SPOKANE MICROGRID DISTRIBUTED GENERATION AND STORAGE

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Project Overview

Problem Statement:

- Downtown Spokane, WA experienced a major transmission line loss due to a windstorm in 2015.
- Power was not able to be restored in a timely manner and facilities vital to the public were out of service.
- The city lacks sufficient alternative power sources, thus a microgrid would help with power reliability during blackouts.

Our Work:

- Provided option for an energy storage system in relation to load matching
- Provided option for converting hospital generators to Diesel/Natural Gas hybrid operation.
- Determined ideal/effective building locations to place photovoltaic generation.
- Designed switching scheme to synchronize distributed generation to the microgrid
- Developed a PowerWorld simulation showing the microgrid power flow

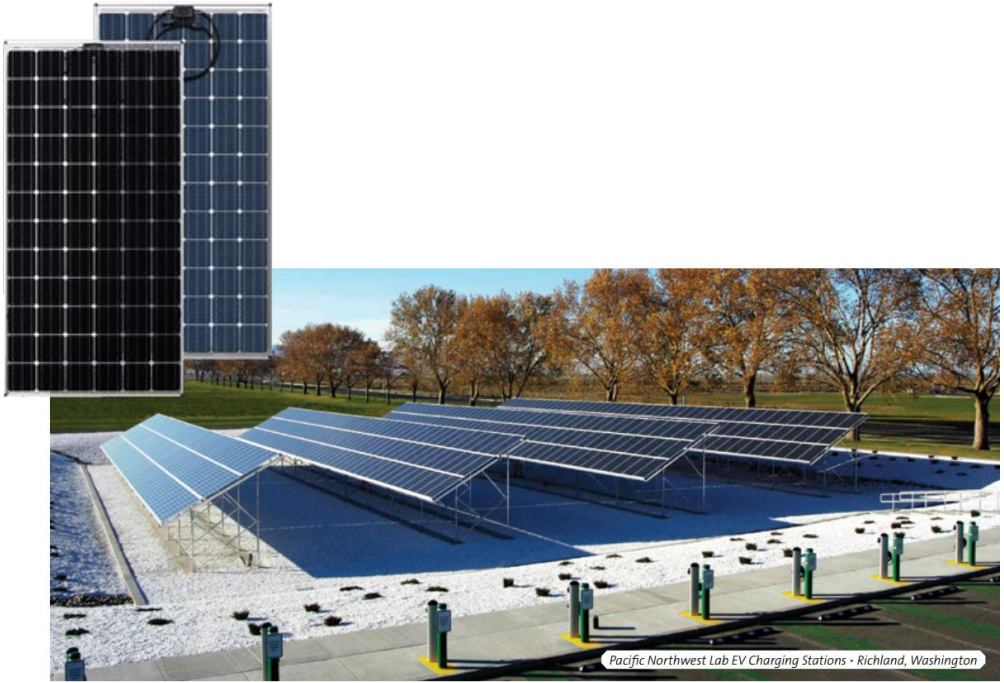
Diesel to Natural Gas Conversion

- GFS Corp (FL)
- Starts up on diesel then converts partly to natural gas
- Maximum 70% natural gas, 30% diesel
- Possibly use for peak shaving, not just emergencies!
- EX: Caterpillar 3412 Engine (480V, 750kW) at Deaconess Hospital ~ $35,000-$36,000

The Solar Panel

Sunmodule Bisun SW 330 XL duo

- Some Specifications
  - P_{max} - 330 W
  - V_{oc} - 46.9 V
  - A_{sc} - 9.51 A
- Why this model?



Energy Storage Solution

UET Vanadium Flow Battery

* 5 containers per battery module (4 battery, 1 inverter/transformer)

* Lifespan: 20 yrs

* Unlimited Cycles

* Today's cost for Implementation: ~ $3.2 million

3 Operating Conditions:

1) Peak Power = 600 kW, Discharge = 2 hrs, Energy = 1.2 MWhr

2) Peak Power = 500 kW, Discharge = 4 hrs, Energy = 2.0 MWhr
   Chosen condition for design implementation

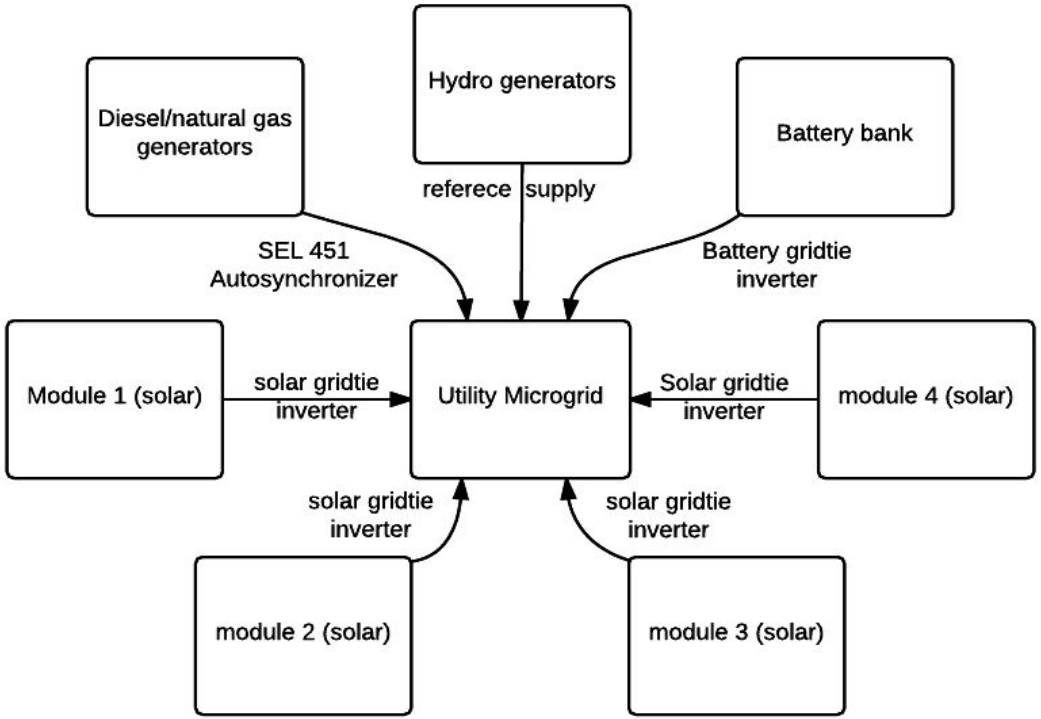
3) Peak Power = 275 kW, Discharge = 8 hrs, Energy = 2.2 MWhr

The Microgrid Map

Please be patient as I transfer over

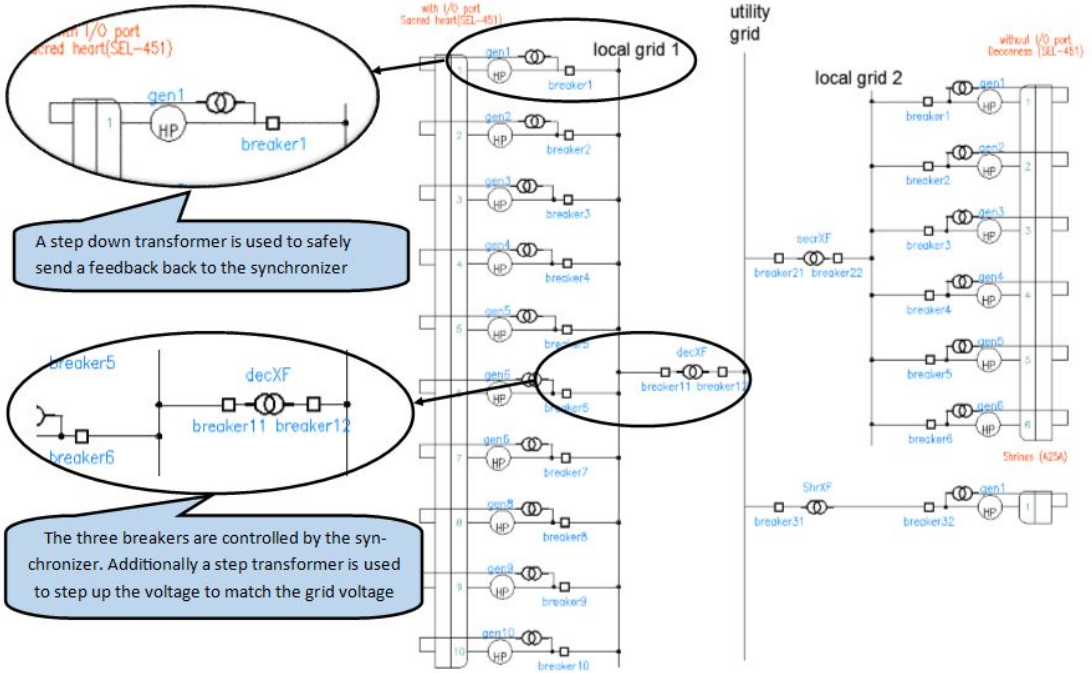
to Google Earth

Grid Synchronization System



Generators Auto-Synchronizer using SEL-451-5

frequency limits	20V - 200V 20V - 200V
slip frequency	0.025-0.5Hz
voltage difference	0.01-0.5 pu
voltage limit	0.8-1.2 pu
nominal frequency	50, 60Hz
Frequency limit	45 - 65Hz



Battery Gridtie Inverter (Parker 890GT - 1800)

Input DC Buss voltage	730V (rated) – 800V (max)
Output AC voltage	480V (nominal)
Rated output	1800kVA
Efficiency	98.7%
AC Circuit Breaker	65kA Interrupting Rating

Solar Gridtie Inverter (APsystem YC500A)

Input DC Buss voltage	55V (max)
peak tracking voltage	22V - 45V
AC output	240V 2.08A max
Power output	500W (rated)
Efficiency: **CEC weighted** **peak inverter** **Static MPPT**	 94.5% 95% 99.9%
night time power loss	65mW max

System Power Cases

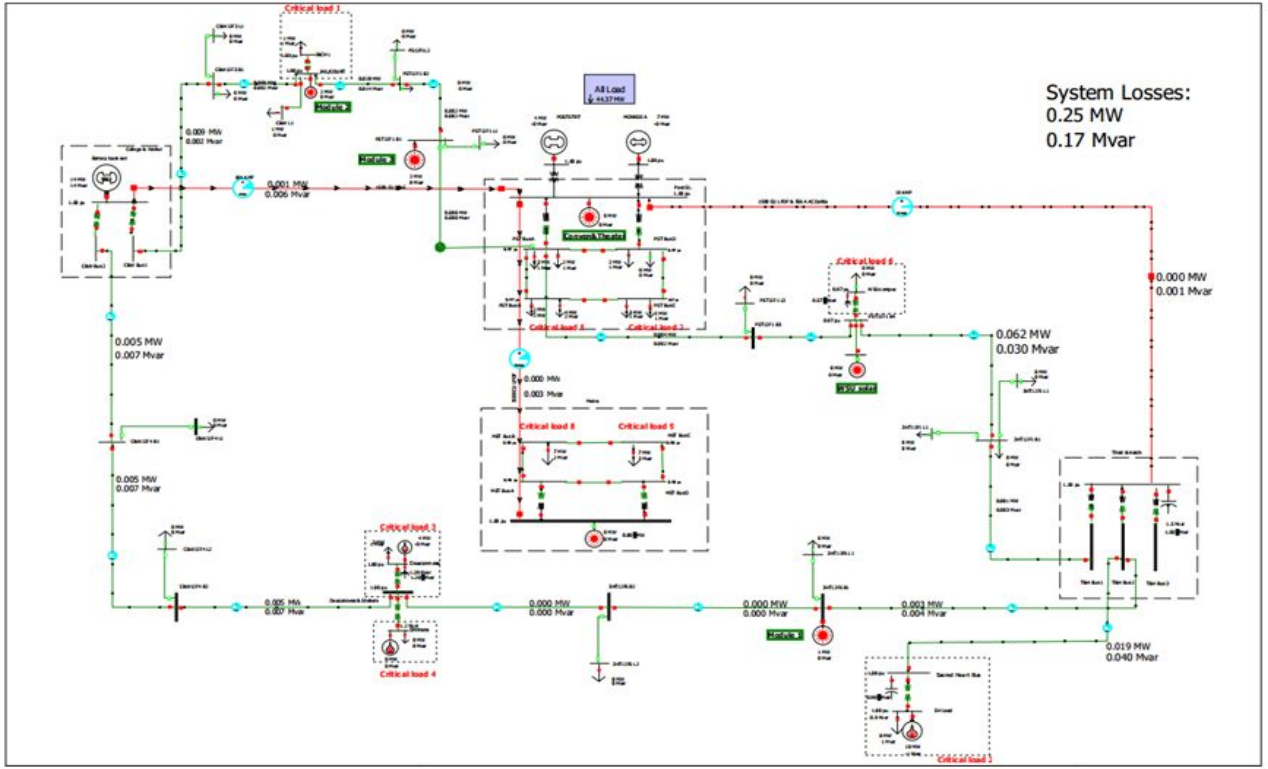
SYSTEM POWER CASES

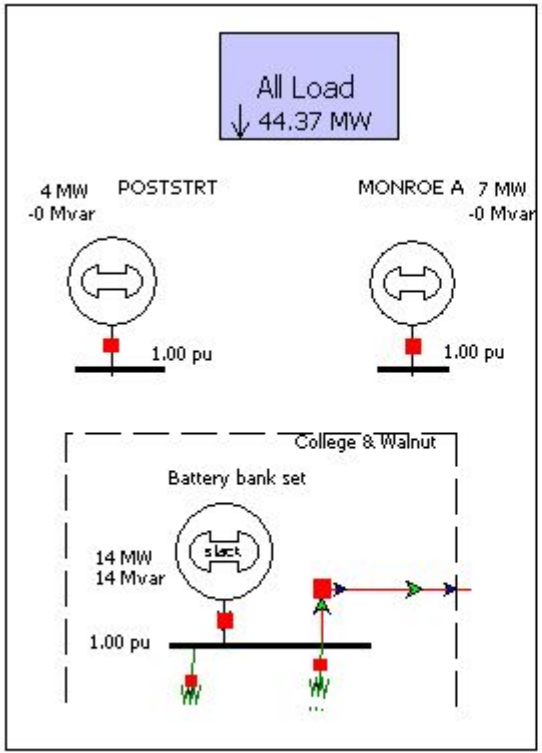
	LOADS	GENERATION		
	Critical Loads (MW)	Photovoltaics (MW)	Hospital Generators (MW)	Hydro (MW)
Worst Case	44.37	4.468	14.745	11
Best Case	39.4	3.839	14.745	23

	Worst Case	Best Case
Total Load (MW)	44.37	39.4
Total Generation (MW)	30.213	41.584
Load Profile Deficit (MW)	-14.157	2.184
Batteries to Supply Load	29	0

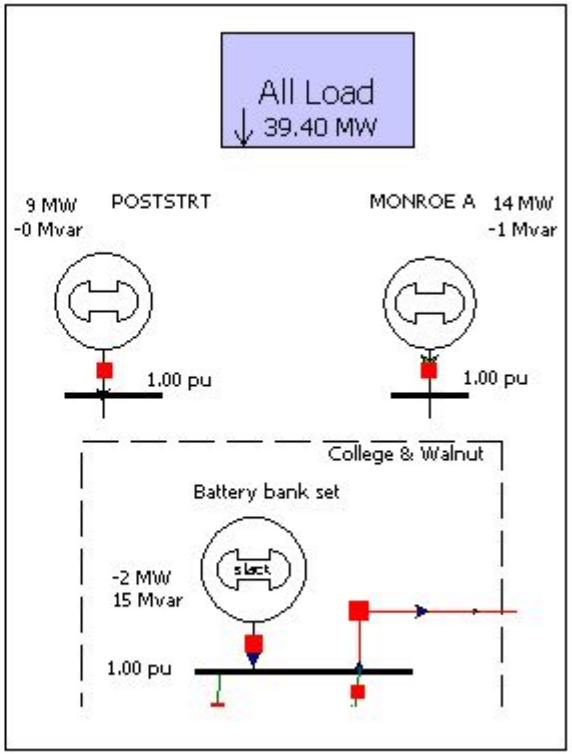
* Batteries chosen are UET 500 kW for 4 Hours (2 MWhrs)
* Worst case is peak daytime load for highest load draw season and lowest generation season (Summer)
* Best case is peak daytime load for lowest load draw season and highest generation season (Spring)

PowerWorld Simulation





Summer season (worse case)



Spring season (best case)

Questions? Comments?