Practical considerations for remote microgrid design and energy management

Michael Ross, Ph.D., P.Eng.
Industrial Research Chair in Northern Energy Innovation

Farid Katiraei,
Sr. Director, Advanced Technology Integration
Quanta Technology

Presentation overview

1. Considerations with integrating renewable generation in remote communities
2. Opportunities through microgrid control and EMS design

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1. Considerations with integrating renewable generation in remote communities
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Source: NRCan/AANDC

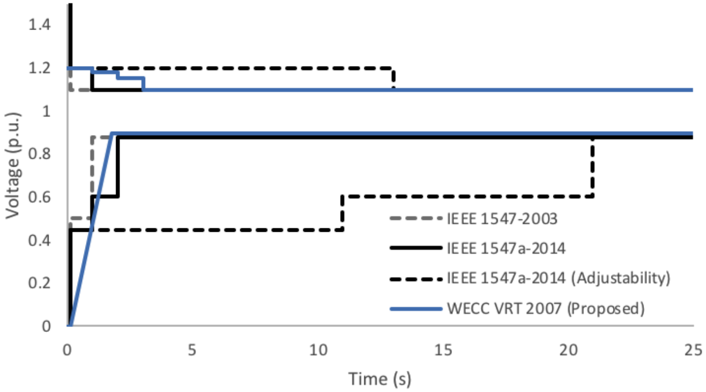
Technical issues/considerations

Safety

Utilities' prime mandate is to provide **safe**, reliable power to their customers

Safety

- Voltage and frequency regulation, power quality
- Protection system analysis
  - nuisance tripping
  - non detection zones
  - protection coordination



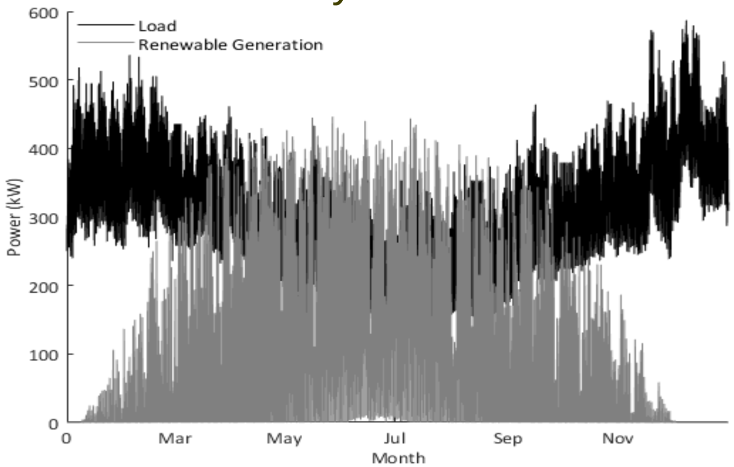
Technical issues/considerations

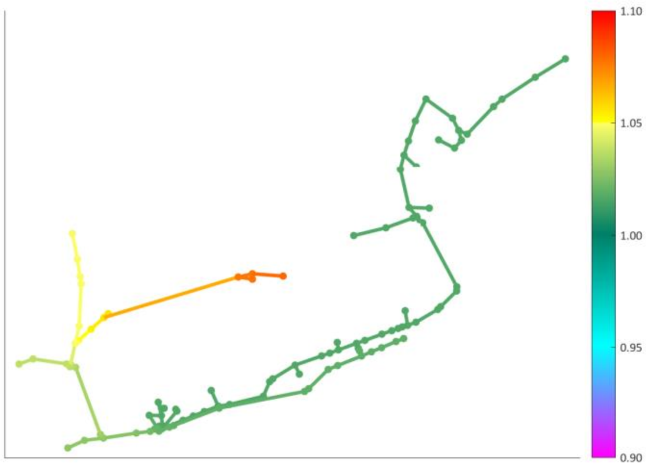
Adequacy

Utilities' prime mandate is to provide safe, **reliable** power to their customers

Adequacy

- Ability to supply the required power and energy without exceeding system ratings or operating limits, and with voltages and frequency within tolerances
  - Energy balance
  - Load flow analysis





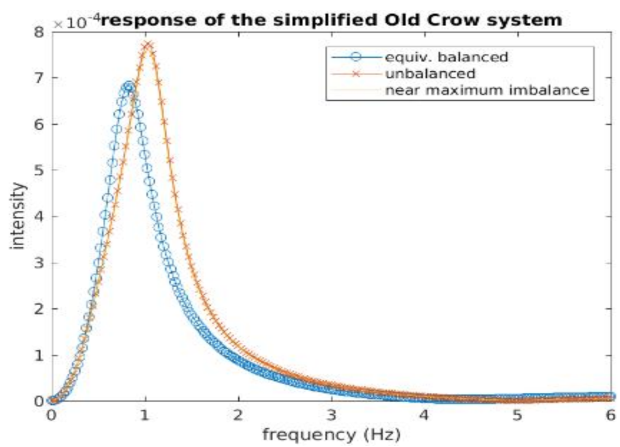
Technical issues/considerations

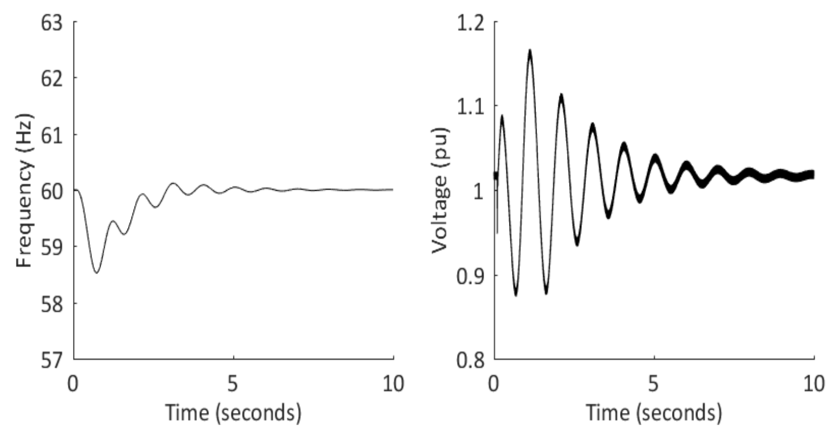
Security

Utilities' prime mandate is to provide safe, **reliable** power to their customers

Security

- Security is the ability to tolerate a credible event without loss of load, over-stress of equipment, or deviation from voltage and frequency tolerances
  - Large disturbance stability
  - Small signal stability





Remote challenges

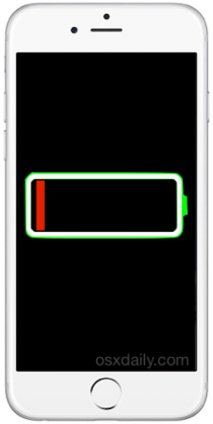
System

- Lower system inertia
- High phase imbalance
- Low X/R ratio
- Legacy equipment
- High reliability requirement

Iqaluit, Nunavut, Canada

Remote challenges

Technology



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Once you've seen one remote community…

You've seen *one* remote community

Presentation overview

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MICROGRID ENERGY MANAGEMENT SYSTEMS MARKET PERSPECTIVE AND VENDOR OFFERING

Farid Katiraei & Shadi Chuangpishit

Bucharest 2018 Microgrid Symposium

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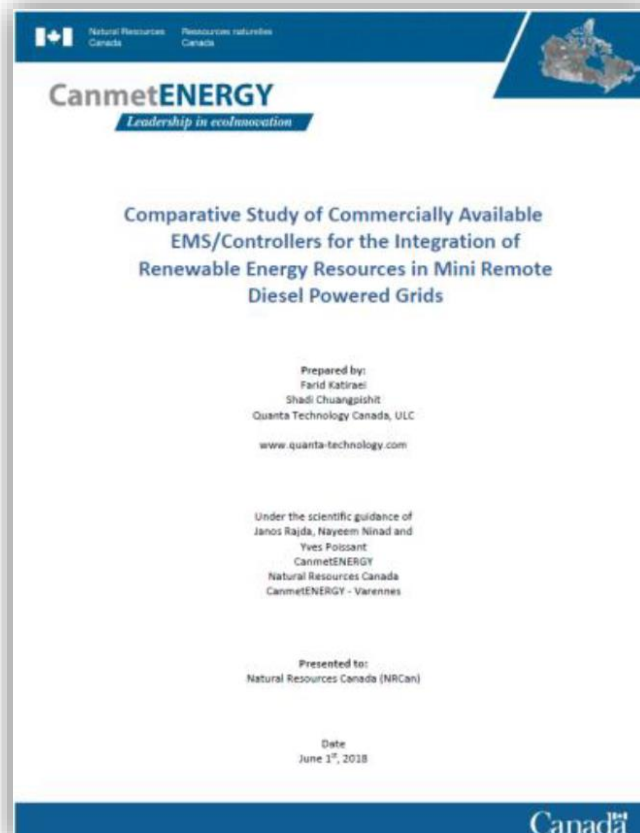
Outline

- Introduction
- Microgrid Energy Management Systems
  - **Technical aspects & Standards**
  - **Structure and functional considerations**
  - **Market perspective -** based on vendor surveys
- Summary and Conclusions

Acknowledgement: Work supported by NRCAN - CanmentEnergy team:

- Yves Poisson
- David Turcotte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CanmetENERGY

Leadership in ecoInnovation

Comparative Study of Commercially Available EMS/Controllers for the Integration of Renewable Energy Resources in Mini Remote Diesel Powered Grids

Prepared by:
Farid Katiraei
Shadi Chuangpishit
Quanta Technology Canada, ULC

www.quanta-technology.com

Under the scientific guidance of
Janos Rajda, Nayeem Ninad and
Yves Poissant
CanmetENERGY
Natural Resources Canada
CanmetENERGY - Varennes

Presented to:
Natural Resources Canada (NRCan)

Date
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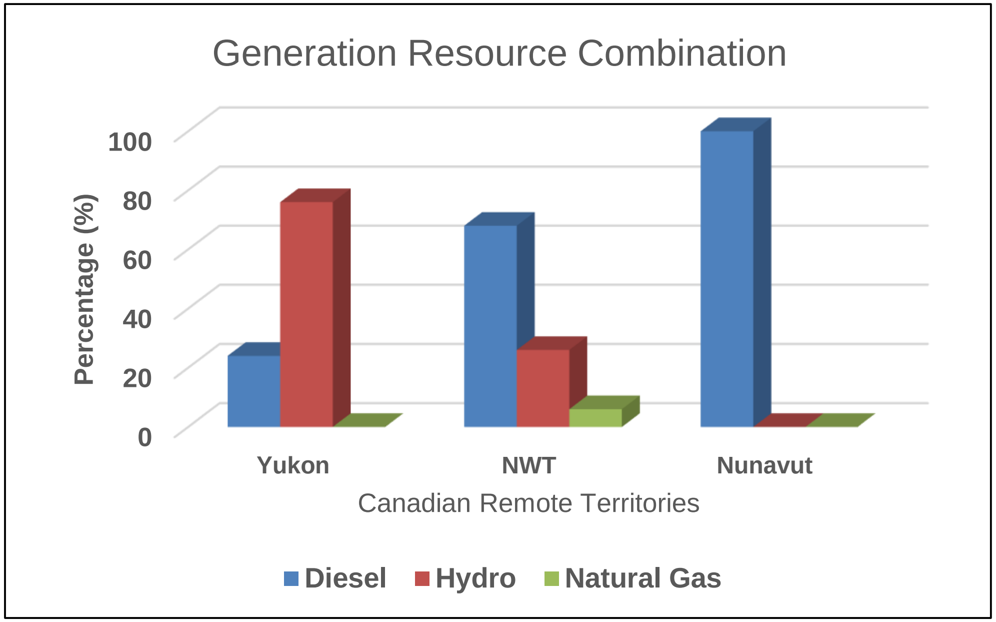
Introduction – NRCAN Project Overview

Canadian remote communities



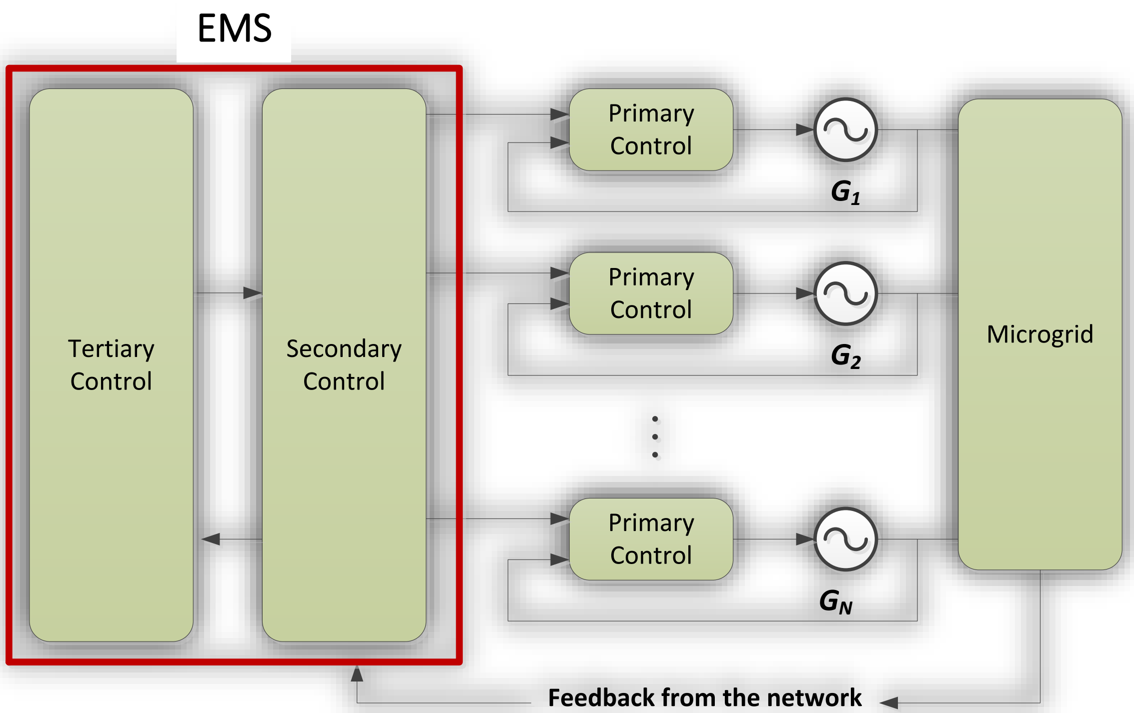
Challenge:
High diesel fuel costs

Solution:
Renewable energy resources integration forming Mini-Grid / Microgrid

Report Objective:
Assess the availability of commercial microgrid controllers and communication interfaces for managing integration and utilization of renewable and sustainable energy resources in Canadian remote communities.

Energy Management Systems (EMS)

- **Primary control** (asset/device level controllers):
  - Performing the role of voltage and frequency regulation and power balancing
- **Microgrid / Mini-Grid EMS** (Supervisory controls or Master controller):
  - Performing the role of coordinating resource utilization and operation of various elements of the system. Different **EMS** types include varying levels of resource Optimization to achieve certain operational goals



EMS Key Requirements

- Managing connection/disconnection/dispatch of DERs
  - Coordinate operation of various assets in different modes of operation
- Reducing diesel (fossil) fuel consumption
- Increasing renewable energy penetration
- Managing voltage (power quality) across the microgrid
- Performing load management for enhancing efficiency

All of the above has to be achieved with better performance & reliability with respect to the existing grid !!!

Microgrid Controller Standards

IEEE 2030.7- Standard for the Specification of Microgrid Controllers

- To address the functions above the device-level control that are associated with the proper operation of a Microgrid and common to all microgrids, regardless of topology, configuration or jurisdiction

IEEE 2030.8- Standard for the Testing of Microgrid Controllers

- The common (core) functions are also defined in a way that they can be tested using a pre-defined test procedures and a set of performance metrics

Purpose:

- Achieve modularity and interoperability of interfaces to enable wide adaptation of the functions and controllers
- Focus on a modular approach that enables potential future expansion and new features.

IEEE 2030.7 - Functional Framework

Vendor Perspective | **Standard Perspective**

Advanced features

Higher level functions
- Operator Interface
- Optimal dispatch
- Grid/Market communications

Basic features

Core level functions
- Connect / Disconnect
- Dispatch (including simple rules)

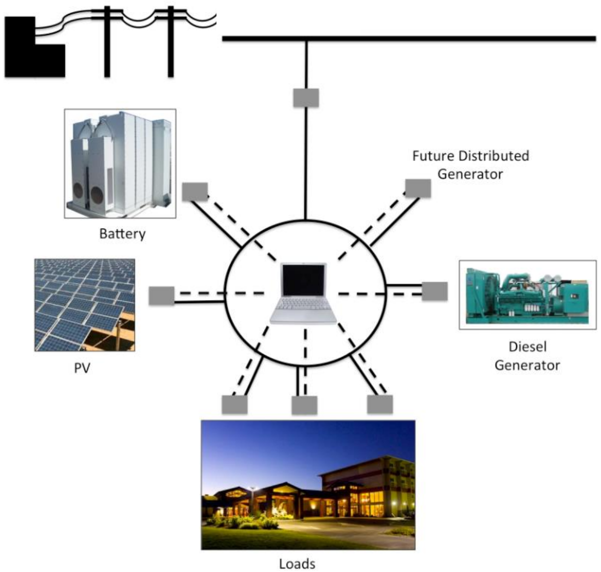
Asset level features

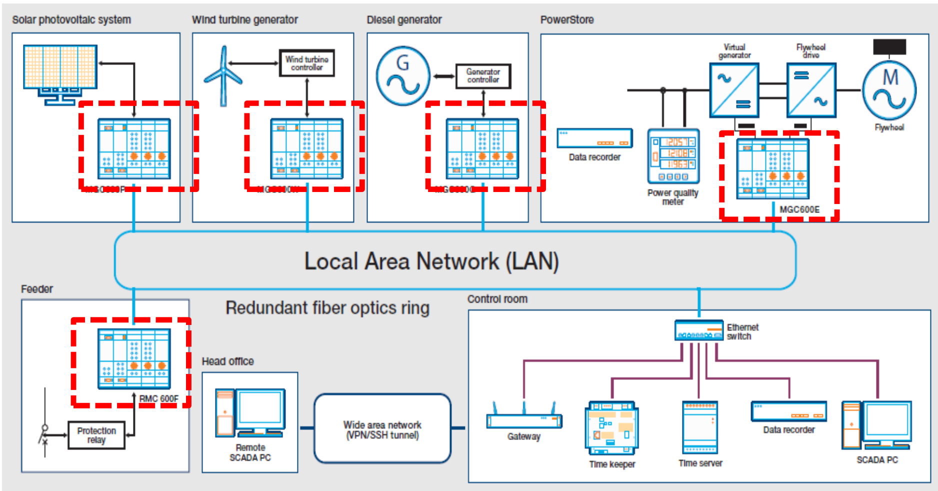
Lower level functions
- Voltage/frequency controls
- Device level controls

Microgrid Controller functional view

EMS Control Architecture (Deployment)

Two types: Centralized Vs. Distributed





Centralized Control | **Distributed Control**

Note: primary controls are distributed by nature (at DER level)

Microgrid Control Systems

Market Perspective

- Who are the market players?
- What do they offer?
- At what price?

North American Market Players – Microgrid EMS

ABB

GE

SMA

SIEMENS

Spirae

IPERC ADVANCING THE POWER OF ENERGY

Younicos

EATON Powering Business Worldwide

ENCORP

smarter grid solutions

SUSTAINABLE POWER SYSTEMS

Schneider Electric

PRINCETON POWER SYSTEMS Clean Power Made Simple™

Advanced Microgrid Solutions

OATI

ARDA power DC-connected energy

Note: Vendor survey was performed in Q1 2017

Examples of EMS Deployment in Real World Projects

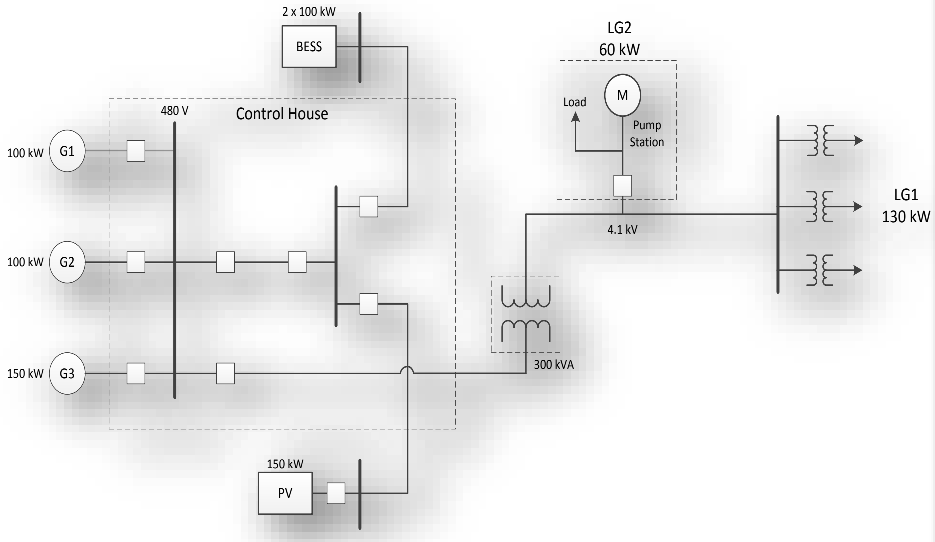
Vendor	Product	Customer/Project/Location
IPERC (S&C)	GridMasterTM	Department of Energy (DoE), Department of Defense (DoD), and Department of Homeland Security (DHS) - SPIDER Projects
		Ameren Illinois Microgrid
		“TransitGRID” (New Jersey)
Alstom (GE)	DMC490	University of Ontario Institute of Technology (Uoit) Microgrid
Schneider	Power Control System (PCS)	Bear Creek Ski Resort Microgrid (Pennsylvania)
		ONCOR Microgrid (Texas)
ABB	MGC600	Solar/diesel Microgrid at Johannesburg Facility
		Ross Island Wind/Diesel (Antractica New Zealand)
Younicos	Y.Q Energy Manager	Graciosa Battery Park (Portugal)
Encorp	Gold Box	**Santa Rita jail** (California)
		Chowchilla and Red Bluff (California)
Princeton Power	GTIB	**Alcatraz Island Microgrid** (San Francisco Bay)
		Annobon Island Microgrid (Equatorial Guinea)
Siemens	SICAM Microgrid Controller Solution	IREN2 project (Wildpoldsried, Germany)
SMA	Fuel Save Cotroller	PV-Diesel Hybrid System (Cojiba/Bolivia)
		University Hospital (Mirebalais, Haiti)
Spirae	Spirae Wave	SDG&E - **Borrego Microgrid** (California)
SPS	Universal Microgrid Controller	San Nicolas Island Wind/Diesel Microgrid (California)

Vendor Comparison

Product or Solution	• Off the shelf with re-defined library of functions • Or requires significant engineering by vendor
Open source or Proprietary	• User programmable • Based on logical blocks and standard schemes
Basic and Advanced features	• Standardized functions for remote applications • Reliability and robustness of solutions
Price	• Hardware/software cost • Design/Engineering/Deployment cost

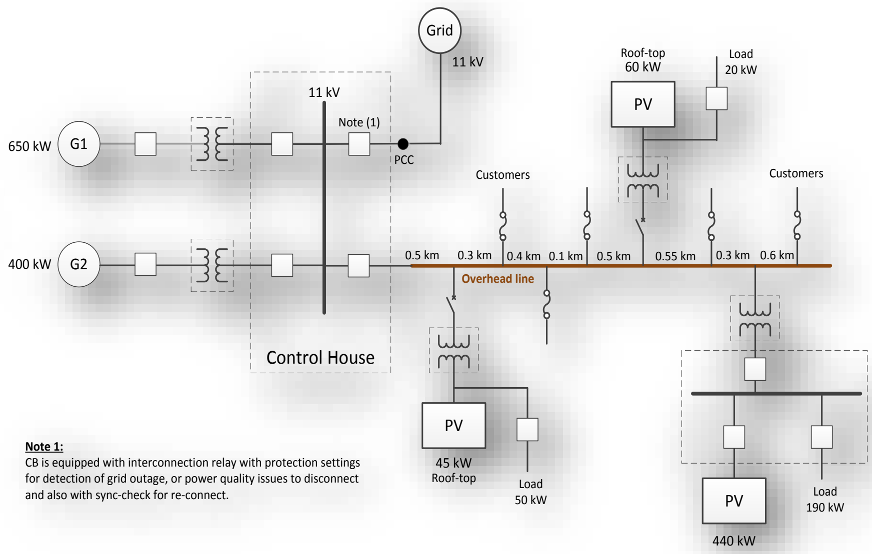
RFQ – System 1 & System 2

Remote Small Mini-grid



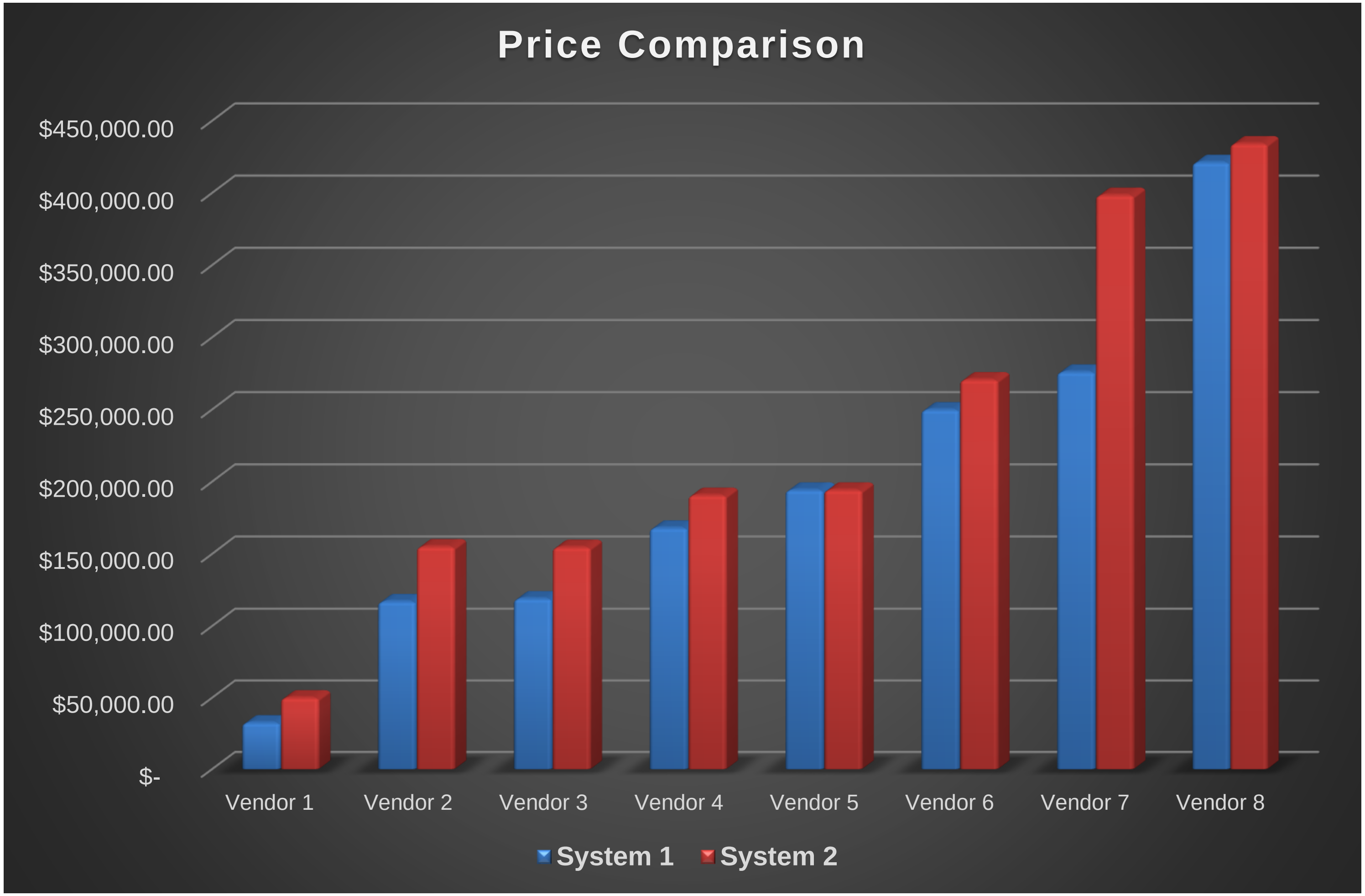
Diesel:
PV:
BESS:
Load:

Remote Micro-grid

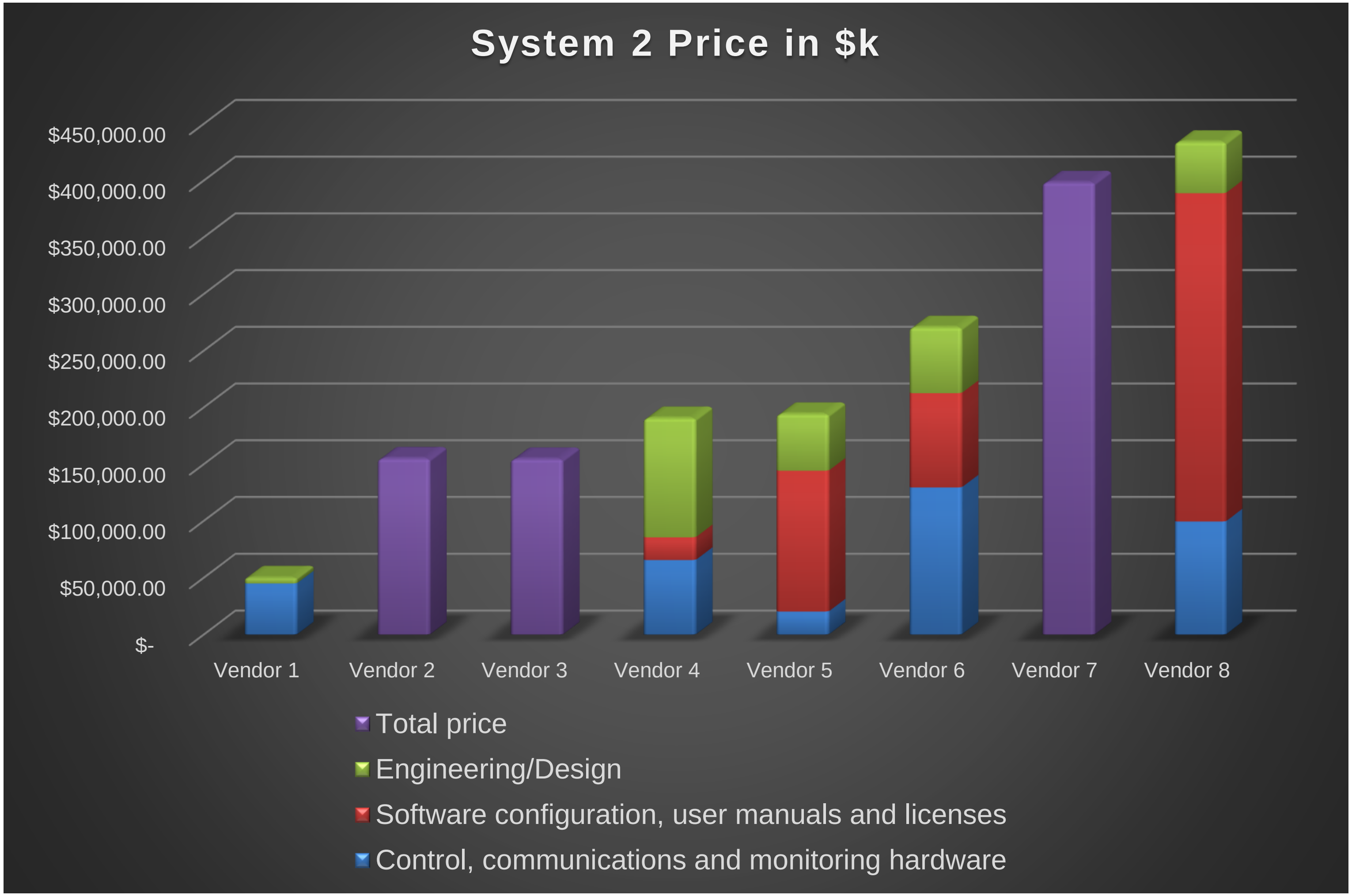


Diesel:
PV:
BESS:
Load:

Price Comparison: Microgrid Controller



EMS Controller: System 2 Prices



Summary & Conclusions

- Great interest on integrating renewables in microgrid has created the vendor focus on Controller products and Solutions
- Major differences in vendor offerings (features and approaches) and therefore, large variations in pricing
- **Not off-the-shelf:** For many vendors, solutions require great deal of engineering and customization
- The main focus would be to develop some baseline system requirements and RFQ template that can help system owners and developers narrow down on solutions and prices.

Michael Ross, Ph.D., P.Eng.
Industrial Research Chair In Northern Energy Innovation
mross@yukoncollege.yk.ca
(867) 456-8539

yukoncollege.yk.ca/energy

Farid Katiraei, Sr. Director, Technology Integration
Quanta Technology Canada, ULC
2900 John Street, Unit 3, Markham, Ontario, Canada
Cell: 647-330-7379
Email: fkatiraei@quanta-technology.com