SUN • WIND • WATER SW² Energy

JPUD Citizens Advisory Board Presentation

Jefferson County

14 December 2015



Local Public Power Opportunities in Sun, Wind, Water (SW²) Energy

• A Presentation on a Green Electricity/Green Fuels [GE/GF] Transition Program •

with details on a proposed

ECONOMIC ANALYSIS OF LOCAL GE/GF OPERATIONS

that include

- local production of green fuels from green electricity
- local production of green electricity from green fuels

PRESENTED TO



Citizen Advisory Board

• a doubling in use of grid electricity



14 December 2015

PRESENTATION PURPOSE

- To Introduce for the First Time Ever a Top-Level Perspective on Energy, Energy Technology, and Energy Markets in Jefferson County
- To Review Where We Are, Where We Came From and Where We Hope to Be Going with Energy
- To Identify Opportunities for JPUD Revenue, Acceleration of Debt Retirement, New Energy Investment, General Electric Rate Reduction/Stabilization, and Building Grid Resilience
- To Describe the Four Basic Functional Units of Renewable Local Green Electricity/Green Fuel [GE/GF] Operations
- To Review the Working Group Structure that has Already Been Assembled for the GE/GF Study Project
- To Outline a Proposed JPUD Role in this Economic Analysis for Transitioning to Sun, Wind, and Water Renewables [SW²] in Jefferson County



PRESENTATION OUTLINE

- 1. The Energy Picture: Global and Local, Fossil Fuels and SW²
- 2. Overview of Jefferson County SW² Energy Development
- GE/GF Detail: Green Electricity/Green Fuel Operations

 a. Green Electricity from Intermittent Sun, Wind and Water (SW² Energy)
 b. Local Production of Green Fuels from Electricity
 c. Green Fuel Storage, Handling and Distribution
 d. Generation of Green Electricity and Heat from Green Fuels
- 4. Local Green Fuel Basics: Anhydrous Ammonia
- 5. Proposed Economic Analysis of GE/GF Operations
- 6. JPUD Opportunities in GE/GF Transition
- 7. Proposed Organization and Financing





1. The Energy Picture: Global and Local, Fossil Fuels and SW²

- Global Energy Difficulties Have Been Building for Years: Peak Oil Limits, Nuclear Risks, Grid Complexities, Climate Change
- Awareness of Local Energy Difficulties Growing Also: Public Power vs. New SW² Investment, Role of External Financial Interests, Resilience Issues w/Grid Ties

Approximated Annual Energy Summary: Jefferson County WA



• JPUD Centrally Positioned: SW², Energy Market Competition, BPA Power Security, Energy Development Financing



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2. Background for Jefferson County Energy Development

- Maritime Transportation from 1800s, Paper Mill Operations Since 1920s, Grid Development with BPA in 1930s and Sixty Years of Fossil Fuels
- Jefferson Energy Center Meetings in 2004, Rita Schenk and Brian Weller In 2005, Local 2020 and C4LP in 2007, Public Power in 2009, JPUD in 2013
- Energy Lunch in 2010, Energy Project Reporting in 2012, EV Financing In 2014, and Jefferson County Energy LLC



- Wildpoldsried Energy Transition Experience in Biodigesters, Central Heating and Wind Shows Big Rise in Local Prosperity
- Jefferson County Energy Transition Could Mean Increase in Electricity Use, Increase in SW² Collection, Lower Electric Rates, a Stackless Paper Mill, and a More Robust Local Grid

2. Background to Jefferson County SW² Energy Development



SUN • WIND • WATER SW² Energy **GREEN ELECTRICITY/ GREEN FUEL** [GE/GF] **OPERATIONS**



- Result of a Fundamental ReThinking of Electric Power Generation And Delivery Using Local Renewable Energy Sources
- Basis for Structured Explanation of GE/GF Functions and Businesses
- Basis for Proposed GE/GF Study Project Organization, Financing, and Deliverable Results



a. Green Electricity from Intermittent Sun, Wind, and Water [SW²]



- Electric Power Must Be Matched with Load on Transmission Grid
- Works Only Within Certain Load And Generation Limits
- Too Much SW² Can Waste Green Electricity with No Place to Go
- Not Enough SW² Requires Additional Power Frequently from Fossil Fuels
- Load Does Not Include Most Home Heating or Transportation Needs



Jefferson County Energy LLC

b. Local Production of Green Fuels from Electricity



- Heart of GE/GF Operation is Local Green Fuel Production from Intermittent Supplies of Renewable Electricity from SW² Energy
- Excess or Unprofitable Renewable Electricity is Used as Generated To Produce Local Supplies of Green Fuels
- Local Green Fuel Production Capabilities Include Electrolysis, Haber-Bosch, and Other High Temperature Processes



c. Green Fuel Storage, Handling and Distribution



- Green Fuels are Stored Locally for Local Use or Sold and Transported to Other Storage Facilities in Other Markets
- Locally Produced Ammonia Fuels are Very Similar to Propane in Storage and Handling Operations
- Local Green Fuel Supply Creates Local Markets for Both Electricity and Fuels - Local Markets that become Linked as Energy Moves to Uses that Produce Most Local Advantages/Profits



d. Generation of Green Electricity and Heat from Green Fuels



- As Needed to Balance Local Loads, Green Fuels are Used to Generate Additional Supplies of Green Electricity (and heat)
- Green Electricity Can Be Generated Using Internal Combustion Engines, Gas Turbines, and/or Fuel Cells
- Thermal Energy (Heat) is a Significant and Valuable By-Product of Local Green Electricity Production
- Energy Exports, (i) Excess Green Fuels and (ii) Green Electricity that is Produced On-Demand from Local Green Fuels, Mean Increased Local Electricity Use



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4. Local Green Fuel Basics: Anhydrous Ammonia

- Like Green Electricity That is Generated From Non-Carbon Energy Sources Such as SW² Energy, Green Fuels are Those That Have No Carbon in Their Molecular Structure and are Produced from Non-Carbon Sources
- Ammonia has a Molecular Structure that Includes Three Hydrogen Atoms (Protons) and One Nitrogen Atom and is a Common Industrial Chemical: 200+ Million Tons Produced Each Year (from natural gas)



- Ammonia is a safe and non-explosive liquid at room temperature and slight pressure (like propane) that is moved with pipelines, trucks, and tankers to major uses as fertilizer in agriculture and refrigerant in office buildings
- Green Ammonia Fuel can be Made Locally from SW² Energy, Water, and Air $Energy + 2 H_2O \rightarrow 2 H_2 + O_2$ $Energy + N_2 + 3 H_2 \rightarrow 2 NH_3$
- In Internal Combustion Engines, Gas Turbines, Fuel Cells, and Burners Ammonia Combines with Oxygen to Produce Energy, Nitrogen, and Water Vapor

$4 \text{ NH}_3 + 3 \text{ O}_2 \rightarrow 2 \text{ N}_2 + 6 \text{ H}_2\text{O} + \text{Energy}$

• A Gallon of Ammonia Fuel is the Energy Equivalent of About .75 Gallons of Gas



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5. Proposed Economic Analysis of GE/GF Operations

• Four Separate Working Groups Charged with Setting Energy Requirements, Technology Definition, Economic Assessment, and Next-Step Planning



- Jefferson County Project Office Charged with Integration of Working Group Output Around Local Energy Objectives and Preparation of All Final Documentation and Business and Financial Plans
- JPUD Should Participate in the GE/GF Project Office



6. JPUD Opportunities in GE/GF Transition

- Increased Purchases and Sales of Electric Power
- Accommodation of All New Local SW² Energy Dvelopment Projects
- Provide Locally Generated Electric Power to BPA On-Demand
- Arrange Further Power Purchases at Low Spot and Non-Firm Industrial Rates
- Double Use of Electric Power in Jefferson
- Deliver Electric Power Needed for 400 GWh/yr in Green Fuel Production
- District Energy Planning and Microgrid Development
- Immediate Participation in GE/GF Study Project
- Accelerate Payment of Current Debt Obligations
- Move Into Position of Investing in New Local Energy Infrastructure



6. JPUD Opportunities in GE/GF Transition

Approximated Annual Energy Summary: Jefferson County WA

[Overlays Show Effect of GE/GF Operations On Energy Sources and Uses]



[Fuel Production with GE/GF Will Add a New 300 GWh Slice to Both Sources and Uses in Overall Annual Energy Picture Bringing Annual County Total to 2.7 TWh]



7. Proposed Organization and Financing

 Local Sponsors and Others are Ready to Create and Fund a New Entity: the Jefferson County Energy LLC - the Master LLC for Local Energy Development



- Local LLC Organization Would Cover Activity in and Funding For Three Other Jefferson County Energy Projects in Addition to the GE/GF Study
- Funding Being Sought from BPA Could Be Made into Local Funding with the Active Participation of JPUD and/or Port Townsend Paper Jefferson County Energy LLC



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