Storage Integration into Hybrid Diesel-Renewable Microgrids in Northern Mines

Mohammad Sedighy, Ph.D., P.Eng.

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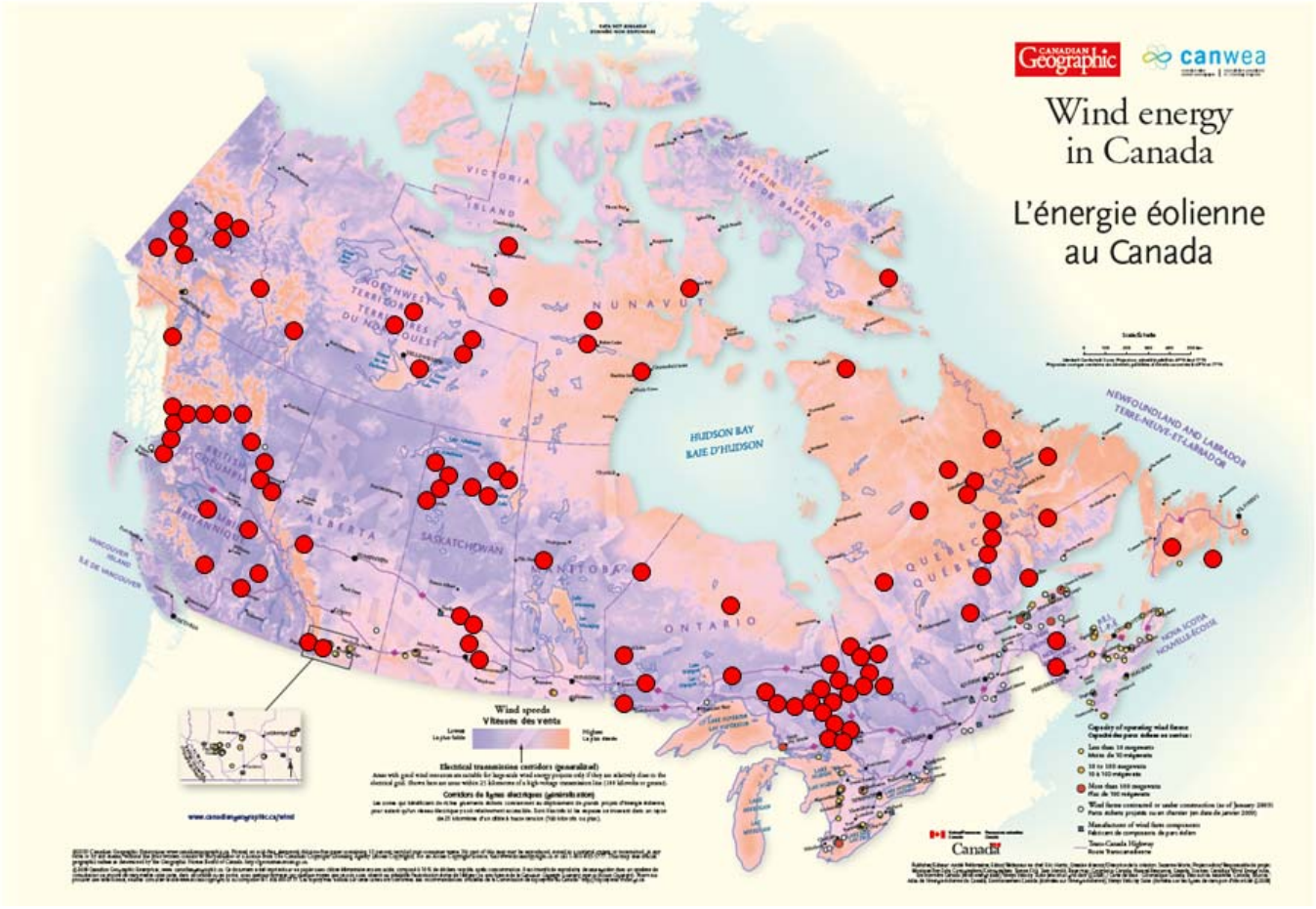
Presentation Outline

- Remote mine microgrids with renewable power
- Raglan Mine #2 Wind-storage Pilot Project
  - Overview
  - Energy Storage
  - Microgrid Controls
- Conclusion

Top 100 Exploration and Deposit Appraisal Projects in Canada Vs. Wind Resource Data



Source: Natural Resources Canada

Business Case for Renewable Power

Remote Mining Energy Cost:

With Diesel Gensets

- Energy represents 20-30% of mining project CAPEX
- Energy represents >25% of OPEX, 30+ cents/kWh

With Renewable Power

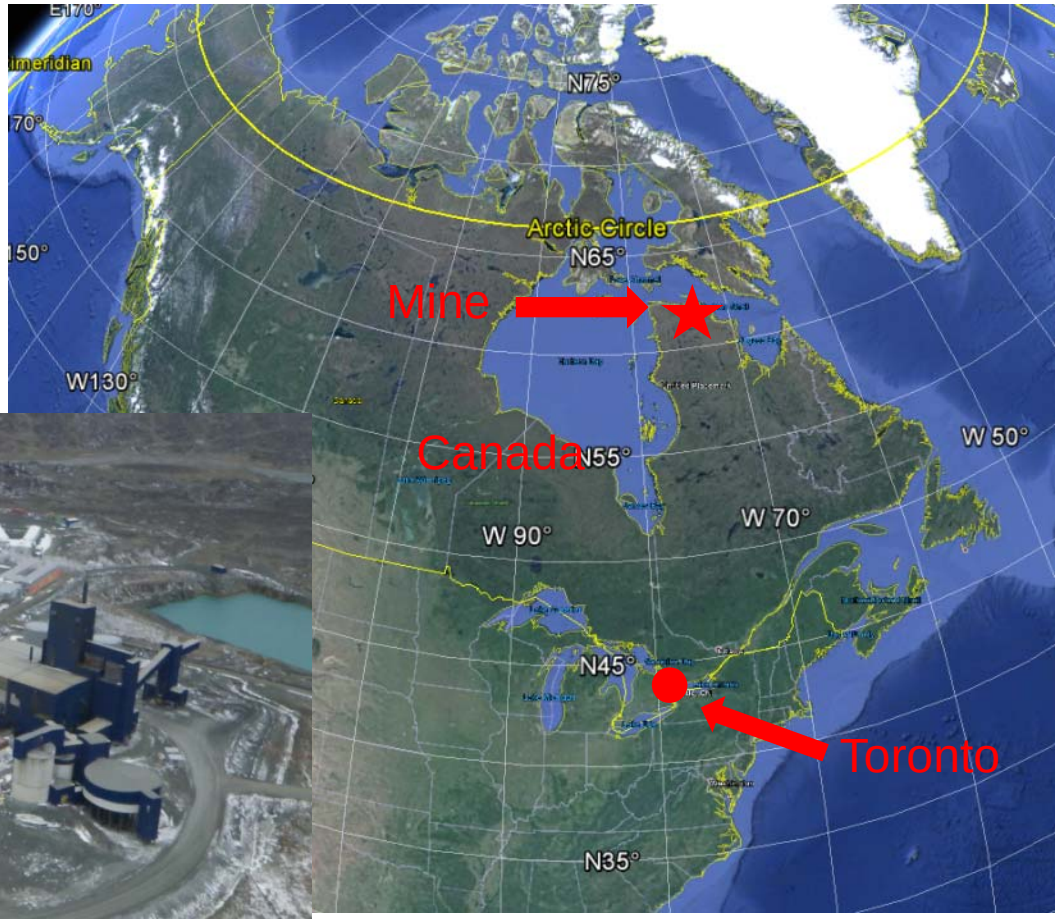
- Cost of electricity: 15 to 22 cents/kWh (with good resource)
- Price certainty for 20 to 25 years

Investment Needed for Renewable Power – CAPEX

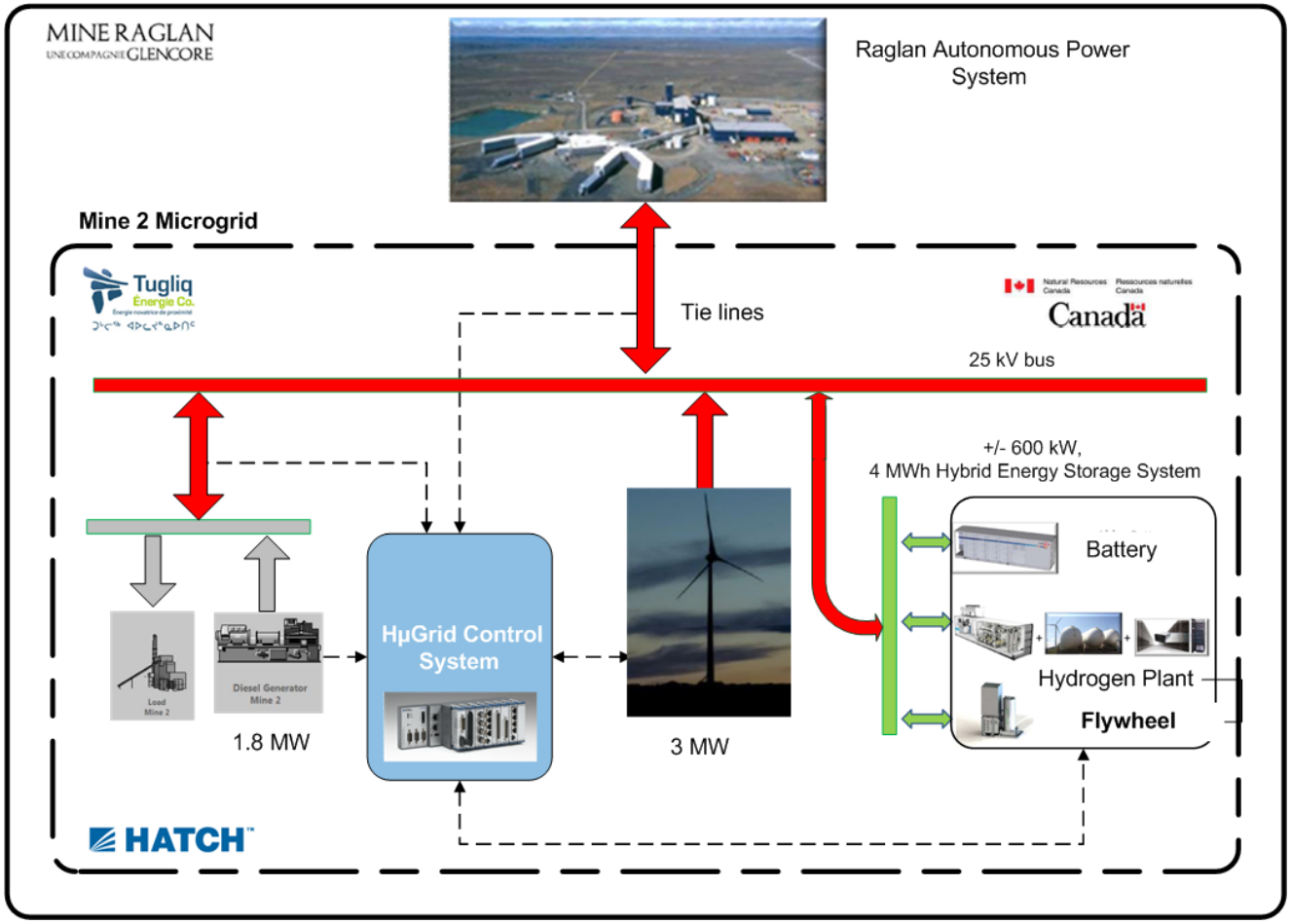
- 2.5 M$ to 4.0M$ per Installed MW
- Typical return on Investment around 7 years

Glencore Raglan Mine

- Located ~2000 km North of Toronto
- Accessible only by sea or air
- Several mines spread of a 70 km area with legacy distributed diesel generation
- Good wind resource

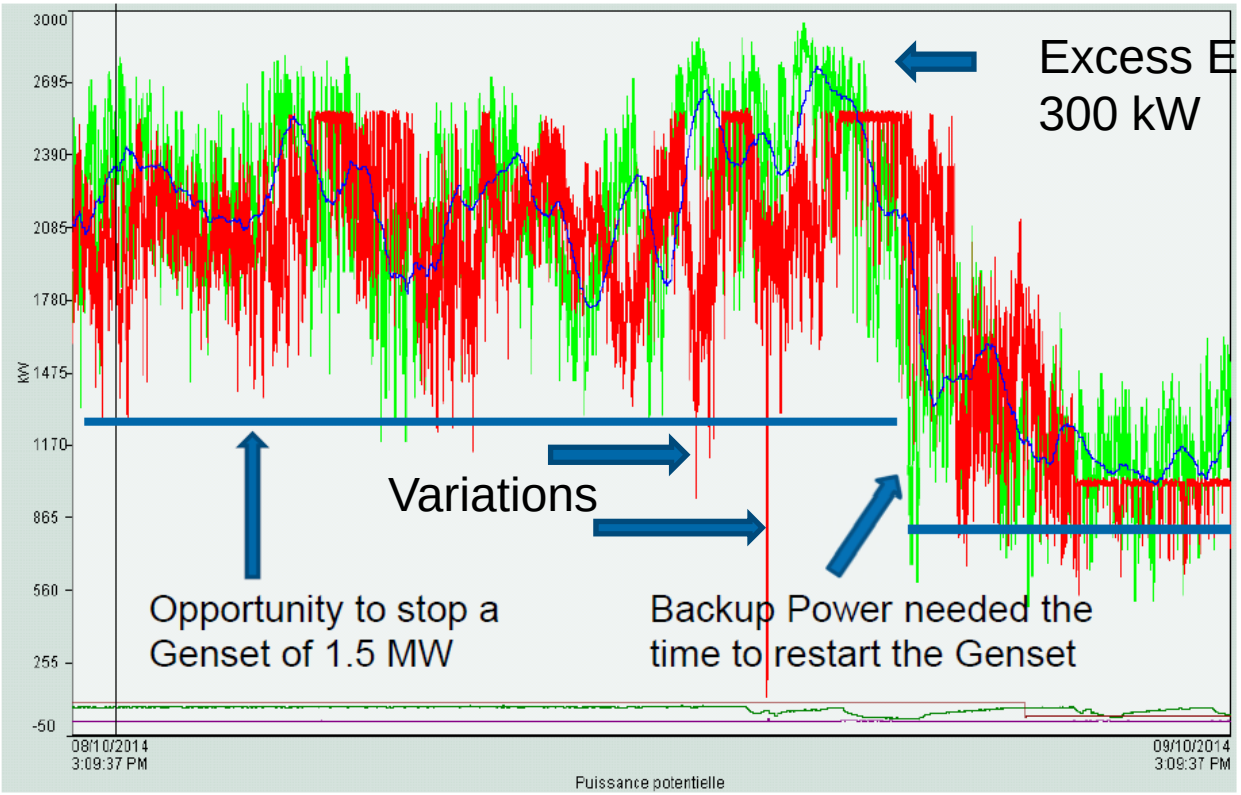


Raglan Mine 2 Wind-Storage Pilot Project Overview

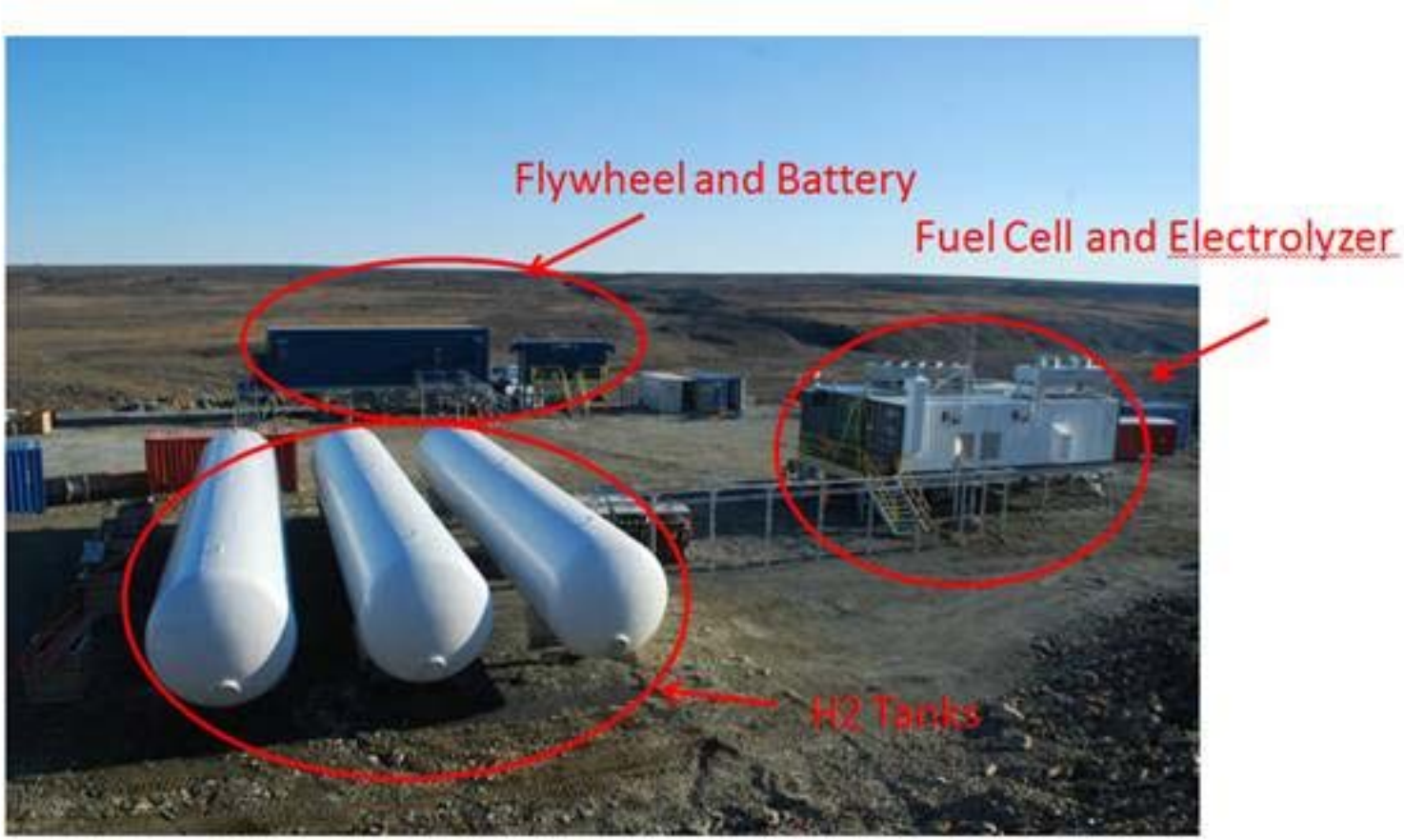


Annual Savings =2.4 Million Liters of Diesel Fuel

Storage Application

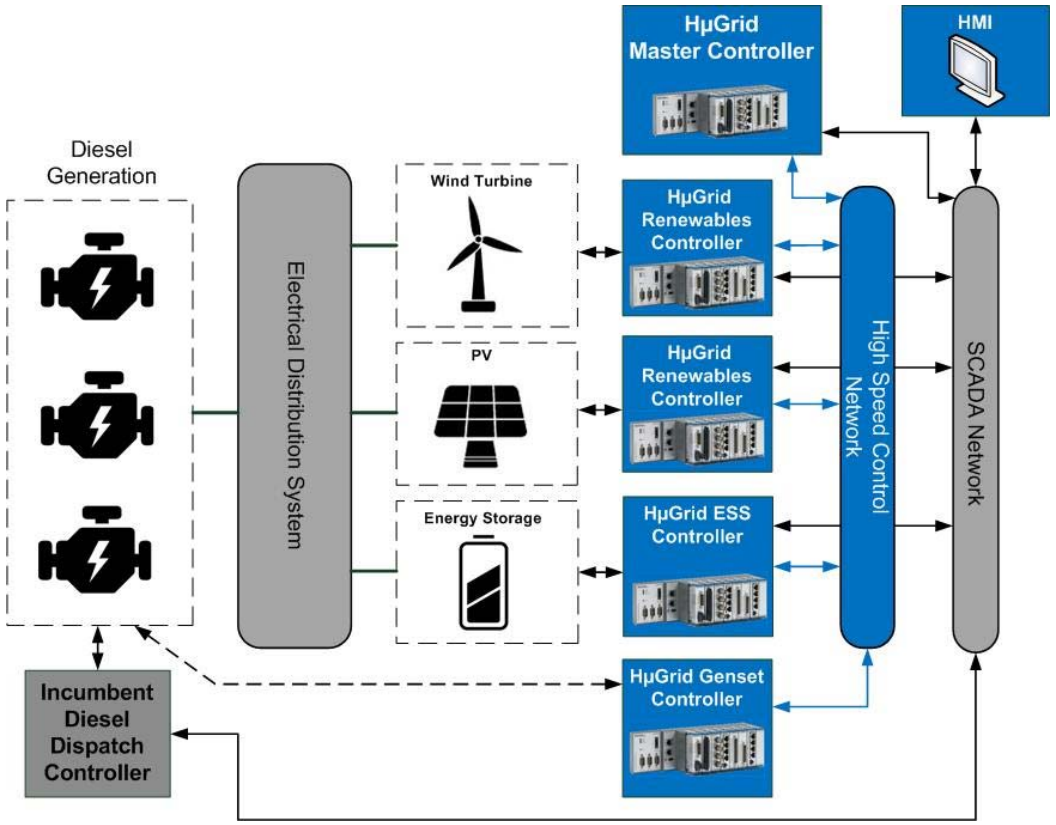


Energy Storage Systems



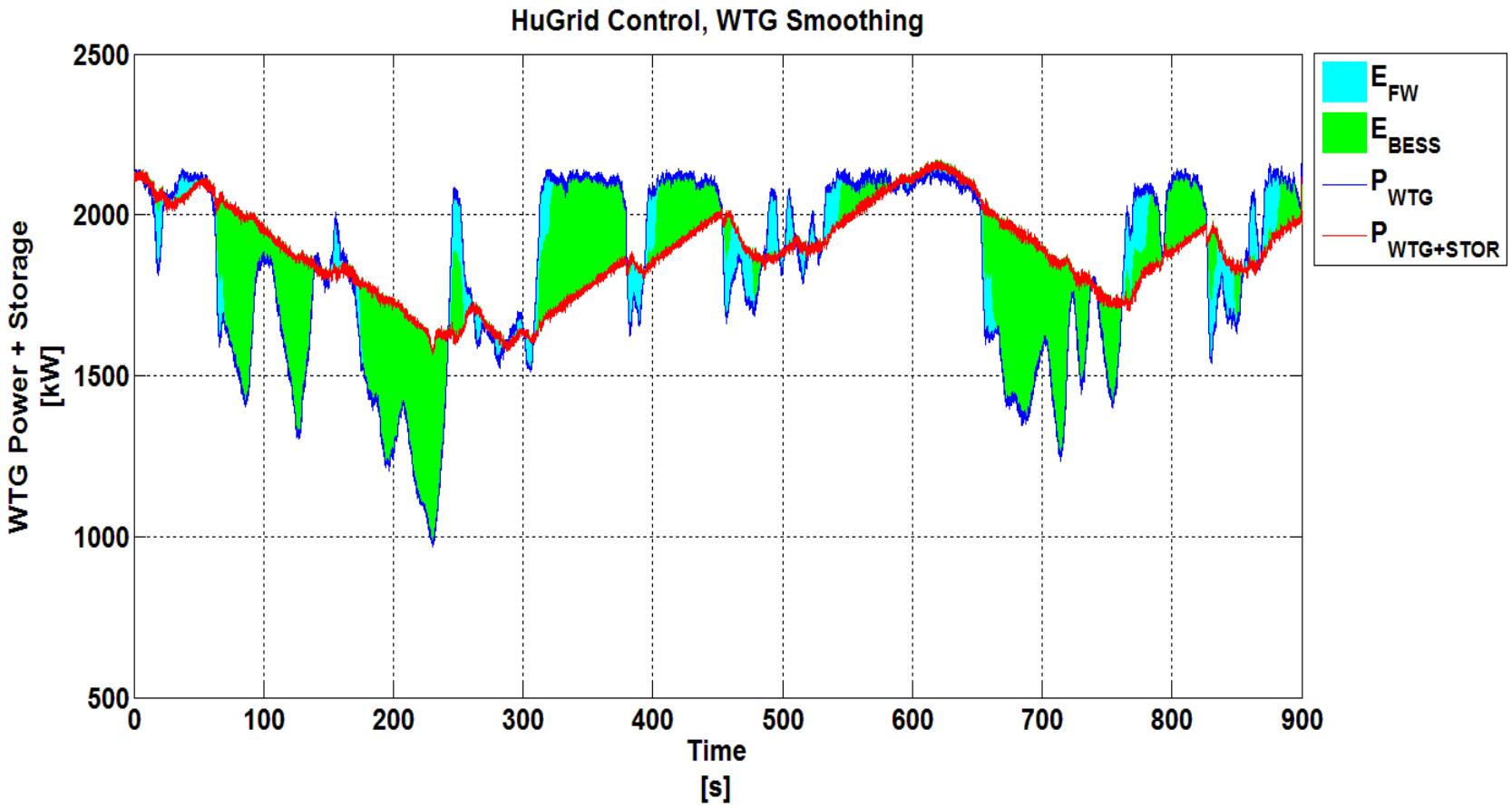
FESS-Pretested and Installed in Pre-Fabricated E-House

Microgrid Control System (HμGrid) –Generic Form

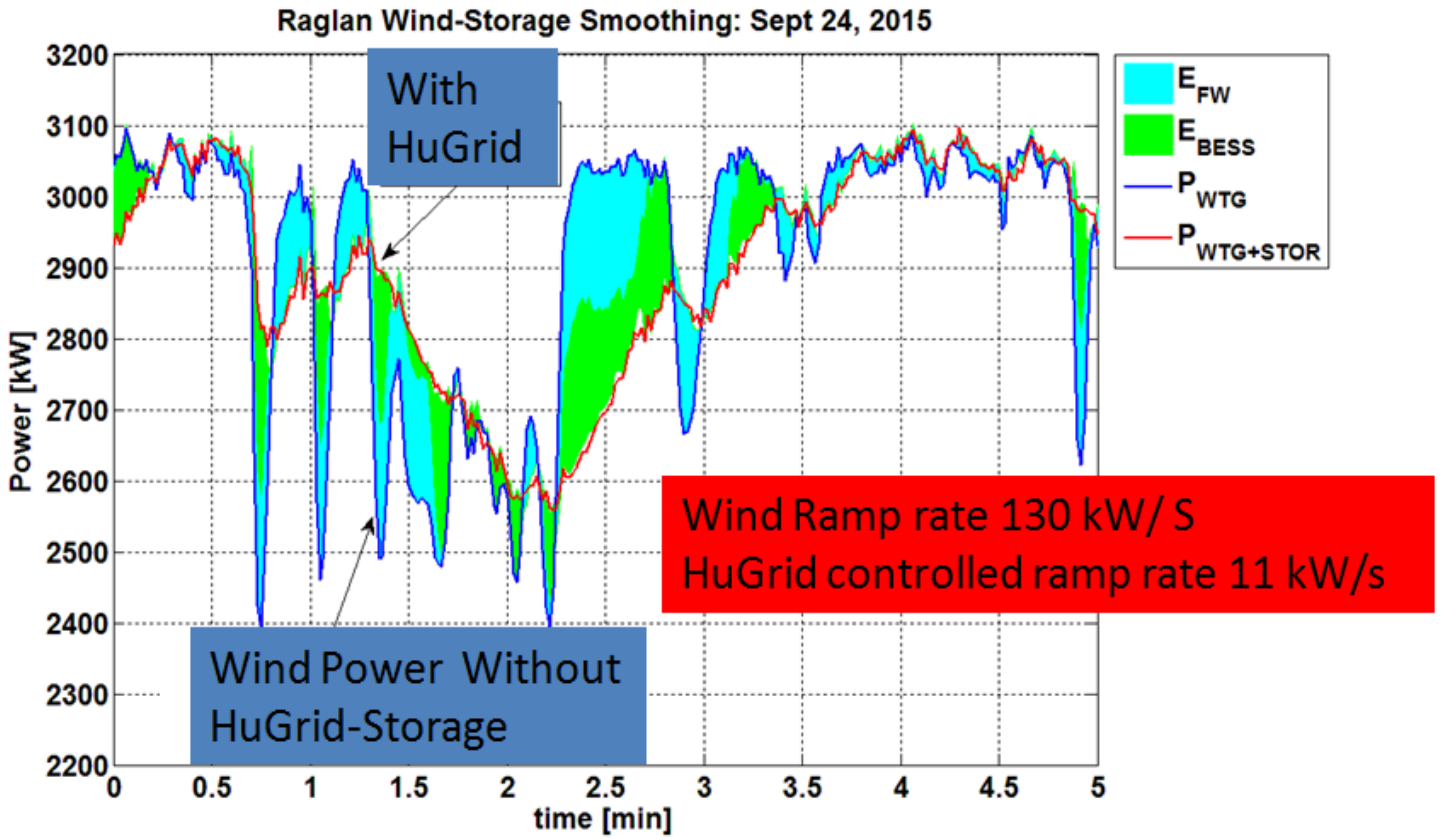


HμGrid Hardware-In-The-Loop Testing with RTDS (Real-Time Digital Simulator) at University of Toronto

Wind Power Smoothing –RTDS HIL Test Results



Wind Power Smoothing – Site Test Initial Results



Closing Remarks

Importance of planning for Northern mine constraints: site logistics and construction season:

- Modularized systems
- Full integrated testing of energy storage and controls before site deployment
- Remote monitoring, diagnostics and tuning

Looking ahead:

- Compare actual performance of various energy storage types under similar loading conditions
- Evaluate the effect of energy storage on fuel consumption reduction
- Increase the utilization of renewable/load forecast in conjunction with storage use