Design and Integration of Heat Pump and Solar Thermal Technologies in NZEBs

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IEA HPP Annex 40 Workshop
May 12th, 2014, Montreal
Solar HP in NZEB Design

- Solar + Heat Pumps attractive solution in NZEB design
  - High renewable energy fractions
  - Flexibility in system design
  - Improved heat pump performance

- Challenges
  - Storage capacity
  - Collector performance
  - Cost
Ice Slurry Heat Pump: Concept

- Solar HP concept by CanmetENERGY-Varennes
  - Ice slurry storage with HP and solar thermal

- Objective
  - Energy efficient and cost effective system integration

- Approach
  - Simulation: Energy Analysis
  - Operation: Test bench
  - Optimization: Techno-economic analysis
  - Transfer: Demonstrate and transfer technology
Ice Slurry Heat Pump: Concept

- Ice slurry storage
  - High latent heat capacity
  - Stable source temperature for HP
  - Improved solar collector performance
Ice Slurry Heat Pump: Concept

- Ice slurry integration with HP and solar thermal (Heating mode)
Ice Slurry Heat Pump: Concept

- Promising initial results
  - 86% reduction in heating operating energy use (Montreal)

Case 1- Electrical Heaters

Case 2- Solar Assisted Heat Pump with Sensible Storage

Case 3- Optimized Solar Assisted Heat Pump with Ice Storage
Ice Slurry Heat Pump: Test Bench

- Objectives
  - Demonstrate and validate concept
  - Develop understanding of system operations
  - Identify areas for system improvement
Ice Slurry Heat Pump: Economics

- Identify areas for cost reductions
- Sizing and economic comparison to common HP systems
- Apply optimization techniques to determine cost effective system sizing
  - Solar collector type and size
  - Ice tank size
  - Distribution tank size
Ice Slurry Heat Pump: Future Work

- Heat pump + thermal storage
  - Grid interaction
  - Advanced control strategies

- Enhanced understanding of system operations
  - Additional climate regions
  - Different building types
  - Integration of performance characteristics from test bench

- System improvement
  - Cost reductions
  - Robust design
Ice Slurry Heat Pump: Vision

- Market research
  - Address barriers to implementation and adoption

- Systematic development and refinement
  - Next generation test bench
  - Demonstration projects
  - Technology transfer of developed HP package
Conclusions

- Heat pumps an important component in NZEB design
  - Efficient integration of renewables into built environment

- Solar + Heat Pump systems offer energy savings potential
  - Key challenges must be overcome

- Innovative ice slurry solar heat pump concept
  - Promising energy savings across Canada
  - Extensive work to enhance system understanding
Questions?