Hybrid wind-diesel system with compressed air energy storage for remote Nordic areas

Presented by:

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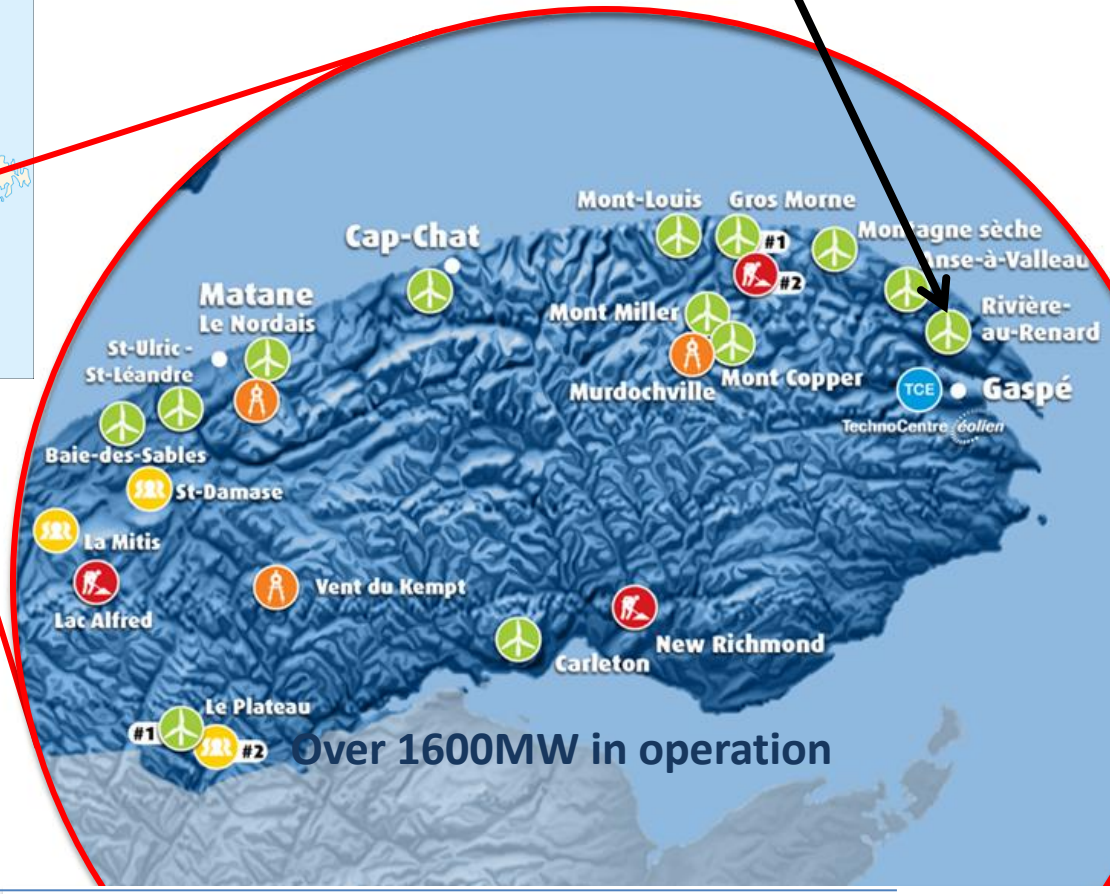
Overview

- What is TechnoCentre éolien
- Nordic context for off grid solutions
- Objectives for Wind-Diesel Hybrid System
- Description of Hybrid Wind-Diesel System with compressed air energy storage (CAES)
- Research program

The TechnoCentre éolien (*Wind Energy TechnoCentre*) is a not-for-profit organisation whose mandate is to contribute to the development of an industrial wind energy network in Québec, able to compete on North American and world stages, while valorising the Gaspésie and Îles-de-la-Madeleine as being central to this emerging niche of Québec's economy.

- ✧Applied research and technological transfert
- ✧Technical support to businesses
- ✧Economic developement
- ✧Communications & events

TCE infrastructure location



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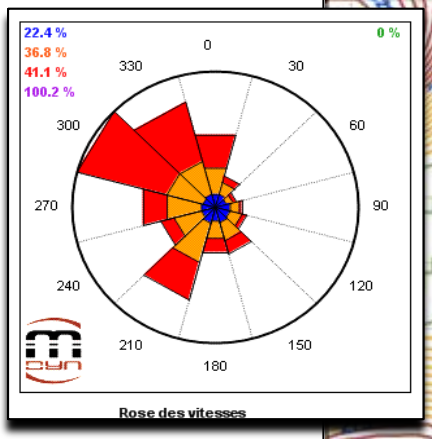
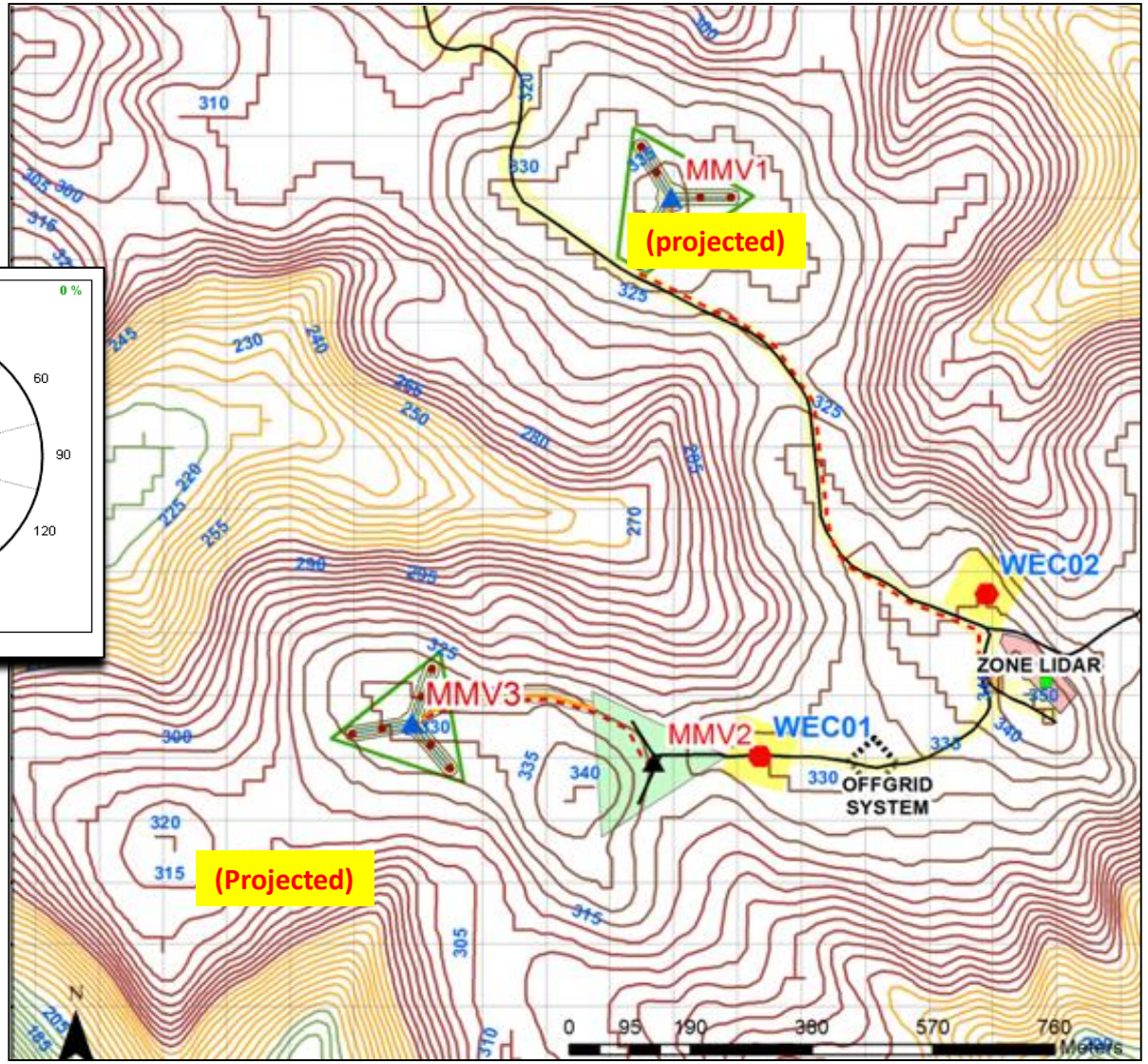
SNEEC test site

Infrastructure Topographic Layout





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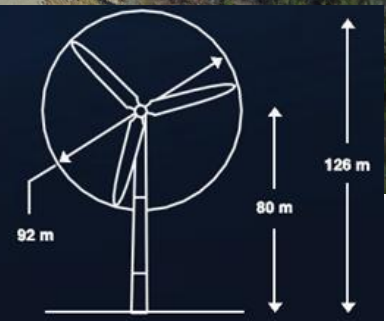
TCE R&D Wind Farm

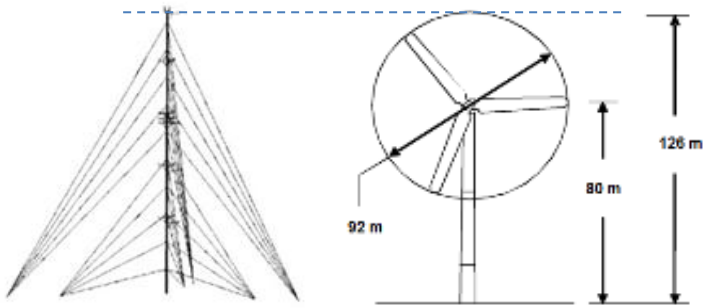
- Two 2.05 MW Repower MM92 wind turbines
- Located in Riviere-au-Renard, Québec, Canada
- Icing & complex terrain
- Commissionned in March 2010
- Research, development and technology transfer projects involving northern climates and complex terrain.

Description	Value
Number of wind turbines	2
Model	REpower MM92 CCV
Rated power / Wind turbine	2.05 MW
Frequency	60 Hz
Rotation speed	7.8 – 15 RPM
Start-up speed	3 m/s (10.8 km/h)
Shut-down speed	24 m/s (86.4 km/h)



IEC wind class: 2
Annual average wind speed: 7.9 m/s
Topography: Complex site with high turbulence, near the sea
Temperature: -30°C to +30°C
Ice conditions: Up to 40 mm of ice

TCE 126m Met Mast

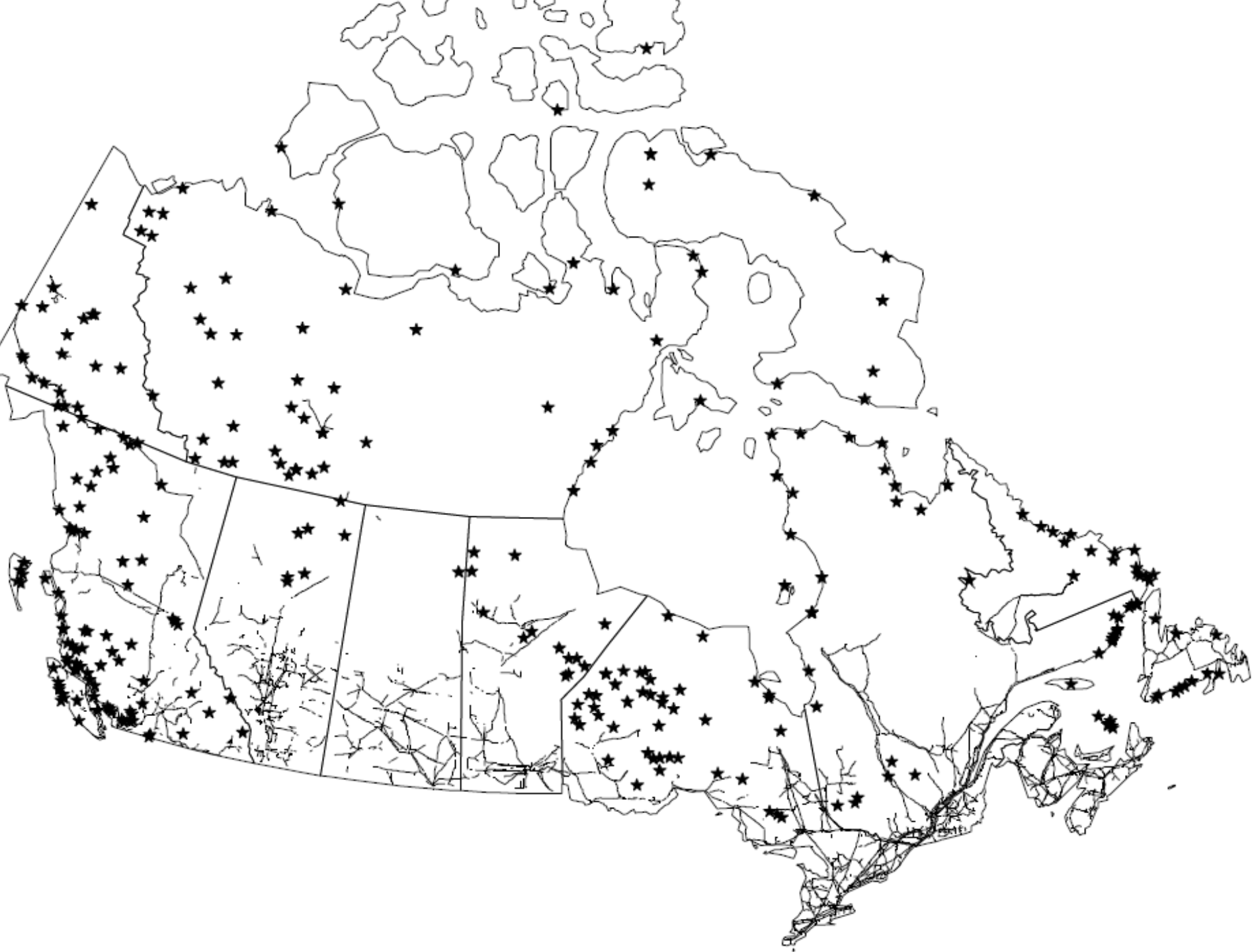


GENERAL OUTLINE OF THE 126m GUYED TOWER

TCE Hybrid Wind-Diesel-CAES System

Nordic context for off grid solutions

- Relying mainly on diesel generators
- Remoteness
  - Fuel costs
  - Fuel storage
- Segmented market
  - Mining facilities
  - Remote communities
  - Single units (telecomm; meteorological stations; radar stations, outfitters)
- Wind-diesel in implementation
  - Low penetration
  - ROI in 5 years



Objectives for Wind-Diesel Hybrid System

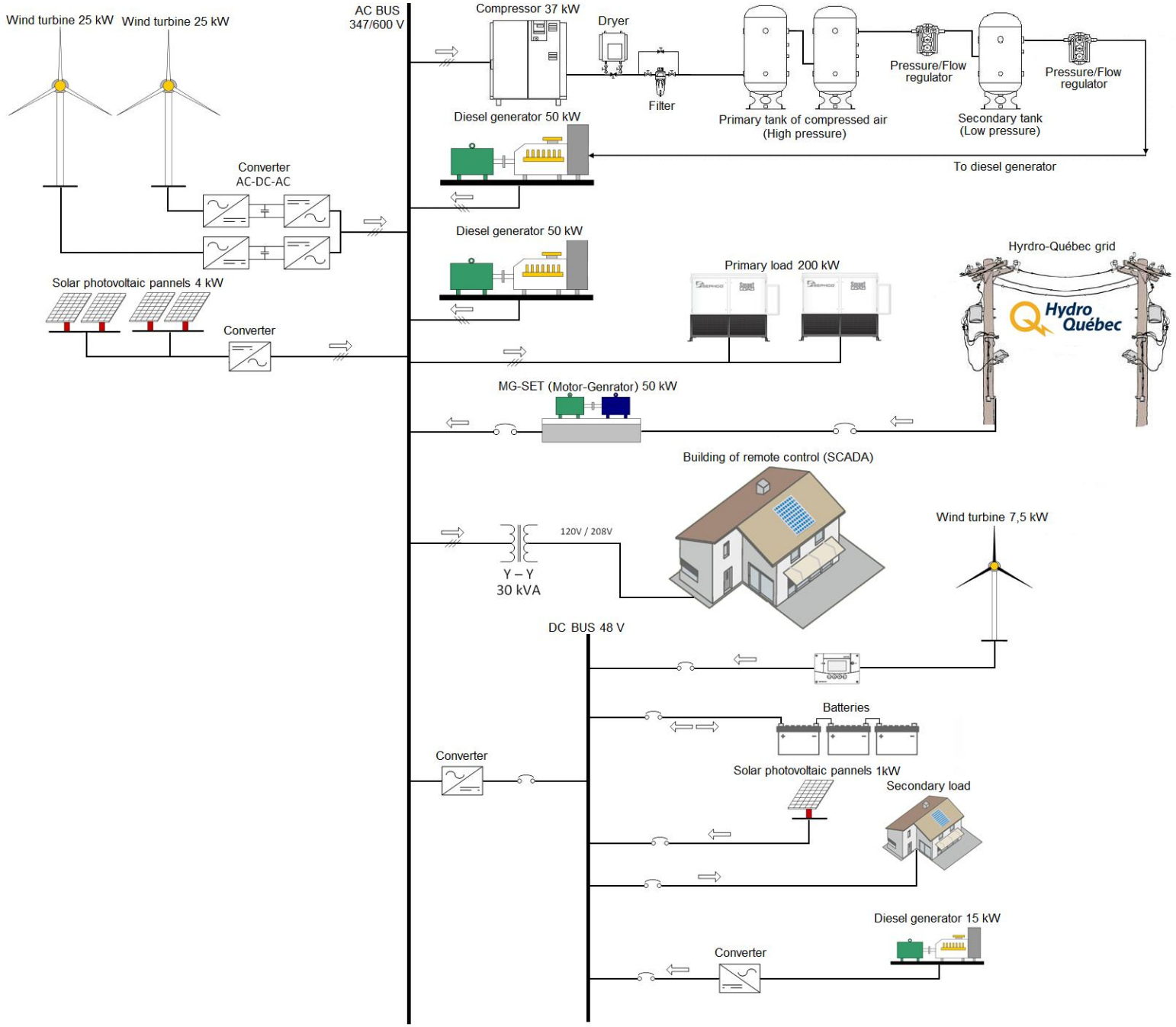
- Develop, test and validate detailed theoretical and experimental models of a wind-diesel-solar system
- Optimise the operation of hybrid systems in accordance with the penetration rate of renewables and other technical factors
- Study and monitor the deterioration of the hybrid systems components and subcomponents
- Create a technological showcase for equipment and systems designed for use in remote Nordic areas
- Create a training centre for Hybrid systems

Description of Hybrid wind-diesel-CAES

- AC Bus
  - 2 direct drive wind turbines (25 kW each)
  - 2 diesel generators (50 kW each) equipped with variable speed transmission)
  - Diesel generator emulator (50 kW, powered by electric motor)
  - Compressed air energy storage system
  - Solar PV (4 kW)
  - Primary load (200 kW resistive load banks; flexible by 5 kW steps)
  - Secondary load (heating, lighting, electronics)
  - SCADA

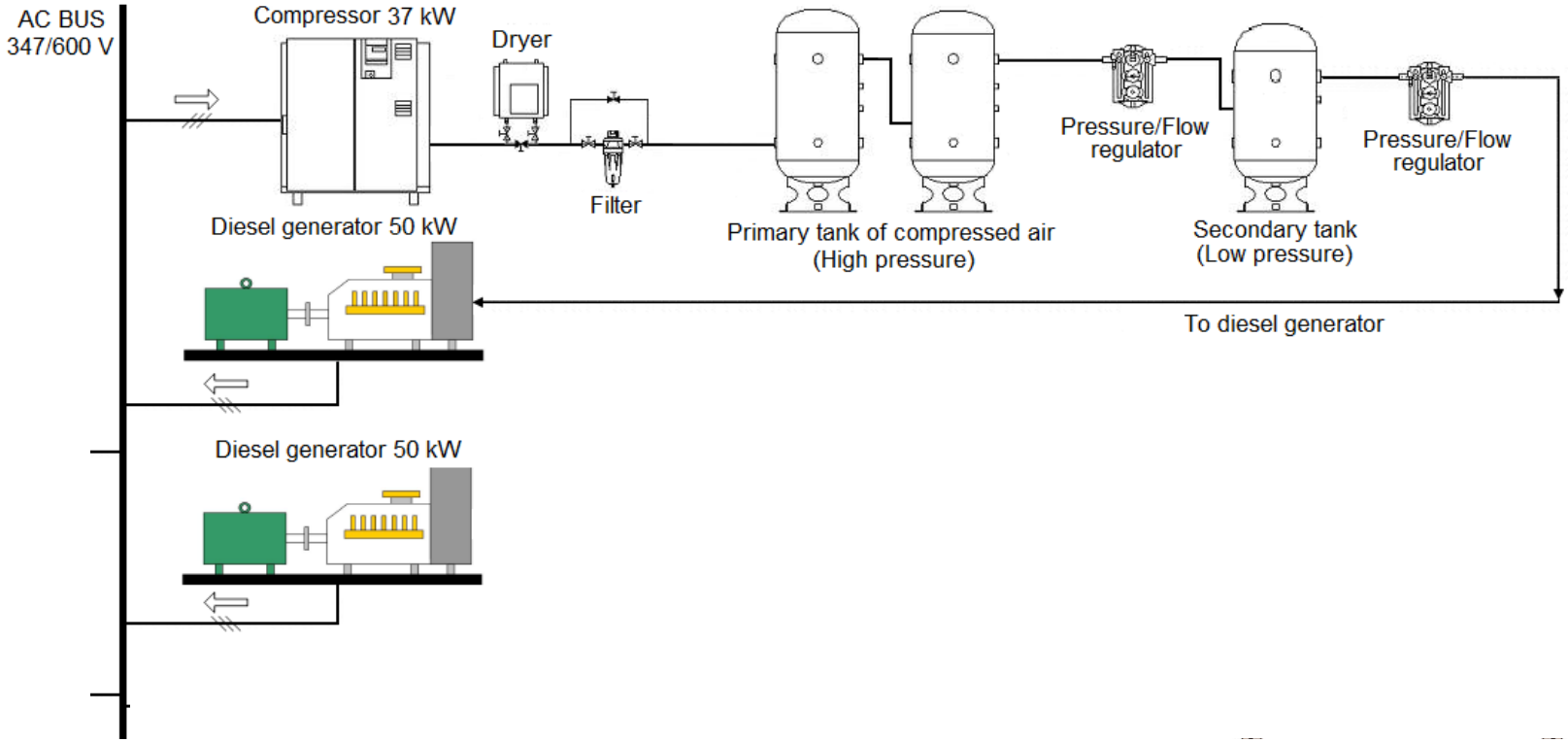
- DC Bus
  - 1 Wind Turbine (7.5 kW)
  - 1 Diesel generator (15 kW)
  - Solar PV 1 kW
  - Batteries
  - Convertors AC-DC/DC-AC

Wind-Diesel-CAES


Wind turbine 25 kW
Wind turbine 25 kW
AC BUS
347/600 V
Compressor 37 kW
Dryer
Filter
Pressure/Flow regulator
Pressure/Flow regulator
Primary tank of compressed air (High pressure)
Secondary tank (Low pressure)
Diesel generator 50 kW
To diesel generator
Converter AC-DC-AC
Diesel generator 50 kW
Primary load 200 kW
Hyrdro-Québec grid
Hydro Québec
Solar photovoltaic pannels 4 kW
Converter
MG-SET (Motor-Genrator) 50 kW
Building of remote control (SCADA)
120V / 208V
Y – Y
30 kVA
Wind turbine 7,5 kW
DC BUS 48 V
Batteries
Converter
Solar photovoltaic pannels 1kW
Secondary load
Diesel generator 15 kW
Converter

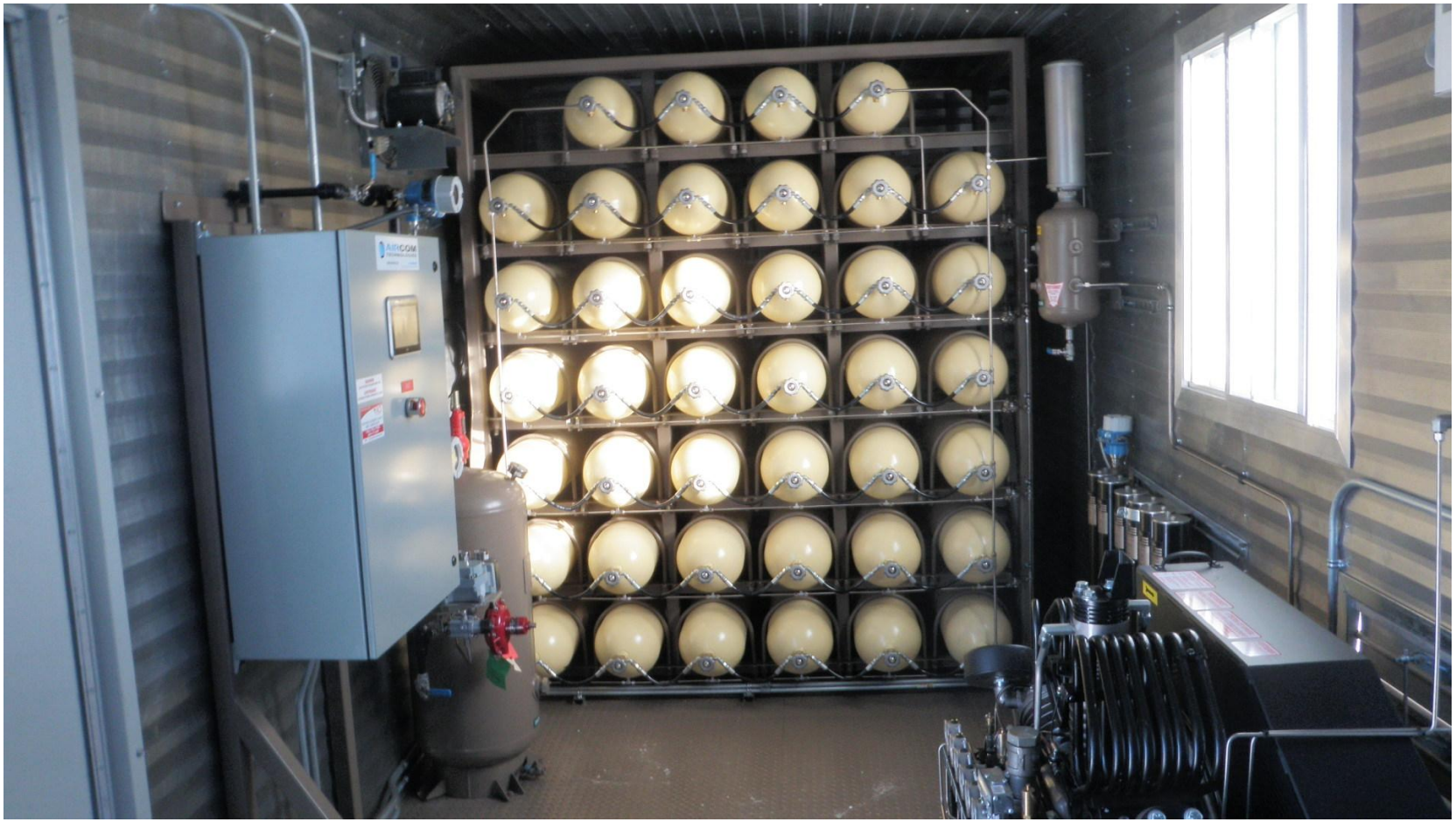
Diesel-CAES subsystem

Schematic of Diesel-CAES



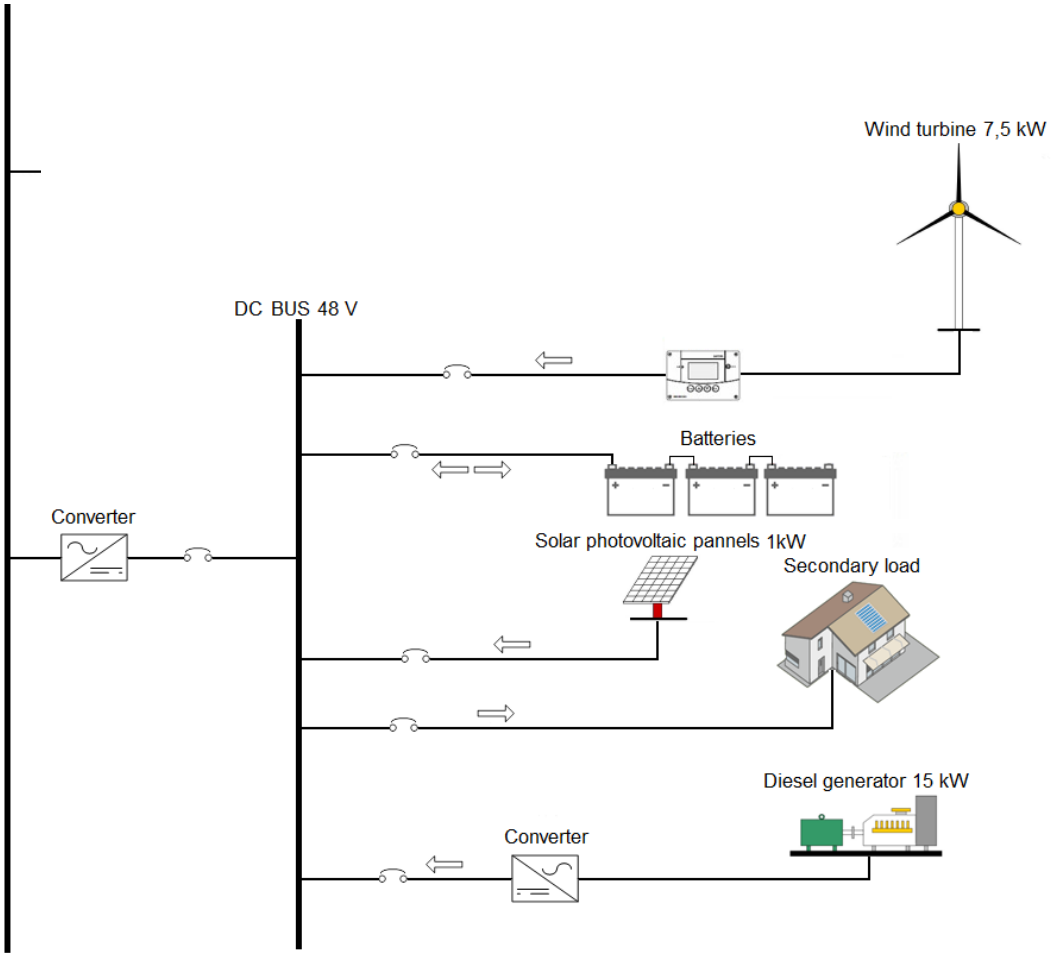
Diesel subsystem

CAES



CAES

DC subsystem



Research program

- Hybrid Wind-Diesel-CAES system Design
  - Electromechanical architecture
  - Mechanic and electric devices modeling
- Simulation development
  - Short term yield forecast
  - Simulator development
- Control, regulation and optimization of the whole system
  - Development of an operational control and management strategy
  - Development of a resistive banks bidirectional modulator
  - Algorithm to control the compressed air intakes
  - Control strategy to coordinate several diesel
  - SCADA development
  - Experimental validation on bench test (virtual)
  - Experimental validation on bench test (in situ)

Thank you, Tack, Danke, Merci!

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