Stationery Energy Storage System Using Repurposed Electric Vehicle Batteries

IEEE PES Winnipeg Jan 28, 2014

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Acknowledgements

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Financial support was provided from NRCan (Clean Energy Fund of Canada) Hydro One, Manitoba Hydro, Toronto Hydro, Ontario Power Authority and Ontario Centre of Excellence

Electrovaya Corp. (Canada) provided used lithium ion based battery system(s) complete with the original battery management system(s)

Agenda

Re-purposed Electric Vehicle Batteries

Stationary Battery Storage System implemented

Discussion Preliminary Test results

Future Directions

Re-purposed Electric Vehicle (EV) Batteries

- EV Batteries "ready" for re-purpose at 70-80% SOC capacity
- EV battery technology develops and changes with time
- Re-purposed battery systems that become available have little or no historical usage information
- Differences will occur between battery vendors, vehicle vendors and from year to year wrt battery voltage, energy rating, BMS protocols etc.

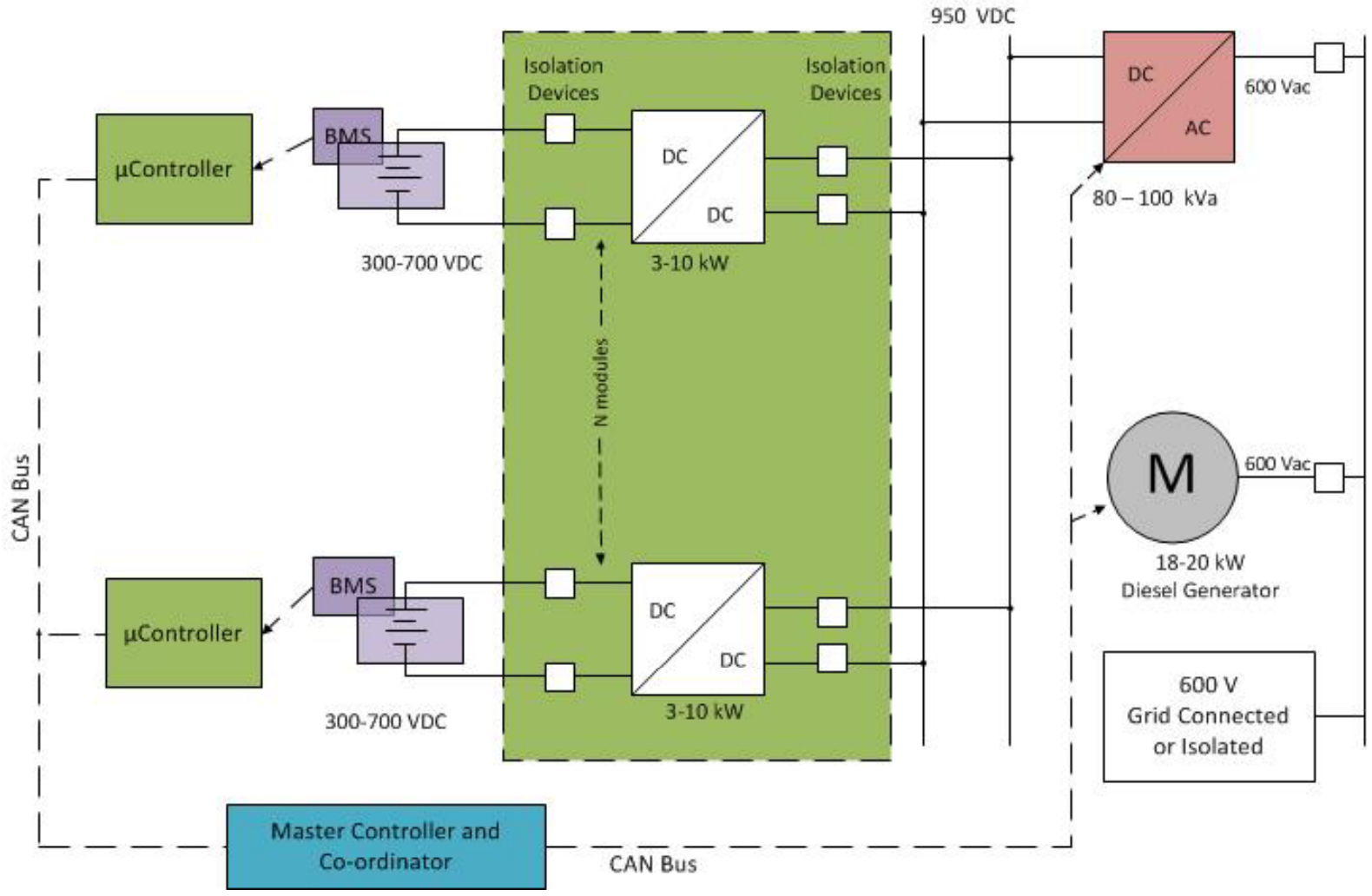
Future is hard to predict but there will be changes in EV batteries available to re-purpose.

Re-purposed Batteries Storage System Generic to Account for Future

- Use batteries packs from vehicles " as is" as much as possible
- Accept different batteries (vendors, voltages, chemistries)
- Ability to install or remove batteries pack, while in service
- Operate batteries pack appropriate to charging or discharging rates and energy capability on an individual basis
- Isolate battery packs that may become defective

Base design on battery dc-dc converters, one per battery pack, and depend on battery BMS for operation data from battery

Stationary Battery Storage System Implemented



Re-purposed battery and BMS

4 battery modules shown

3 400 Volt
1 300 Volt

Each with battery pack has OEM BMS

Dc-Dc converters

Use dc-dc converter : One per battery pack

5 and 10 kW ratings
Battery side 300-700V
Collection bus 950 V

Protection and isolation
Communication to battery BMS
Communication to Master Control
Software architecture allows supporting many BMS protocols (provided they are documented)

Two stage boost – buck converter
Designed and optimize using PSCAD simulation software

When battery "dies" pair
a "new" re-purposed battery with this Dc-Dc converter

100 kW DC- AC Inverter

DC collection bus contains the parallel batteries

Off-the shelf Converter

DC –AC inverter connects batteries to AC system 950 VDC to 600 Vac

DC – AC inverter rated at 100 kW in our project with 5 parallel Battery system

Can handle many more……..

Master Co-ordinator

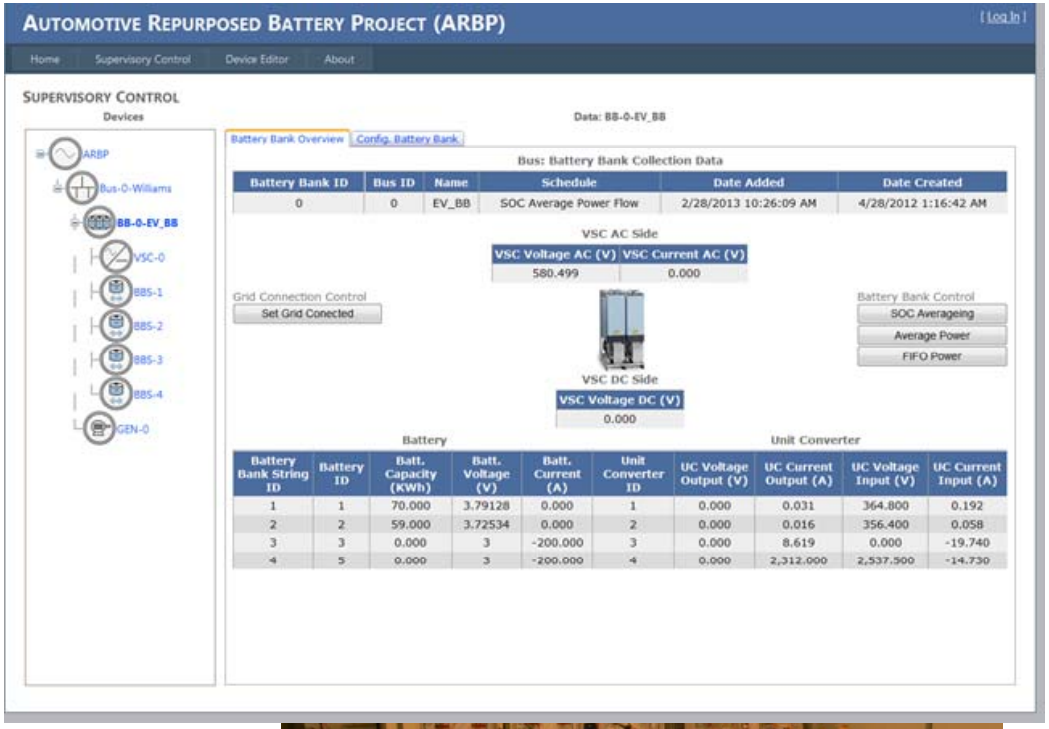
Operator Interface for battery system
Connects dc-dc (s) and dc-ac

For each dc-dc (via Can interface)

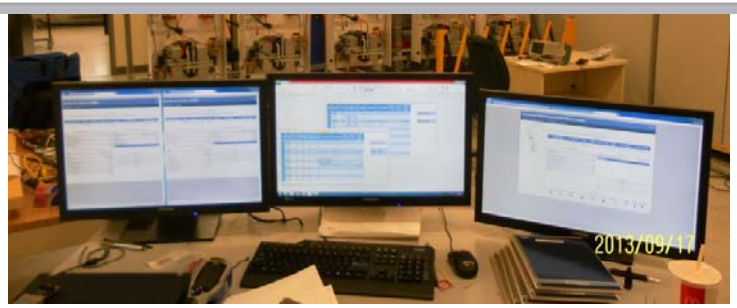
- Start and stop
- Adjust charge or discharge setpoints

- Other devices on system
  - Dc-ac control mode
  - Diesel setpoints for micro grid

System monitoring and alarm



Web interface to easily integrate for utility control centre
High processing power to allow integration of complex scheduling and power dispatching algorithms.



Discussion System Preliminary Results

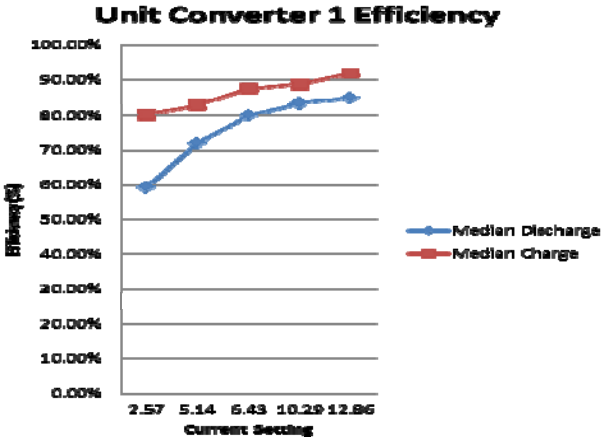
Operated system with two 400 Volt and one 300 Volt battery working together in both charge and discharge modes.

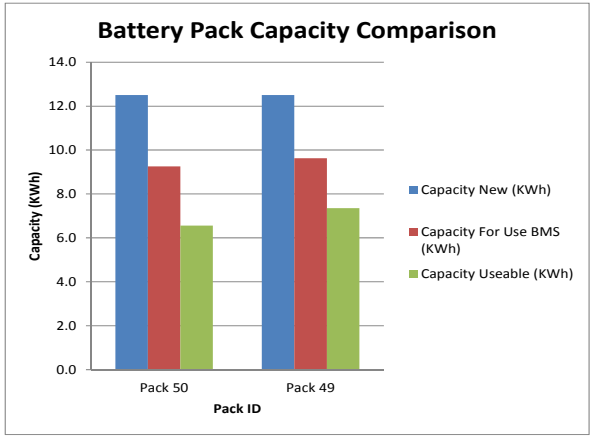
Perform battery efficiency tests

- 80-90% discharge
- 75-85% charge

Battery Capacity testing

- Approximately 20% lower then predicted
- Conservative margins for both charge and discharge





Future Work

Testing of battery system continues

add 600 V battery modules

Development of test system into a micro grid test system

Testing of Battery System together with Diesel

Looking for reduction in fuel costs and reduced emission based on actual load patterns of remote diesel sites

Guidelines for battery system to be re-purposed

Short term current rating ?

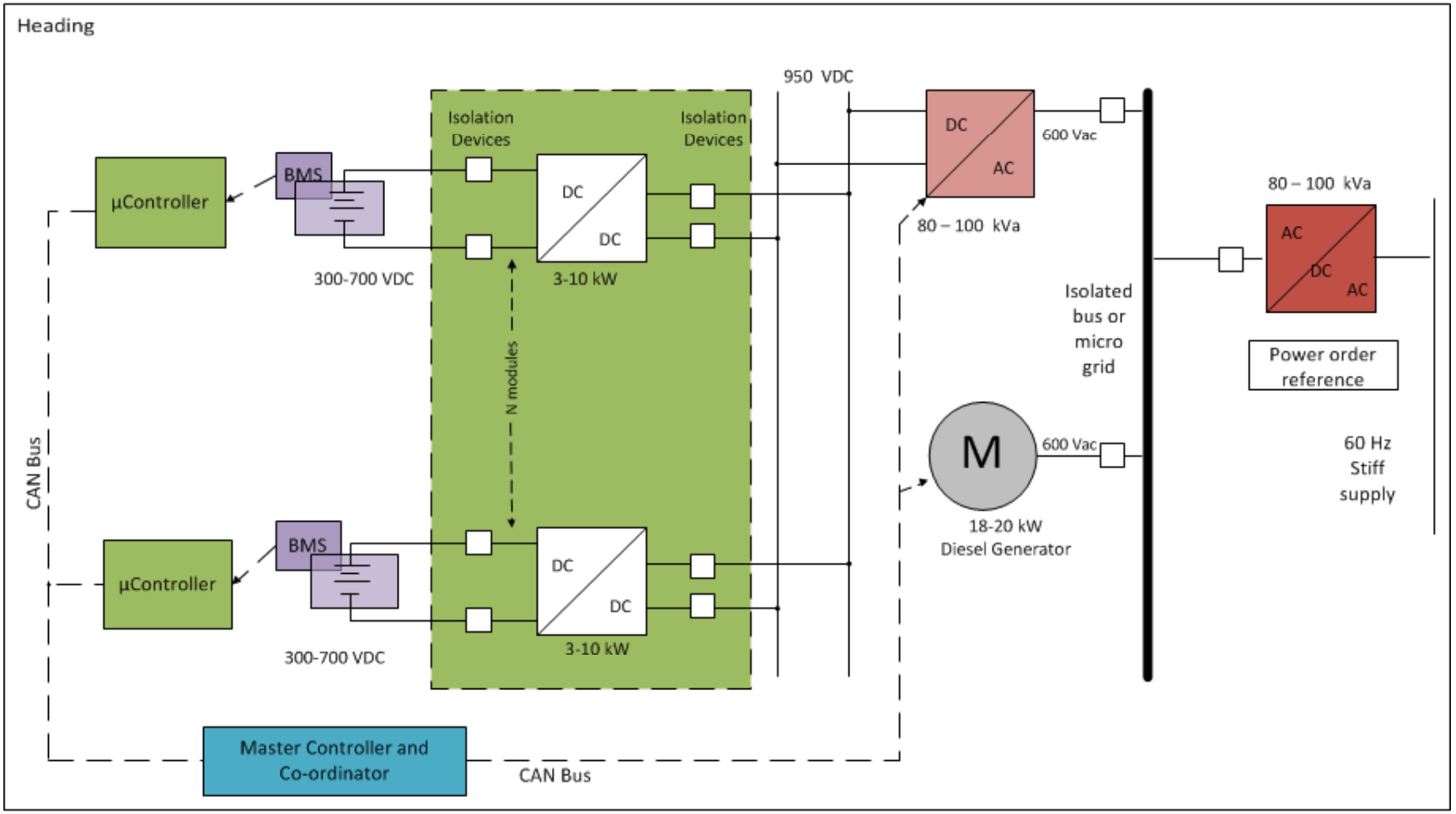
BMS communication protocol and any BMS protection description

Applications specifically for re-purposed batteries

Do you treat re purposed batteries system the same as a new batteries system ? Or choose lower short term current type (steady state load sharing for example).

Test protocol(s) to determine life (remaining life) of re-purposed batteries.

Micro grid - Islanded Test System



- Battery system / Diesel / Programmable electronic converter (load)
- Form a micro grid

Conclusion

Demonstrated a generic robust topology for re-purposing electric vehicle batteries into large utility stationery energy storage system.

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Thank you

Questions?

Project team members

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