



Energy Independence Project Tools and Spreadsheets

**Presented by
Alan Zelenka
Energy Services Leader
Kennedy/Jenks Consultants
June 4, 2009**



Energy Independence Project



Award Winning Project

❖ ACEC Oregon 2009
Project of the Year



❖ AAEE 2009 National
Grand Prize for Planning



Kennedy/Jenks Consultants
Engineers & Scientists

Project Objective

- ❖ Investigate what it would take for wastewater treatment plants to become energy independent by optimizing plant energy efficiency and using renewable resource opportunities.





Approach and Scope

- 1. Technical Advisory Committee Directed**
- 2. Energy Audit & Energy Efficiency**
- 3. Energy Profile & Net Energy Requirement**
- 4. Seven Resource Assessments**
- 5. Evaluation Criteria**
- 6. Resource Scoring**
- 7. Develop Recommendations**

Two Demonstration Plants



▼ Gresham

- | 20 MGD
- | Served by PGE
- | Gravity fed system
- | Activated sludge system
- | Cogen using digester gas

❖ Corvallis

- 9.7 MGD
- Served by PP&L
- Pumped system
- Trickling filter system





Resource Assessments

Resources Evaluated:

- 1. Fuel Cells using digester gas**
- 2. Internal Combustion (IC) Engines using digester gas**
- 3. Microturbines using digester gas**
- 4. Micro-Hydro**
- 5. Solar Photovoltaic**
- 6. Small Wind**
- 7. FOG & Food Waste to increase digester gas**



Resource Assessment Outline

❖ **Used a common template to evaluate each renewable resource option, including:**

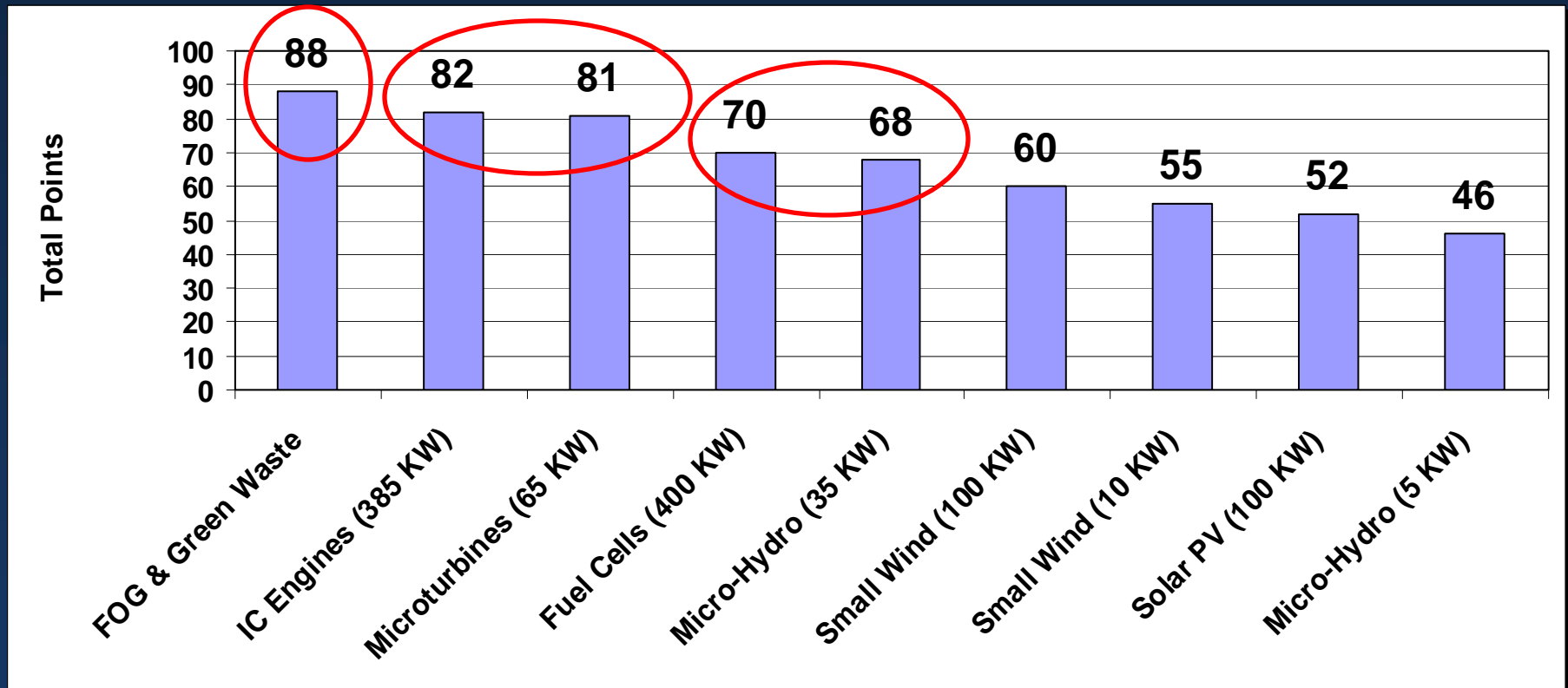
- History
- Technical Description
- Vendors
- Size and kWh Production
- Project Examples
- Potential Funding Sources
- Cost
- Political & Community Impacts
- Environmental Impacts
- GHG Impacts
- Operational Impacts



Scoring Matrix

	Total	Rank	Cost	Adequate Size	Tech Maturity & Reliability	Political & Community Impacts	Env Impacts	GHG Impacts	Ops Impacts
FOG & Food Waste	88	1	50	4	8	5	15	3	3
IC Engines (385 KW)	82	2	50	4	9	3	10	3	3
Microturbines (65 KW)	81	3	45	4	6	5	15	3	3
Fuel Cells (400 KW)	70	4	30	4	5	5	20	3	3
Micro-Hydro #1 (35 kW)	68	5	25	3	5	5	20	5	5
Small Wind #2 (100 KW)	60	6	25	3	5	3	15	5	4
Small Wind #1 (10 KW)	55	7	20	3	5	3	15	5	4
Solar PV (100 KW)	52	8	10	3	9	5	15	5	5
Micro-Hydro #2 (5 KW)	46	9	5	1	5	5	20	5	5

Rankings





Applying the Study Methodology

- ❖ The study methodology was designed to be applicable to any entity and can easily be **scaled-up!**
- ❖ We can apply this to a Treatment Plant, a whole City, and an **entire community!**
- ❖ Can include significant public involvement!
- ❖ The results will be clear and credible data and **actions** the you can act on!



Cost

❖ **Costs derived for each resource option:**

- **Equipment & Engineering Cost**
- **Total Installed Cost**
- **Starting O&M Cost**
- **Less Incentives**
- **Net Capital Cost**
- **First Year Cost**
- **10 Year Average Cost**
- **Levelized Cost**
- **Utility Cost**





Levelized Costs

Resource	Levelized Cost (cents/kWh)
FOG & Food Waste	-9.5
IC Engines	2.9
PP&L	4.4
Microturbines	4.9
PGE	6.8
Fuel Cells	7.9
Micro-Hydro #1 (35kW)	15.4
Small Wind #2 (100 kW)	16.5
Small Wind #1 (10 kW)	19.0
Solar PV	36.5
Micro-Hydro #2 (5 kWx5)	111.8

Summary Costs

Resource	Unit Size (KW)	O&M Cost (cents/KWh)	Equipment Cost (\$)	Installed Total Cost (\$)	1st Yr Incentive Value (\$)	Net Capital Cost	1st Year Cost	10-Yr Avg Cost	Levelized Cost
Fuel Cells	400	3.0	\$1,970,000	\$2,364,000	\$1,481,300	\$882,700	-60.8	11.1	7.9
IC Engines	385	3.0	\$1,185,000	\$1,481,250	\$984,400	\$496,850	-59.2	2.3	2.9
Micro-Hydro #1	35	0.5	\$938,000	\$1,172,500	\$480,379	\$692,121	-124.8	16.6	15.4
Micro-Hydro #2	5x5	0.5	\$500,900	\$626,125	\$295,879	\$330,246	-890.7	118.	111.
Microturbines	65X2	3.0	\$760,000	\$950,000	\$586,609	\$363,391	-37.7	6.9	4.9
Small Wind #1	10	1.0	\$42,100	\$62,625	\$46,791	\$15,834	-249.6	29.8	19.0
Small Wind #2	100	1.0	\$400,000	\$500,000	\$301,947	\$198,053	-127.7	23.2	16.5
Solar PV	100	1.0	\$720,000	\$900,000	\$456,367	\$443,633	-348.8	37.5	36.5
FOG & Food Waste		4.0	\$1,000,000	\$1,100,000	\$234,000	\$866,000	-12.1	-12.0	-9.5
PP&L							4.6	5.0	4.4
PGE							7.2	7.8	6.8

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Inputs

\$975,000	Primary Equipment Cost
1	Number of Units
\$210,000	Other Equipment Costs
25%	Engineering Costs (% of Project Cost)
\$296,250	Engineering Costs
\$0	Fuel Costs (\$/Yr)
20	Life of Units
385	kW per Unit
95%	Capacity Factor
3,203,970	Annual kWh Generation
\$0.030	O&M Cost (\$/kWh)
6.0%	Loan/Bond Rate
13.0%	Loan/Bond Issuance Cost %
2.5%	Inflation
3.1%	Real Discount Rate
5.7%	Nominal Discount Rate
\$0.0463	Average 2007 Utility Cost (\$/kWh)
1.8%	Utility/Fuel Cost Escalator



Results

-\$0.1864	First Year Cost (\$/KWh)
\$0.0463	First Year Cost Utility Power
\$0.0074	10 Year Average Cost
\$0.0502	10 Year Average Utility Cost
\$0.0092	Real Levelized Cost
\$0.0426	Real Levelized Utility Cost



Evolution of the Model

- ❖ **More Robust**
- ❖ **More Functionality**
- ❖ **More Incentive Options (such Third-Party Leases using federal tax credits)**
- ❖ **Model Food Waste-To-Energy Projects**
- ❖ **GOAL:** Take any WWTP, model digester improvements, multiple types of generation sources, numerous types of incentives, and find out if it makes economic sense.



Waste-To-Energy Financial Model (WEFM)

❖ **Modules:**

- 1. Historical Gas Production Data**
- 2. Gas Production Module**
- 3. Capital Cost Module**
- 4. Inputs Module**
- 5. Incentives Module**
- 6. Results Module**



Contact Kennedy/Jenks

Energy Services Leader

Alan Zelenka

AlanZelenka@KennedyJenks.com

Eugene Office: (541) 338-8135

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