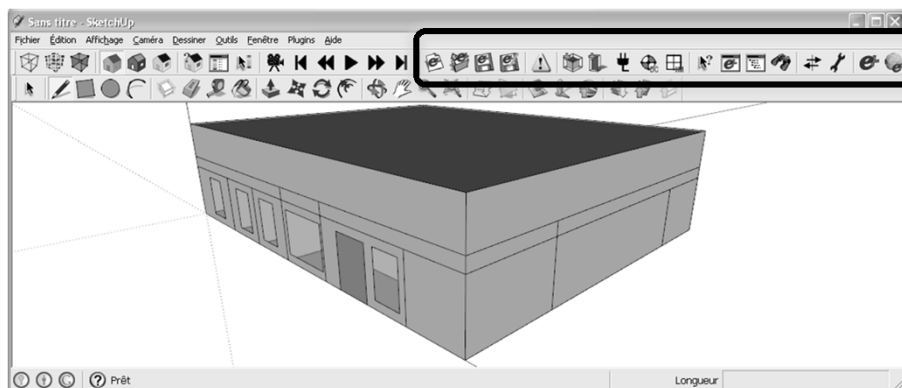
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Creating the geometry

- > Geometry created with Google SketchUp
- > IDF (thermal zone definition) with OpenStudio Plugin



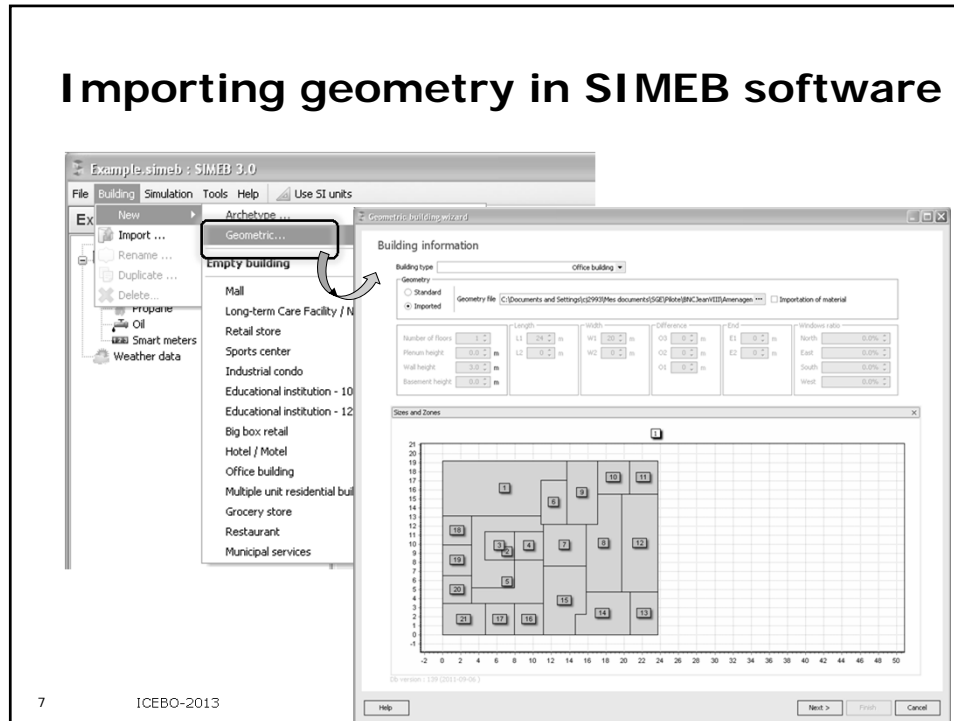
6

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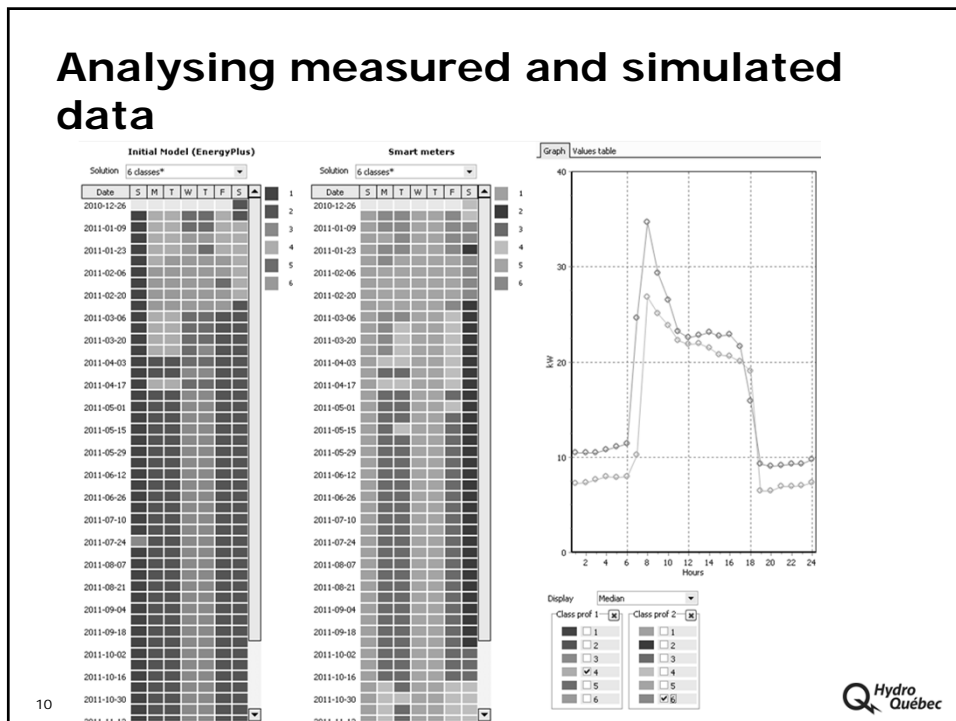
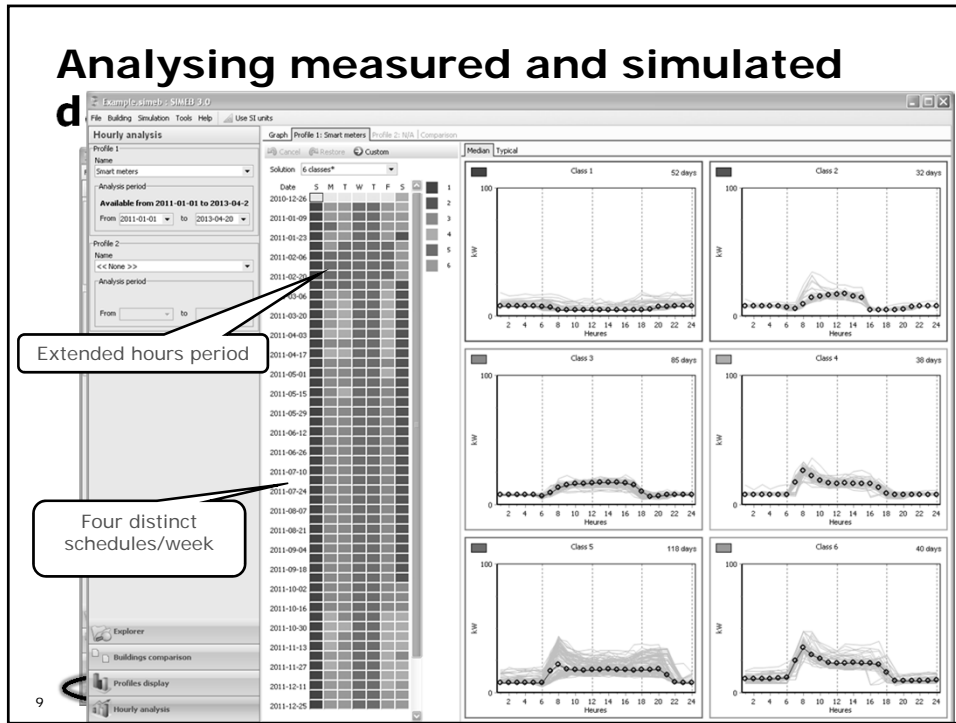


Importing geometry in SIMEB software

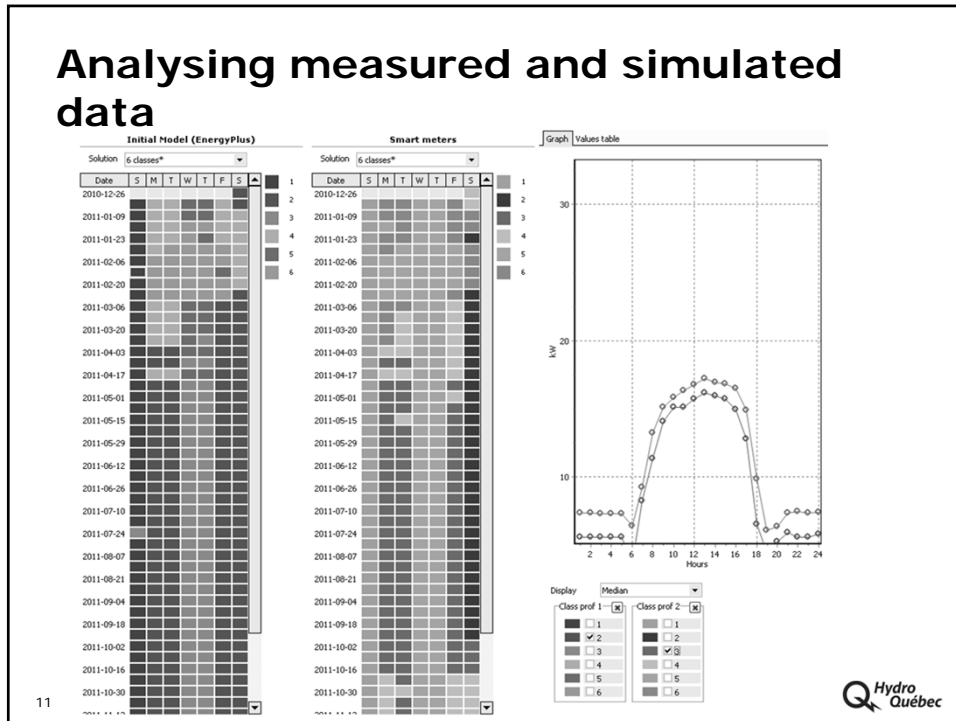


Creating a full building model in SIMEB

- > **Define general parameters:**
 - Building envelope, window glazing
 - External lights
 - DHW...
- > **Thermal zones specifications:**
 - Lighting, plug loads,...
 - Zone heating (baseboard, terminal reheat,...)
 - Occupancy and fresh air requirements
 - Schedules
- > **HVAC Systems and Plants:**
 - Ventilation, heating/cooling capacities
 - Loops setpoints, etc.

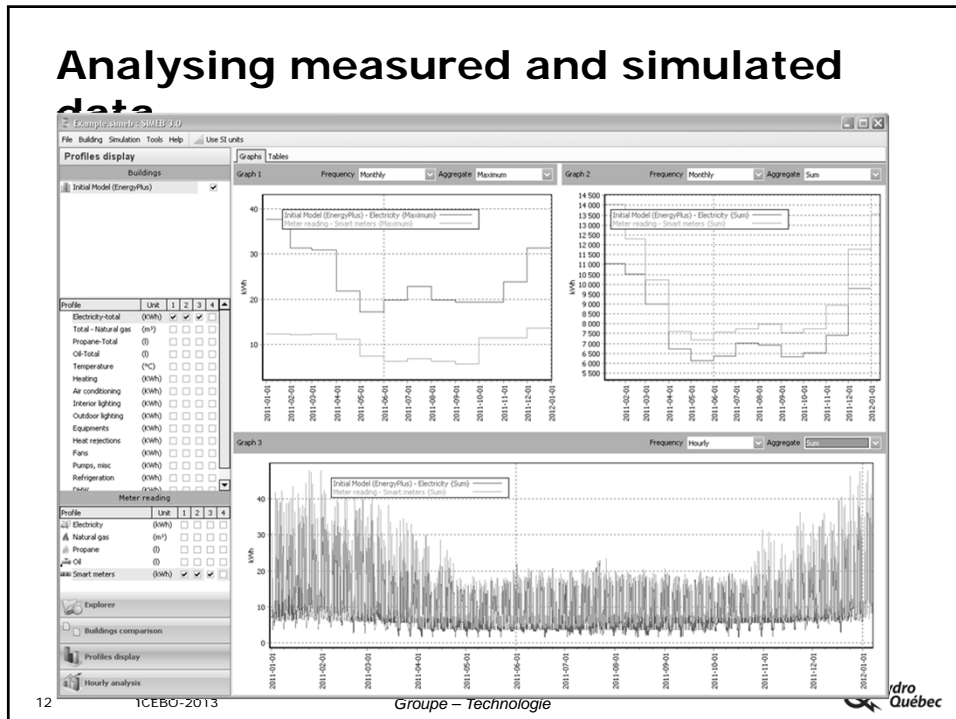


Analysing measured and simulated data



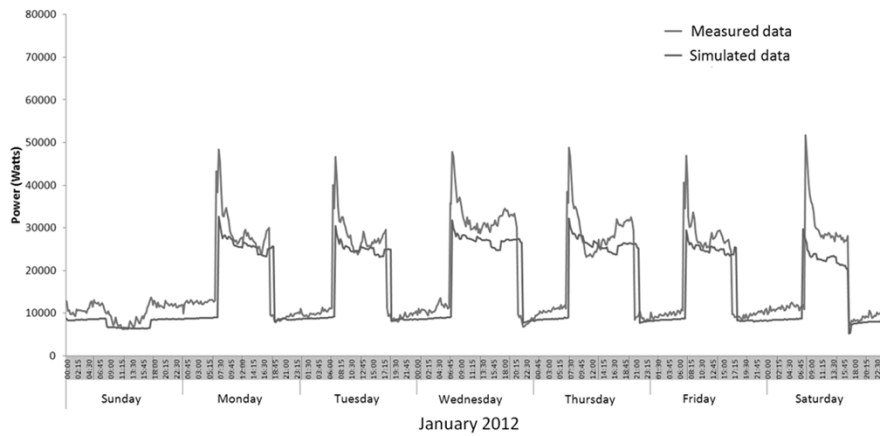
11

Analysing measured and simulated data



12

Analysing measured and simulated data



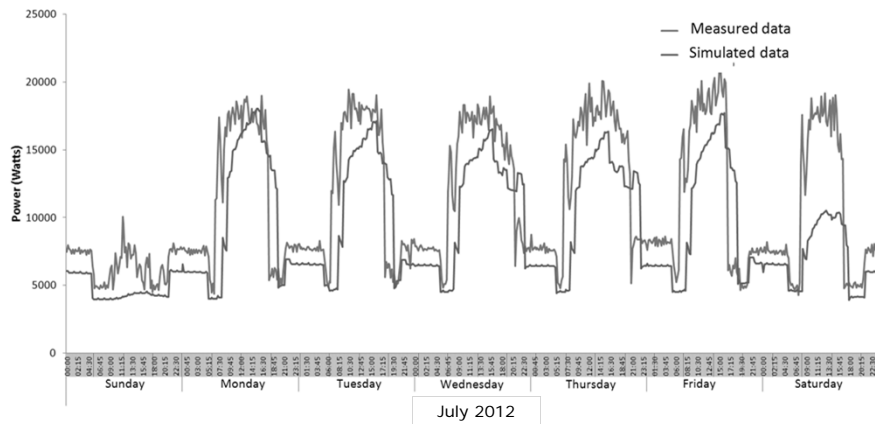
13

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Analysing measured and simulated data



14

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Sensitivity analysis and calibration

- > **Identify influent parameters by launching simulations with different values (extreme)**
 - Hints from SIMEB Pre-Calibration Module
 - Window types, Envelope R-Value, Minimum OA, Static fan pressure, Plug load intensity, etc.

- > **Establish an optimization plan** (↓ Δ simulated and measured profiles)
 - Parameter selection and their limits
 - Calibration period (annual or specific period)
 - Objective function and type of algorithm (PSO, GPS,...)

- > **Launch and manage optimization runs**

15

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Sensitivity analysis and calibration

- > **ExCalibBEM Software (in development) has been used to perform these previous tasks**
 - > **Interface to GenOpt, developed by LBNL DOE Lab**

Optimization program integrating multiple algorithms for the minimization of a cost function that is evaluated by an external simulation program, such as EnergyPlus.

- > **Easy creation of IDF templates and Objective functions coupled with external log data**
- > **Easy retrieving and plotting of results (DVIEW format)**

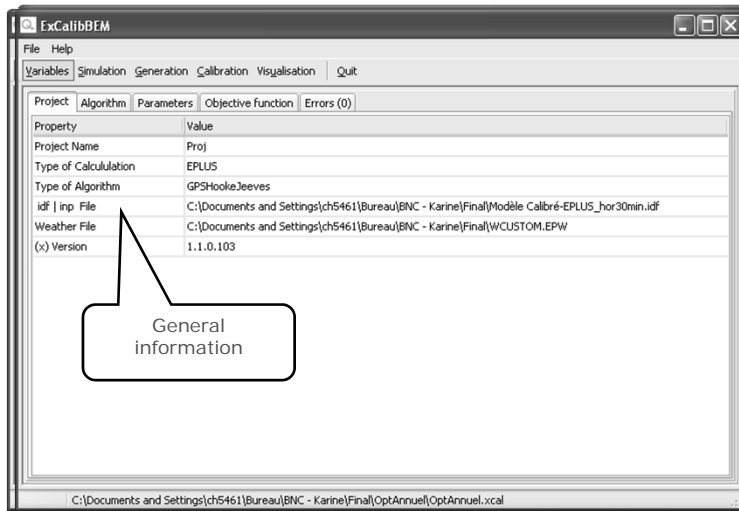
16

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Quick look at ExCalibBEM interface



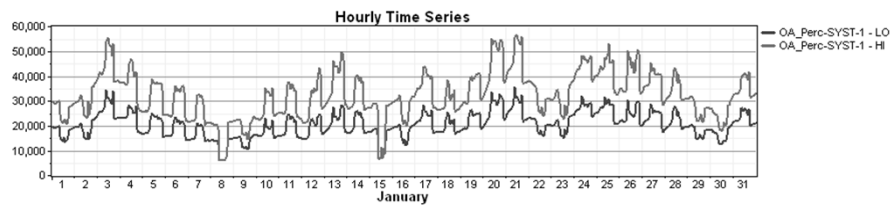
17

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Sensitivity analysis



Parameter	Winter	Summer
OA SYST-1 to SYST-3	VHI (Offset)	LI
Envelope R value	HI (Peak demand)	LI
Fan Static Pressure SYST-1 to 3	VLI	HI (Peak demand)
Clear glass instead of tint glass	LI (Peak demand)	LI (Peak demand)
Plug loads for 3 majors zones	LI	HI (Offset)

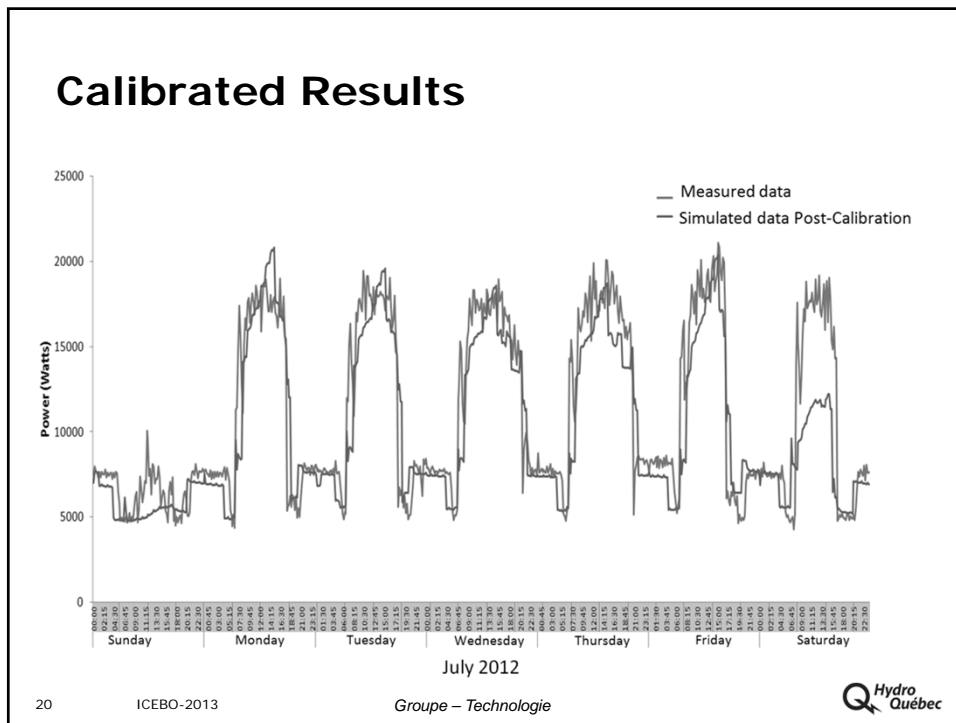
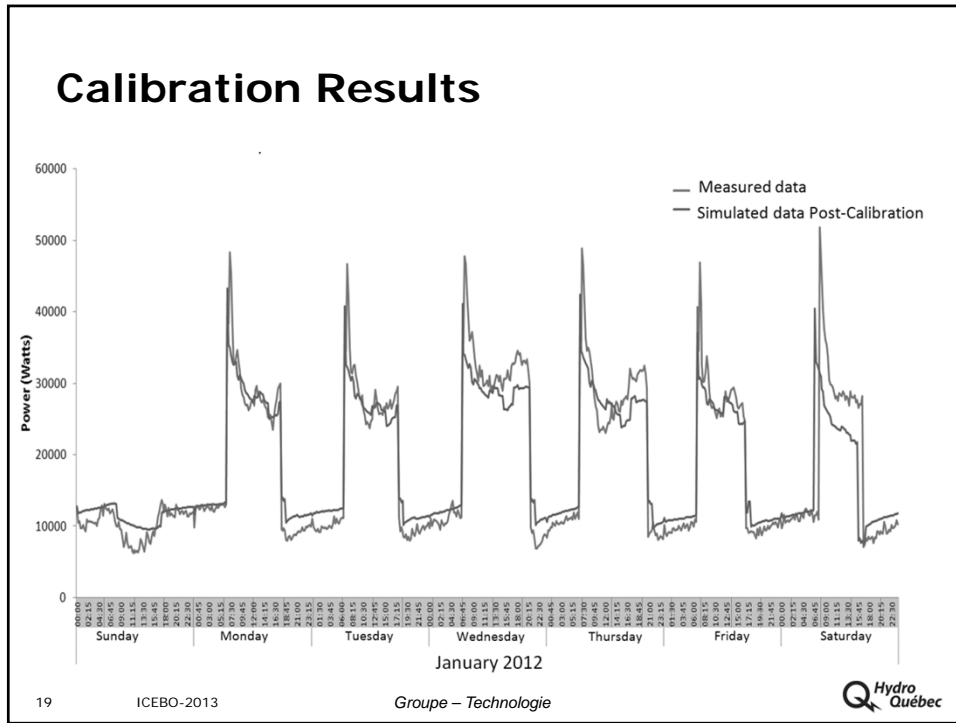
V : Very, L : Low, H : High, I : Impact

18

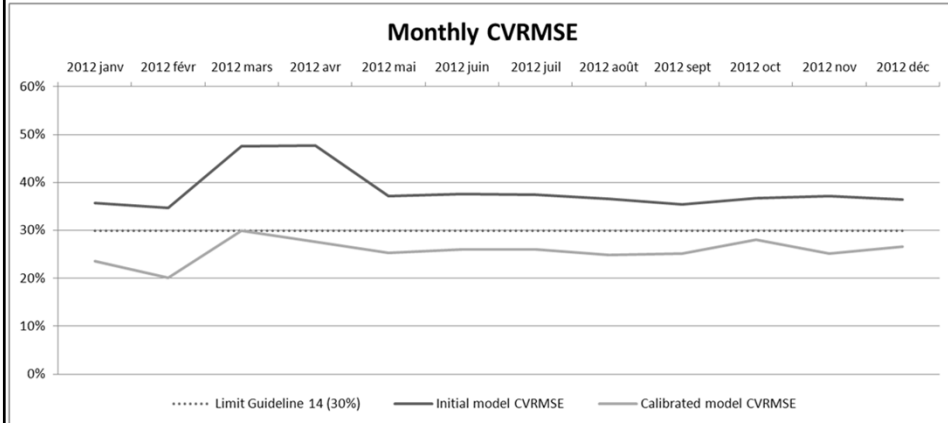
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Calibrated Results



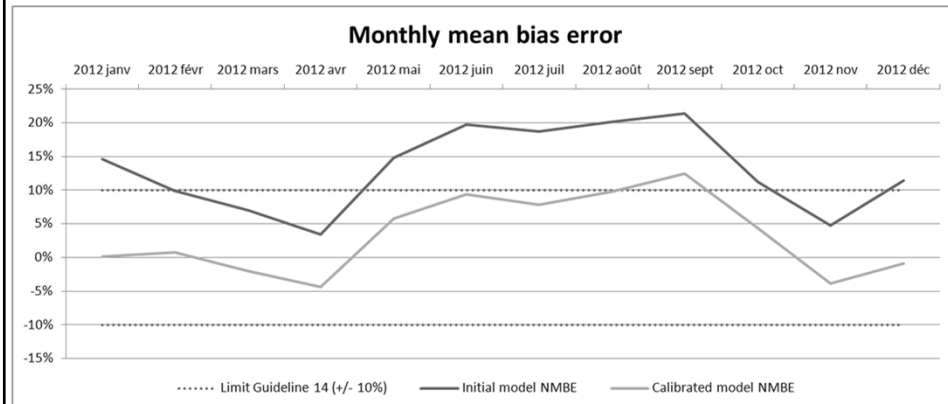
21

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Calibrated Results



22

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Conclusion

- > **Calibrating model for a demand response objective : Challenging and High Effort**
 - > Capturing building and human erratic behaviour
 - > HVAC control prediction

- > **Tools must be developed to facilitate:**
 - > Model creation
 - > Analysis between simulated and measured profiles
 - > Parameter identification for calibration
 - > Parametric and optimization runs

- > **The model will be refined and used to assess the impact of demand response measures**

23

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