Natural Resources Canada Ressources naturelles Canada

Introduction of Hydrogen Technologies to Ramea Island

CLEAN ENERGY TECHNOLOGIES

Morel Oprisan

IEA Wind – KWEA Joint Workshop

April, 2007

Canada

Presentation Overview

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2. Background
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1. Ramea Island

Newfoundland

Ramea Island

Island of Newfoundland

- World class wind resource
- Potential for many 100’s of MW

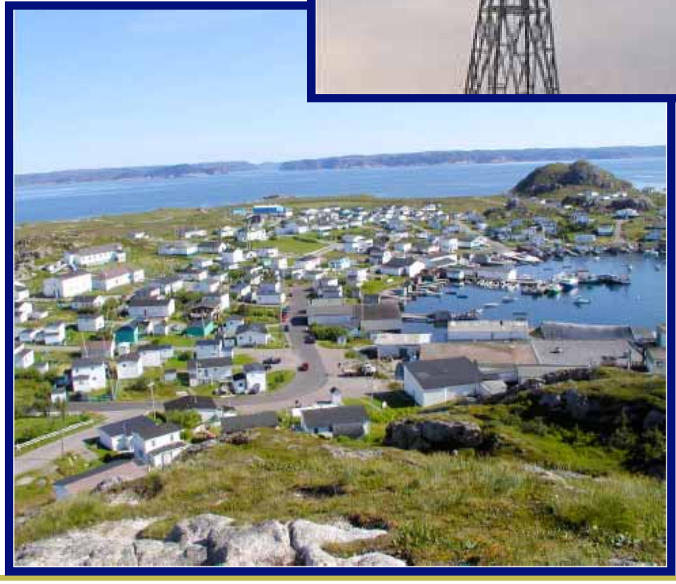
Ramea Island

- Not connected to Island grid
- Ferry access only
- ~ 350 customers
- 1,078 kW peak load (winter)

2. Background

- Commissioning of first Wind-Diesel demonstration project in Canada in 2004
- NRCan's unique control system integrates wind with existing diesel generation
- +12 months of successful operation:
  - CF = 0.33
  - Wind production ~ 1 million kWh electricity / yr
  - Diesel fuel savings ~ 10%
  - ~ 750 tonnes / yr GHG emissions reductions
  - Improved air quality

Windmatic 65 kW Turbine



Town of Ramea

Current Situation on Ramea

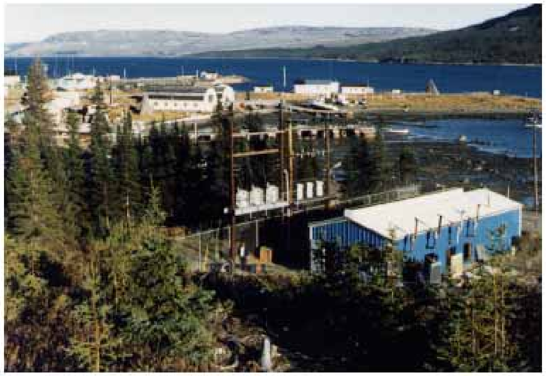
- Installed wind capacity: 6 x 65 kW = 390 kW
- Real wind capacity: 390 kW x 0.33 = 129 kW
- Total energy produced = 4,201 MWh in 2005
  - Diesel / Wind (90% / 10%)
- Installed diesel capacity: 3 x 925 kW = 2,775 kW
- Often one only diesel generator running at 300 kW
- Excess wind energy is dumped, therefore, **storage** would increase wind penetration

Wind-Diesel System in Ramea, Newfoundland

Potential for Commercialization

Existing NL Hydro isolated diesel systems:

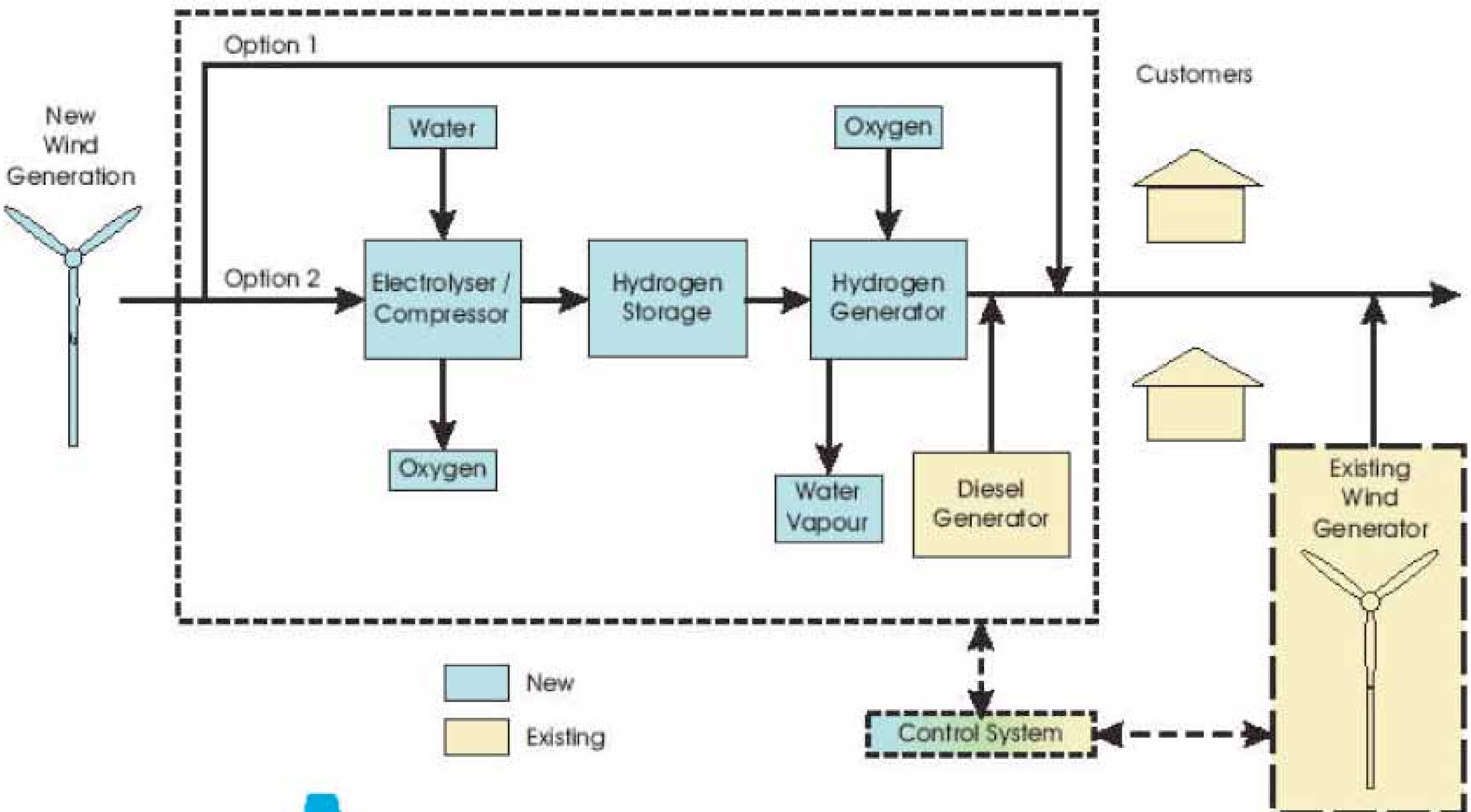
- Black Tickle
- Cartwright
- Charlottetown
- Hopedale
- L'Anse au Loup
- Makkovik
- Mary's Harbour
- Nain
- Norman Bay
- Paradise River
- Port Hope Simpson
- Postville
- Rigolet
- St. Lewis
- Williams Harbour



- Francois
- Grey River
- Little Bay Islands
- McCallum
- Ramea
- St Brendan's

Significant potential for deployment in remote communities in Canada and around the world

3. Hydrogen Integration



4. Project Phases

A. Feasibility study

- Modelling and feasibility study done by NRCan
- Goals: Establish potential for hydrogen storage and contribute to equipment sizing

B. Implementation on Ramea

- Led by Newfoundland and Labrador Hydro
- Other Canadian Federal Government funding: $3M CAD confirmed, $1.7M CAD pending

5. Project Partners

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HYDRO THE POWER OF COMMITMENT

MEMORIAL UNIVERSITY

MAKING A SIGNIFICANT DIFFERENCE
UNIVERSITY OF NEW BRUNSWICK

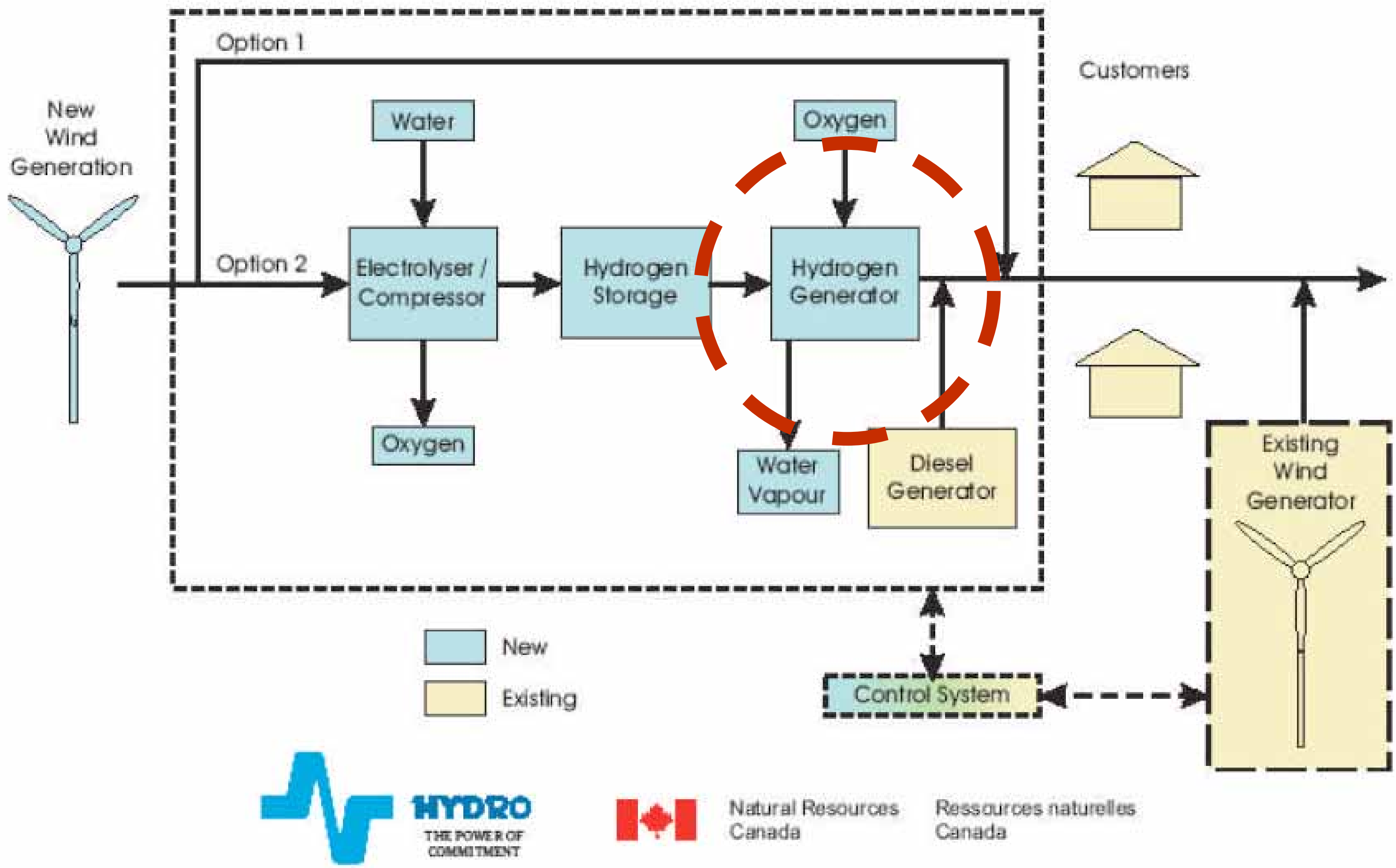
FRONTIER POWER SYSTEMS

6. Equipment Sizing

- Hydrogen Generator
- Hydrogen Storage / Compression
- Electrolyzer
- Wind Capacity
- Control System

Relationship between components is complex

Hydrogen Generator



Hydrogen Generator

- Known, reliable internal combustion technology
- Lower cost than fuel cell
- Current fuel cell technology not mature enough
- Previous operator experience

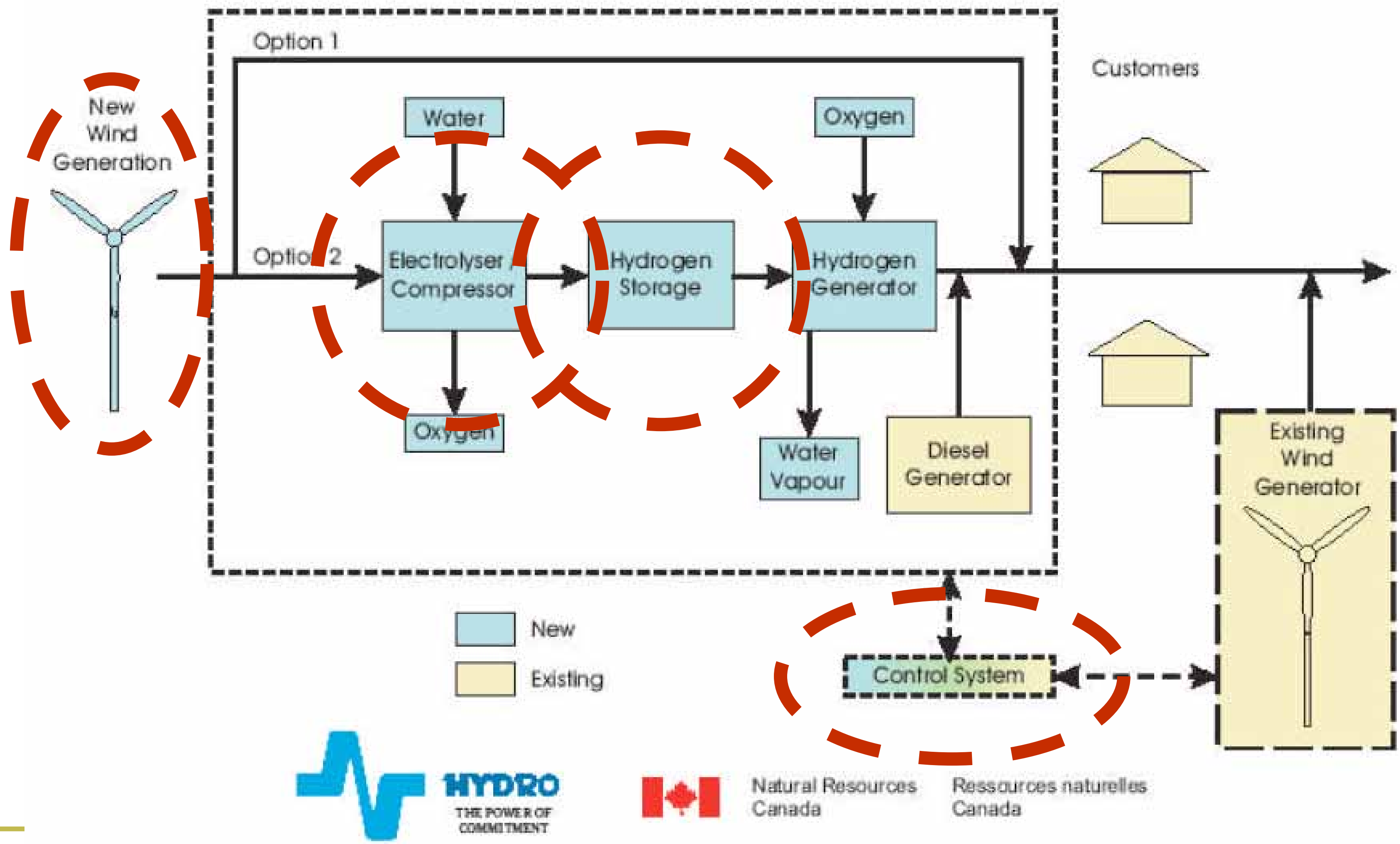
HEC 250 kW H_2 Genset

Hydrogen Generator

- 250 kW (4+1 engines, 4 x 62.5 kW)
- Supplied by Hydrogen Engine Center Canada
- Based on 4.9 L Ford engines
- Testing for performance, emissions, modelling parameters in Spring 2007
- Post-testing: Loaned and delivered to NL Hydro

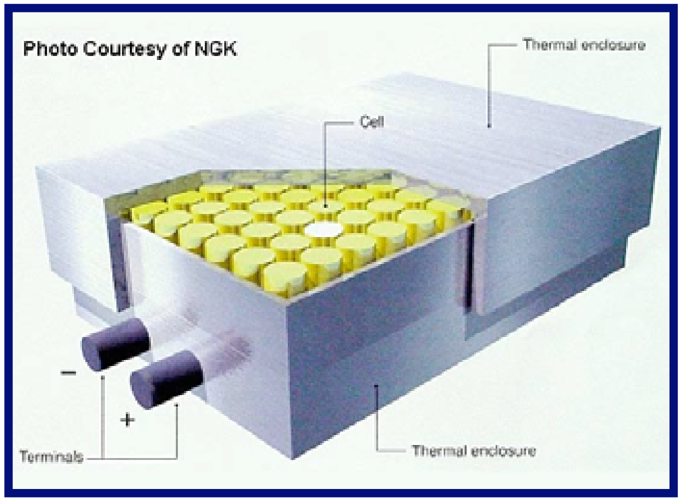
Interior View of HEC 250 kW H_2 Genset

Other Equipment



Hydrogen Storage

- Conventional H_2 storage leaves smaller environmental footprint than batteries
- Looking at long-term storage applications towards a H_2 economy
- Complementary to NRCan's existing R&D into advanced utility-sized batteries (e.g. VRB and NaS)



Sodium Sulphur Battery

Hydrogen Storage / Compression

Preliminary Estimate

- Work backwards from genset requirement to determine how large storage needs to be
- Genset H_2 consumption: 250 Nm^3/hr

H_2 Storage

- Min genset autonomy: 8 hours
  8 hr x 250 Nm^3/hr ≈ **2000 Nm^3 required storage**
- At 6700 psi (typical steel storage), require 6837 L $H_2$0 equivalent volume

9 x 19-ft cylinders

Electrolyzer

Preliminary Estimate

- Work backwards from storage requirement to determine minimum electrolyzer H_2 production
- Maximum time to fill H_2 storage: 24 hrs
  2000 Nm^3 / 24 hrs = 79 Nm^3/hr
  + additional capacity

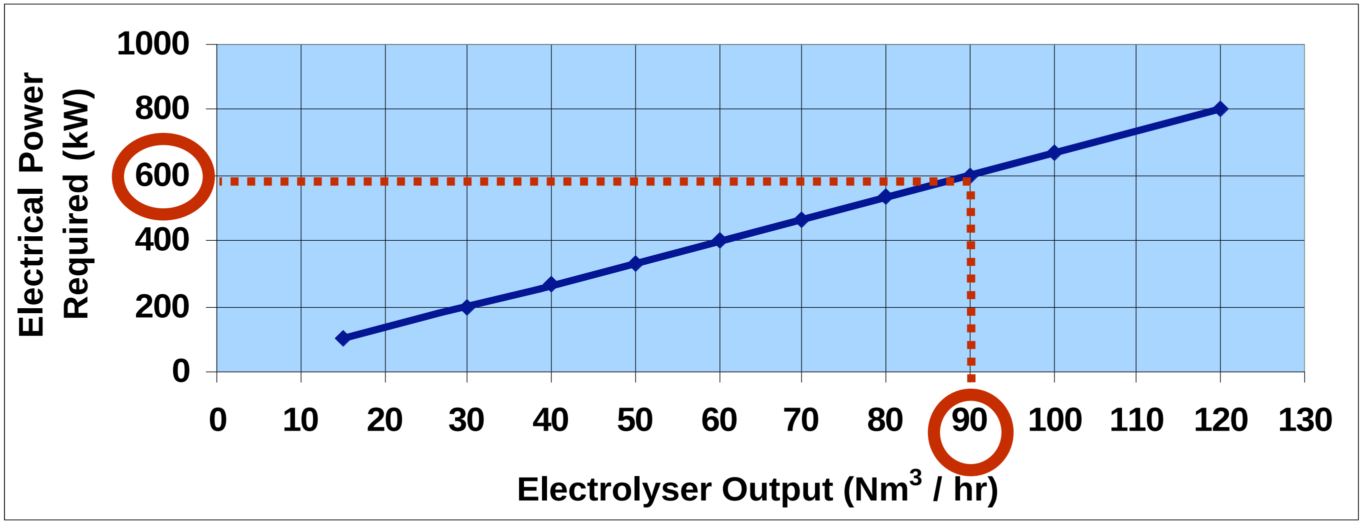
~ 90 m^3/hr electrolyser

Hydrogenics Electrolyzer

Wind Capacity

Preliminary Estimate

- Work backwards from electrolyzer electrical requirement to determine minimum wind capacity (kW)
- Assume CF = 0.33



~ 1500 kW planned installed wind capacity

Control System

- Control system must work with each component's control system and with the existing wind-diesel control system
- Must optimize each component's production so that overall wind penetration is maximized

Enercon E33 Turbine

7. Project Timeline

August 2007: Project Definition & Sanctioning

- Committed funding finalized & funding contracts completed
- Project partnerships established and agreements in place
- System modelling, component sizing and project design

December 2008: Project In Service

- Finalize equipment selection and design
- Procure equipment
- Control system design, testing, development and commissioning

December 2011: Three Years Operations & Reporting

8. Expected Performance

- Preliminary performance will be optimized through feasibility study
- Round trip efficiency expected to be approximately 25%

Component	Approximate Efficiency
Electrolysis + Compression	80%
Storage + Decompression	90%
Hydrogen Internal Combustion	35%
Approximate Round Trip Efficiency	**25%**

Thank You

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