Snohomish County PUD
Arlington Microgrid
for
WA Solar

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Agenda

- Intro to Snohomish PUD
- Why Energy Storage?
- MESA Overview
- MESA 1
- MESA 2
- MESA 3 - Arlington Microgrid
- Batteries – State of the Industry
- Solar – State of the Industry
- EVs – State of the Industry
- Solar – PUD Program
Snohomish County PUD

- **Total Electrical Customer:** 341,000
- **Resource Mix:**
  - 82% BPA Hydro and Nuclear
  - 7% PUD Hydro
  - 6.5% Wind
  - 4.2% Market Purchases
  - 0.3% Solar, biogas, cogen, etc

- **Energy Sales:** 8.5 million MWh
- **Winter Peak Demand:** 1365 MW
- **Average Demand:** 749 MW
- **Residential Rates:** 10.25¢ per kWh
- **Average # of Employees:** 1002
The ongoing addition of intermittent and variable renewable energy sources to the region’s power supply mix will drive more interests and investment in the development and application of storage technologies and demand response.
MESA - Modular Energy Storage Architecture

- **Utility I/T**
  - DNP3
  - MESA-ESS

**Energy Storage Control System**
- MESA-Battery
- MESA-PCS

**ESS**
- Battery
- PCS

**Grid**
- Modbus
MESA 1 - Lithium Ion

- 2 MW / 1 MWh
- Lithium Ion Battery
- Commissioned in 2015
- Utilized WA State Clean Energy Funds (CEF1)
- Renewable Energy Integration and Grid Support
MESA 1 - Li-Ion Battery Cells
MESA 2 - Vanadium Flow Battery

- 2.2 MW / 8 MWh
- Vanadium Flow Battery - UniEnergy Technologies
- Commission in early 2017
- Utilized WA State Clean Energy Funds (CEF1)
- Renewable Energy Integration and Grid Support
MESA 2 - Vanadium Flow Battery Cells
Arlington Microgrid and the Multiple Uses of Energy Storage
Use Cases

- **Disaster recovery** – Provide back-up power to a new office building that will be used during disaster recovery response.


- **Grid Support and Ancillary Services** – Provide grid support and ancillary services when not being used for either of the above two uses.

- **The V2G (Vehicle-to-Grid)** – Demonstrate how EVs can assist with actively contributing to the distribution system.
Components

- 500kW/1000kWh - Energy Storage System
- 500 kW Solar Array with Smart Inverters
- Supplemental generation
- V2G - Vehicle-to-Grid system

- Microgrid Control System in combination with a MESA compliant battery control system and Building Energy Management Systems.

- Clean Energy Technology Center (CETC) serves two purposes – (1) provides the initial microgrid load to test controls prior to the construction of the new office and (2) will be used to demonstrate the technology to the public.
Microgrid Diagram

- Energy storage
- Charge controller and inverter
- PV system
- Intelligent solar PV controller and inverter
- Electric vehicle and charging system
- Clean Energy Technology Center
- Local area network
- Microgrid controller and energy management system
- Point of common coupling
- Distributed energy resource optimizer at Snohomish PUD
- Electrical grid
- Arlington Office
- Electrical power
- Communications
- Smart meter
Arlington Site
Project Info

- **Funding**
  - WA State Clean Energy Fund 2 (CEF2) - $3.5M

- **Schedule**
  - 2018 Design and Site Preparation
  - 2019 Microgrid Construction
  - 2020 Data Collection and Reports

- **Design**
  - Burns and McDonnell – Fort Worth, Texas
Industry changes that benefit our project

- **Solar cost**: 80% reduction in panel cost in last 6 years (www.powemag.com January 2017).
- **Solar PV inverters**: Can now provide grid support versus just anti-islanding protection.
- **Li-Ion Energy Storage cost**: 10-15% decrease in battery cost per year over past 5 years (Doosan Gridtech).
- **Electric Vehicles**: Automakers are starting to embrace two-way charging systems (Vehicle-to-grid) – (Greentech Media and Nissan, 1/9/17).
- **More MESA compliant** software and equipment vendors (MESA members now at 28).
- **More Engineering firms** with experience in renewables, energy storage and microgrid controls.
Battery Storage - Utility Scale

- **US Electricity Peak Demand** = 840 GW
  - Total Energy Storage = 24 GW (mostly pumped storage)
  - Battery Energy Storage = 1 GW (mostly Li-ion)
- **Lithium Ion** - 97% of current new market, 67% of current installations
- **Others** -
  - Lead Acid - still a very large market
  - Vanadium Redox Flow (small percentage of market but leaks are an issue)
  - Molten Sulphur, Liquid Metal
  - Solid State Batteries - solid electrolyte versus liquid or gel
- **US** 12 battery mfgs, **China** 140 battery mfgs

**Issues**

- **Recycling**
  - Lead in car batteries was mostly mined 60-70 years ago and is now recycled and reused
  - Only 2 companies in the US doing recycling but companies pay for recycling
- **Issues with Li-Ion materials and mining**
  - Lithium - from Brine and rock - Chili, Bolivia, Argentia and Nevada (not a commodity yet - put in bag and ship) (lightest of metals) - Deserts in South America and hard rock in Australia
  - Cobalt - Tanzania and Republic of Congo, Africa - child labor & pollution - critical & expensive - could potential have shortages - demand could outstrip supply by 2020, 50% plus is from DRC and they at a national political crisis.
LITHIUM-ION BATTERY COST OUTLOOK, 2011-2030 ($/KWH)

Battery pack costs ($/kWh)
Energy Storage and Electric Vehicles

- BNEF observed values: annual lithium-ion battery price index (average of PHEV+BEV packs), 2011-14
- BNEF expected 2015 value (average of PHEV and BEV packs)
- Estimate current Tesla cost (BEV pack only, 18650 format)
- Long term Tesla cost target

- $800/kWh
- $400/kWh
- $250/kWh
- $100/kWh

Bloomberg New Energy Finance

August 2015
Solar - Utility Scale

- 800 + solar-powered plants
- US: ~47.1 GW total installed
- ~8% in 2017 up from 2% in 2016
- California gets 8% from solar
- Worldwide solar installed in 2016 was 76 Gigawatts
- 50 GW in 2015
- China and the US led the surge
- Globally - 305 GW
- First Solar just made a panel that is 22.1% efficient. Commercial line is currently 16.4%
- Theoretical max with cadmium telluride cells is 30%, significantly higher than conventional silicon
- Monocrystalline silicon is the gold standard. Record is 25% eff.
- Standard cells capture visible light (violet to red) and therefore can never be more than 32% efficient
Electric Vehicles - State of the Industry

- EV and Battery Storage conference in Novi, Michigan (Sept 2017)
- EVs are driving the battery market – up with technology – down with cost
- India to sell only EVs by 2030
- China and Europe are considering the same thing
- China is discussing a ban on ICEs (China is largest car mfg in the world)
- Japan – EVs and Hybrids with Fuel Cells (Hyundai – Tucson)
- Gov Jay Inslee (WA) is providing $1M for charging stations and wants 50,000 registered EVs by 2020 (8,000 in 2013)
- Gov Gary Brown mandate to integrate EV charging into the grid by 2020.
- Ford - 21 EV models by 2020
- BMW – 17 models by 2020
- Tesla, Karma (Chinese company), Google, Apple, Faraday Future, BYD (Chinese)
- Uber Elevate – Electric flying vehicles (2020 experimental, 2023 commercial, 2030 no pilot)
- VW – No new R&D on ICEs – only EVs
  - $1B to California EV networks
  - $2B over 10 years in EV infrastructure
  - Cycle 1 – California, Cycle 2 – National
Energy Storage Product Overview

- **Product Line**
  - **Automotive**
  - **Residential**
  - **Commercial**

- **85 kWh**
  - 7000 batteries

- **10 kWh**
  - 800 batteries

- **500 kWh**
  - 41,000 batteries
500 kW (691 hp)
85 kWh
Insane Button
0-60 mph in 3.2 seconds

250 kW, 500 kWh
No insane button, but voltage and frequency response is instantaneous.
Community Solar

- Program under development in 2018.
- Array capacity: 500 kW with potential for expansion
  - Site is approximately 3 acres including fences and access roads
- Funded by the panel subscribers
- Customer receives monetary benefits on monthly bill
- Estimated 250 watts per panel, which equals 5 shares per panel
  - 10,000 total shares
- Shares estimated at $160 (50 Watts)
- May provide customers and service organizations an opportunity to “buy down” share costs for low income customers to buy shares
Rooftop Solar

- Sunset Solar Express incentive program in June 2017
- Offer net metering
- Facilitate safe interconnection with our grid
- Offer technical support
- Maintain a directory of contractors familiar with our program expectations
- Administer State Production Incentive