

NBC SUSTAINABILITY PROGRAMS AND PROJECTS

James McCaughey, P.E.
Environmental, Safety, and
Technical Assistance Manager

NBC History of Sustainability

- 1985 – Recognized for **Energy Efficient Operations**
- 1993 – **Most Efficient Large Wastewater Treatment Facility** in RI
- 1992 – **NBC Pollution Prevention Program**
- 1994 – Named an “**Environmental Success Story**” and finalist for an **Environmental Sustainability Award**
- 1995 – Field's Point – **Best Operated and Maintained large WWTF** in the country by the US EPA
- 1996 – AMSA’s Award for a **Wildlife Management Program** at Bucklin Point
- 1998 – Pretreatment Program receives **US EPA's National Pretreatment Excellence Award**
- 2000 – AMSA’s Award for the 1999 **Shellfish Transplant Program**
- 2007 – NACWA Education Award for the **Classroom Program**, Woon Watershed Explorers
- 2008 – Standard & Poor’s ratings raised on NBC **Revenue Bonds** from “A+” to “AA-“
- 2009 – **Worksite Health** Award from the Providence Chamber of Commerce and Blue Cross/Blue Shield
- 2011 – NBC named one of the “**Best Places to Work in Rhode Island**” by PBN



NBC Sustainability Programs and Projects

- ▶ NBC Pollution Prevention Program
- ▶ Wind Turbines
- ▶ Biogas Combined Heat and Power
- ▶ WWTF Energy Management Systems
- ▶ Fats Oil and Grease Environmental Results Program
- ▶ On-Going and Planned Projects

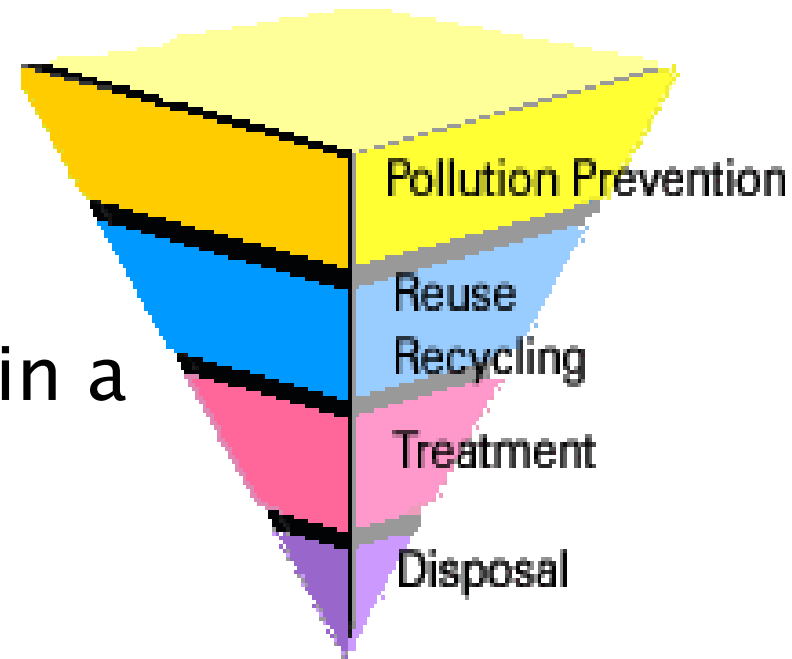


NBC Operations Building
Houses new Plant Computer
Control Center – Completed
Dec. 2011
LEED Silver Certified

Pollution Prevention Act of 1990

Waste Management Hierarchy:

1. Prevented or Reduce at Source
2. Recycled or Recover
3. Treated in Safe Manner
4. Disposed of or Otherwise
Release to the Environment in a
Safe Manner



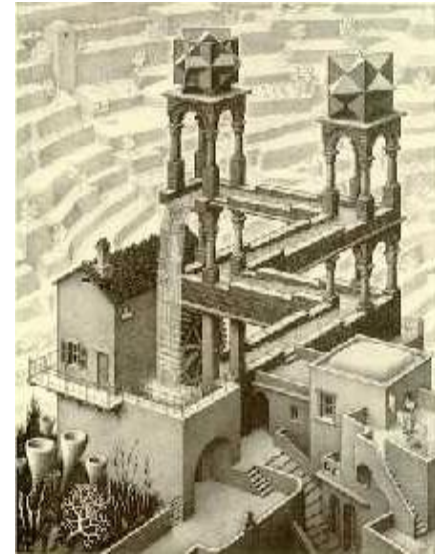
NBC Pollution Prevention Program

Program Title	Grant Number	Year Awarded	Award Amount
NBC Pollution Prevention Program	NP818873-01-0	1992	\$300,000
Pollution Prevention College Course	NP991705-01-1	1995	\$60,000
CLEAN P2 - Regulatory Relief Program	NP991756-01-0	1996	\$85,000
NBC Metal Finishing 2000 Program	NP991195-01-0	1997	\$35,000
NBC Metal Finishing Seminars	NP991402-01-0	1998	\$25,000
Environmental Management Systems	NP991679-01-0	1999	\$32,000
Environmental Best Management Practices	NP98121801-0	2000	\$35,000
MP&M Pollution Prevention Audits	NP98142601	2001	\$50,000
Pollution Prevention in RI Hospitals	NP98154501-0	2002	\$25,000
Pollution Prevention for Scrap Yards	NP98182201-0	2003	\$25,000
Stormwater Pollution Prevention	NP97107901-0	2004	\$35,000
EPA Energy Conservation	NP97126001-0	2005	\$35,000
RI Biogas Feasibility Study	N/A	2006	\$25,000
RI Wind Energy Feasibility Study	N/A	2006	\$25,000
SIG Grant		2008	\$275,000
Total:			\$1,067,000

Renewable Energy Opportunities

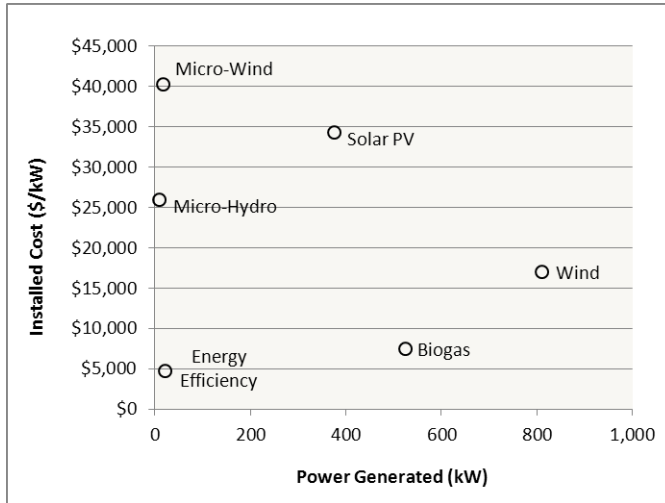
2005 EPA Grant

- Renewable Energy
 - Green Power
 - Alternative Energy
 - Clean Energy
- Naturally Replenished in a Short Period of Time
- Generally Clean (Green)
- Readily Accessible



- Solar
- Wind
- Water (Hydro-Power)
- Geothermal
- Bio-Mass / Bio-Gas

NBC Energy Projects



Electric Generation	Unsubsidized Cost Estimate	Capacity Factor	Average Output (kW)	Installed Cost (\$/kW _{actual})	Portion of WWTF Load (2013)	
					Bucklin Point	Fields Point
Typical EE Project	\$55,086	100%	21	\$4,713	1.4%	0.9%
Biogas CHP	\$3,920,000	88%	525	\$7,461	35%	0%
Wind	\$13,768,511	18%	810	\$16,998	0%	34%
Solar PV	\$12,896,054	14%	376	\$34,273	25%	0%
Micro-Wind	\$725,000	18%	18	\$40,278	1.2%	0%
Micro-Hydro	\$500,000	54%	17	\$28,979	0%	0.7%

Total Potential Renewable Generation

61%

35%

Energy Efficiency

Location	Description of Energy Efficiency Project	Energy Savings (kWh/yr)
Bucklin Point	Efficient Blower Selection	618,757
Bucklin Point	Optimal DO and Blower Control	502,416
Bucklin Point	VFDs on Recycle Pumps	81,858
Fields Point	VFDs on Blowers 1, 2 & 3	198,345
Fields Point	Power Washing Diffuser Heads	25,266
Fields Point	Pilot Tube Air Station Sensors	24,788
COB	Lighting upgrade at Corporate Office Building	63,419



NBC Field's Point WWTF

- ▶ Field's Point WWTF Operations
 - 45 MGD (170.1 MLD) Average
 - 65 MGD (246 MLD) Secondary
 - 200 MGD (756 MLD) Primary
 - Chlorination/De-chlorination
 - Sludge Gravity Thickeners
 - 4 Pumping Stations

- ▶ Field's Point WWTF Energy Use
 - 1.34 MW Electrical Load
 - 13,020,000 kWh/year
 - \$1,600,000/year
 - 23% of Annual Operating Budget



Renewable Opportunities:

- Wind
- Hydro-Electric
- Small Solar

Project Feasibility Study – Wind

\$25,000 Grant from State of RI

Technical and Economical Feasibility

Wind Data - On-Site Measurement 2007 - 2009



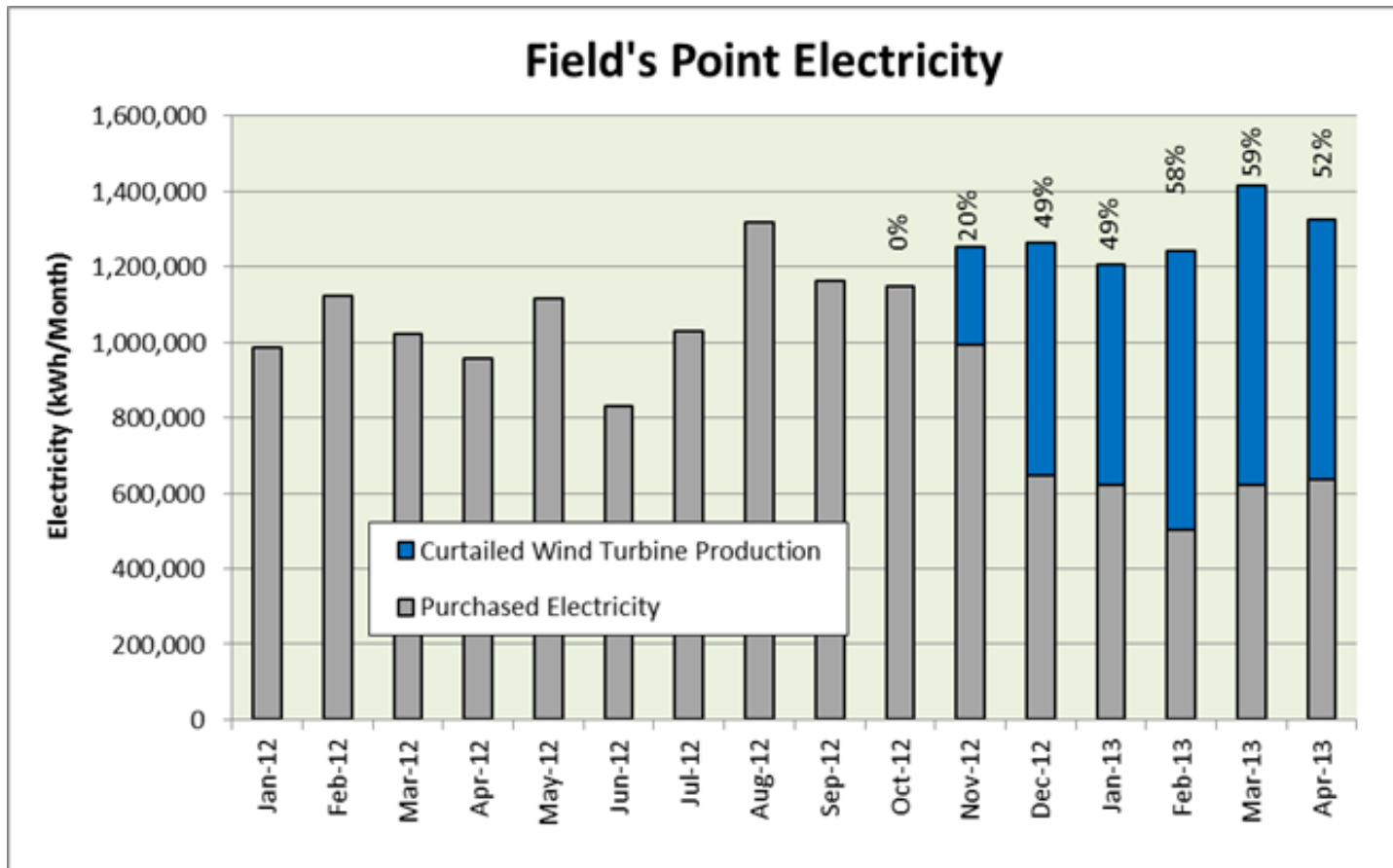
Wind Energy

Three Goldwind – GW/82 1500 Wind Turbines
 1.5 MW each
 Multi-pole Synchronous – Permanent Magnet
 Hub Height: 70 Meters (230 feet)
 Blade Length: 40.28 meters (132.2 feet)
 Mass of Single Blade: 6,800 kg (7.5 tons)
 Rotor Diameter: 82 meters (270 feet)
 Total Height: 111 meters (364 feet)

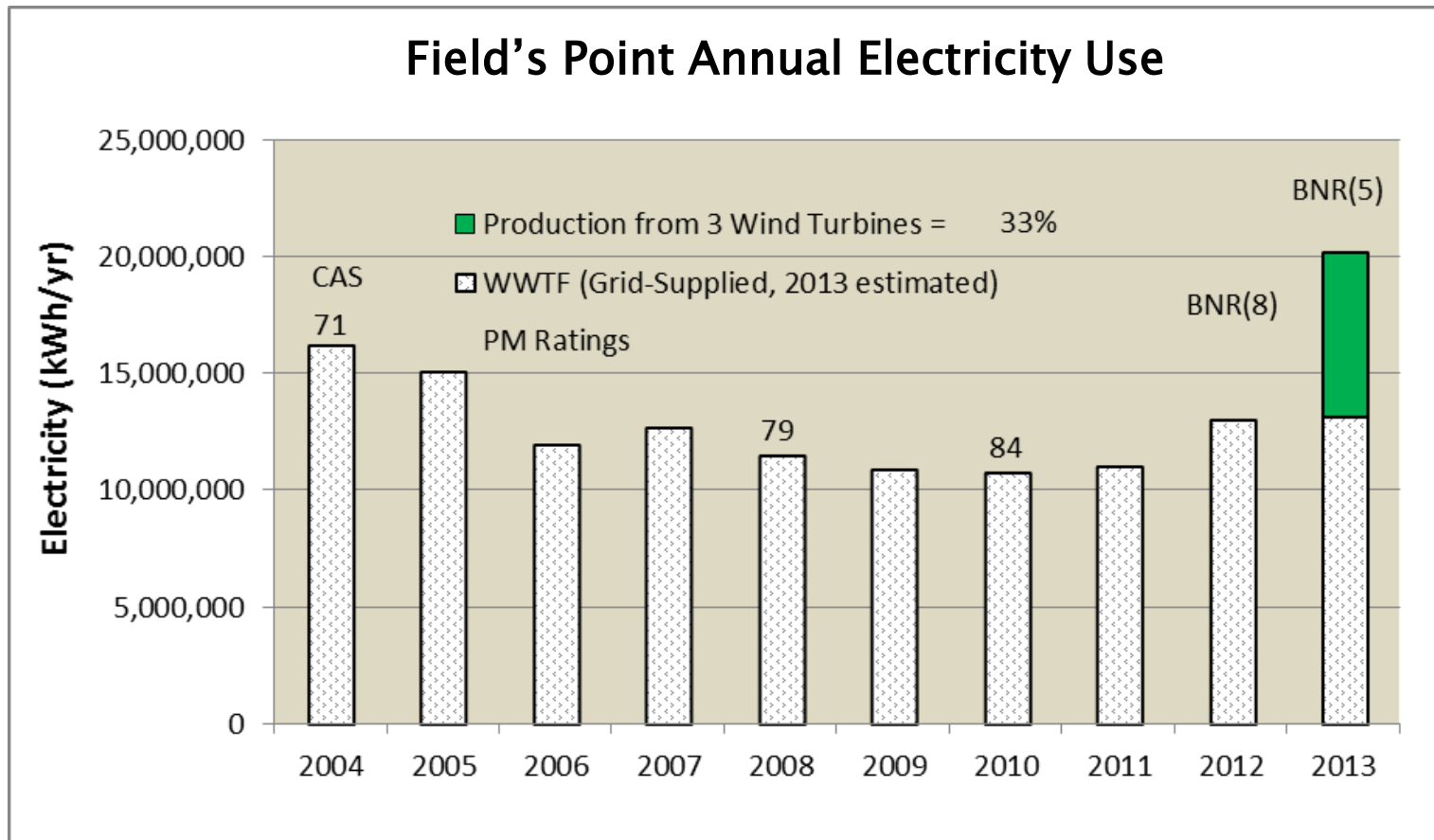


Total Project Cost	\$13,500,000 (2013)
Electric Production	7,113,000 kWh/yr
Percent of Use	40%
GHG avoided	2,945 tons/yr CO ₂
Offset equivalent	633 homes
Electric Rate (kWh based 2011)	\$0.097 per kWh
Estimated average REC	\$0.035 per kWh
O&M Cost	\$0.011 per kWh
Total Savings Rate	\$0.121 per kWh
Simple Pay Back Period	15.6 Years

Wind Energy Recent Monthly Production



Wind Energy Future Annual Production



NBC Bucklin Point WWTF

▶ Bucklin Point WWTF Operations

- 24 MGD (90.8 MLD)
- 46 MGD (174 MLD) Secondary/Tertiary
- 116 MGD (438 MLD) Primary
- UV Disinfection
- **Anaerobic Digestion**
- 3 Pumping Stations

▶ Bucklin Point WWTF Energy Use

- 1.46 MW Average Demand
- 12,870,000 kWh/year
- \$1,520,000/year
- 30% of Annual Operating Budget



Renewable Opportunities:

- Biogas
- Large Solar

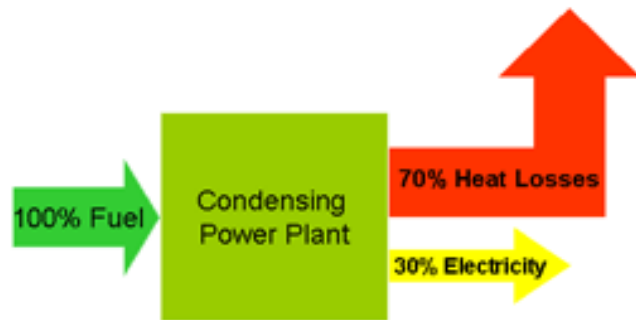
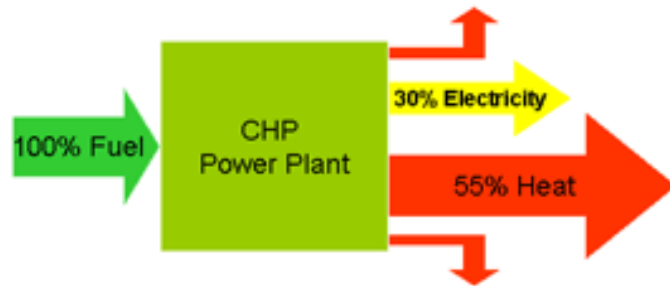
BioGas Energy

Bio-Gas

- ▶ By-Product Anaerobic Digestion
- ▶ Contains
 - CH_4 60 %
 - CO_2 35%
 - H_2S 0 - 300 ppmv
 - Trace Contaminates
- ▶ Energy Content
 - 550 BTU/SCF
- ▶ Energy Value
 - \$12.6 / MMBtu (\$0.70 / HCF)



Combined Heat and Power



Combined Heat and Power

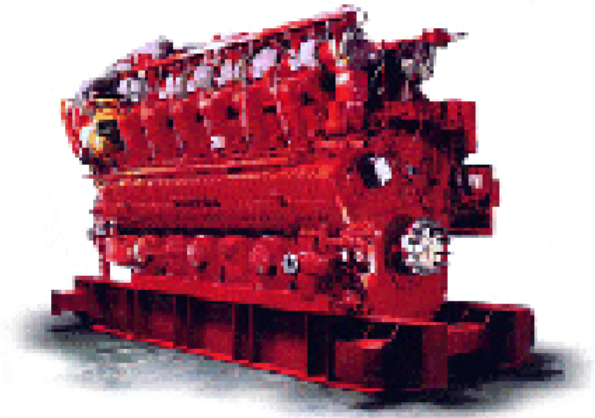
- Electrical Efficiencies: 30 - 35%
- Heat Capture: 40 - 55 %
- Heat Loss: 10 - 20 %

Conventional Power Plant

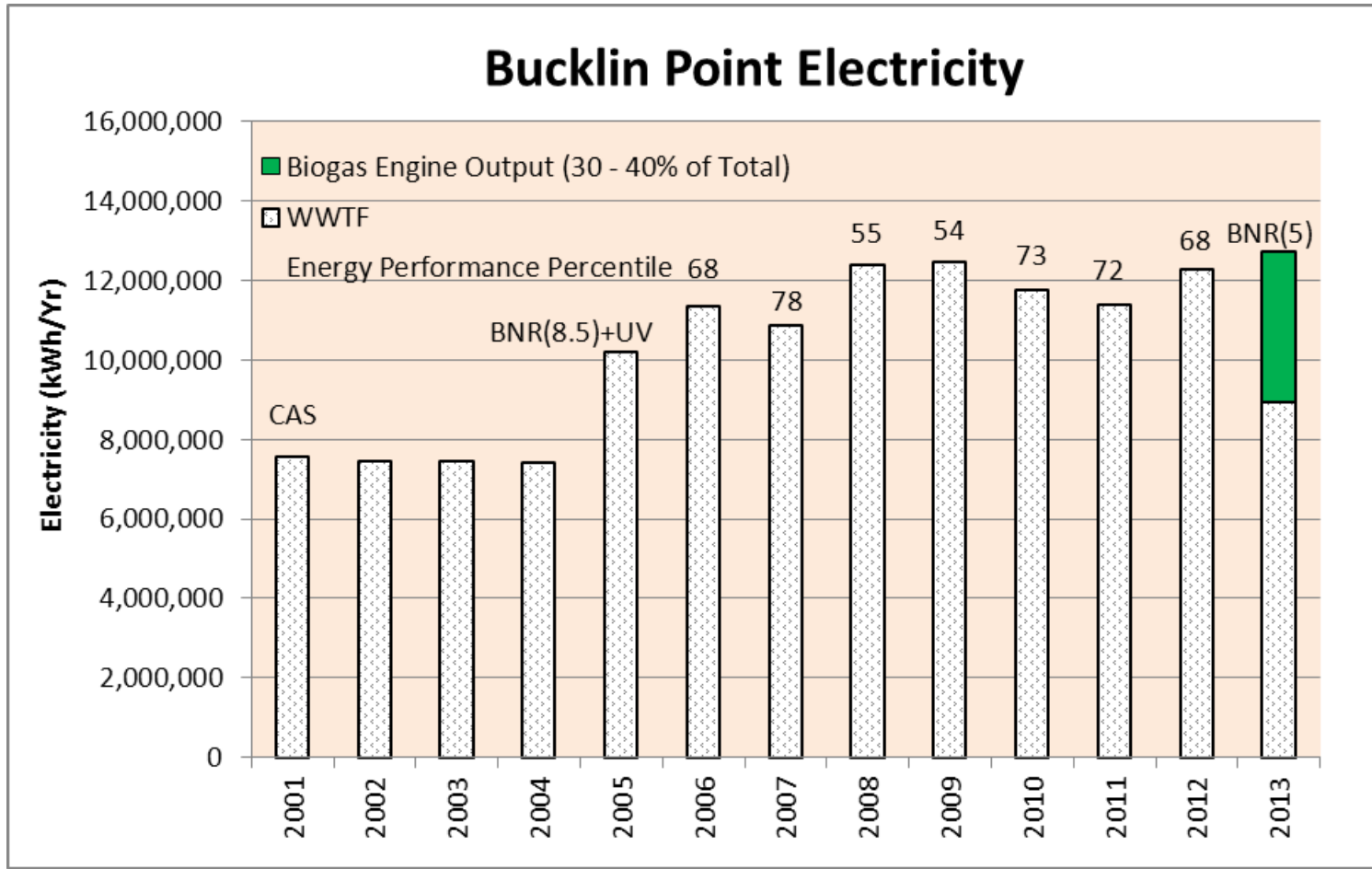
- Electrical Efficiencies: 30 - 35 %
- Heat Loss: 60 - 70%

NBC Bucklin Point Biogas Energy Project

- ▶ \$25,000 Grant from State of RI – Feasibility Study
- ▶ 600 kW Combined Heat and Power (CHP) System
- ▶ 36% of BP Electricity Demand
- ▶ 90 % of BP Digester Heat Demand
- ▶ 250,000 SCFD Biogas Production (60% Methane)
- ▶ Estimated Project Cost: \$3,920,000
- ▶ Estimated Annual Operating Cost: \$172,000
- ▶ Estimated Annual Electricity Cost Savings: \$440,000
- ▶ Estimated Annual Natural Gas Cost Savings: \$47,000



NBC Bucklin Point Biogas Calculated Energy Production



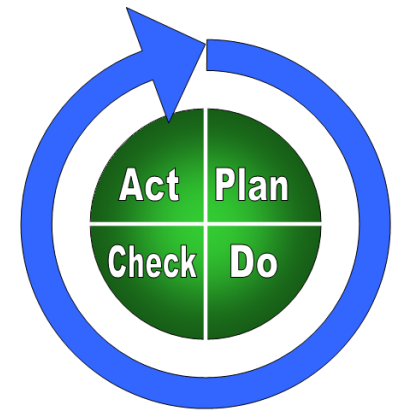
Sustainable Energy Management Program for WWTF

Energy Focused –Environmental Management Systems (EF-EMS)

- ▶ EPA Energy Management Guidebook for Wastewater and Water Utilities
- ▶ Energy Star Portfolio Manager
 - Measure and Benchmark Energy Use Performance
 - Energy Conservation and Efficiency
 - Renewable Energy Opportunity Assessments

Fats Oils and Grease Environmental Results Program (FOG-ERP)

- ▶ Restaurants and Food Service Facilities
- ▶ FOG Management – Use as an Energy Source



EPA 2008 State Innovations Grant

\$275,000 Grant Award

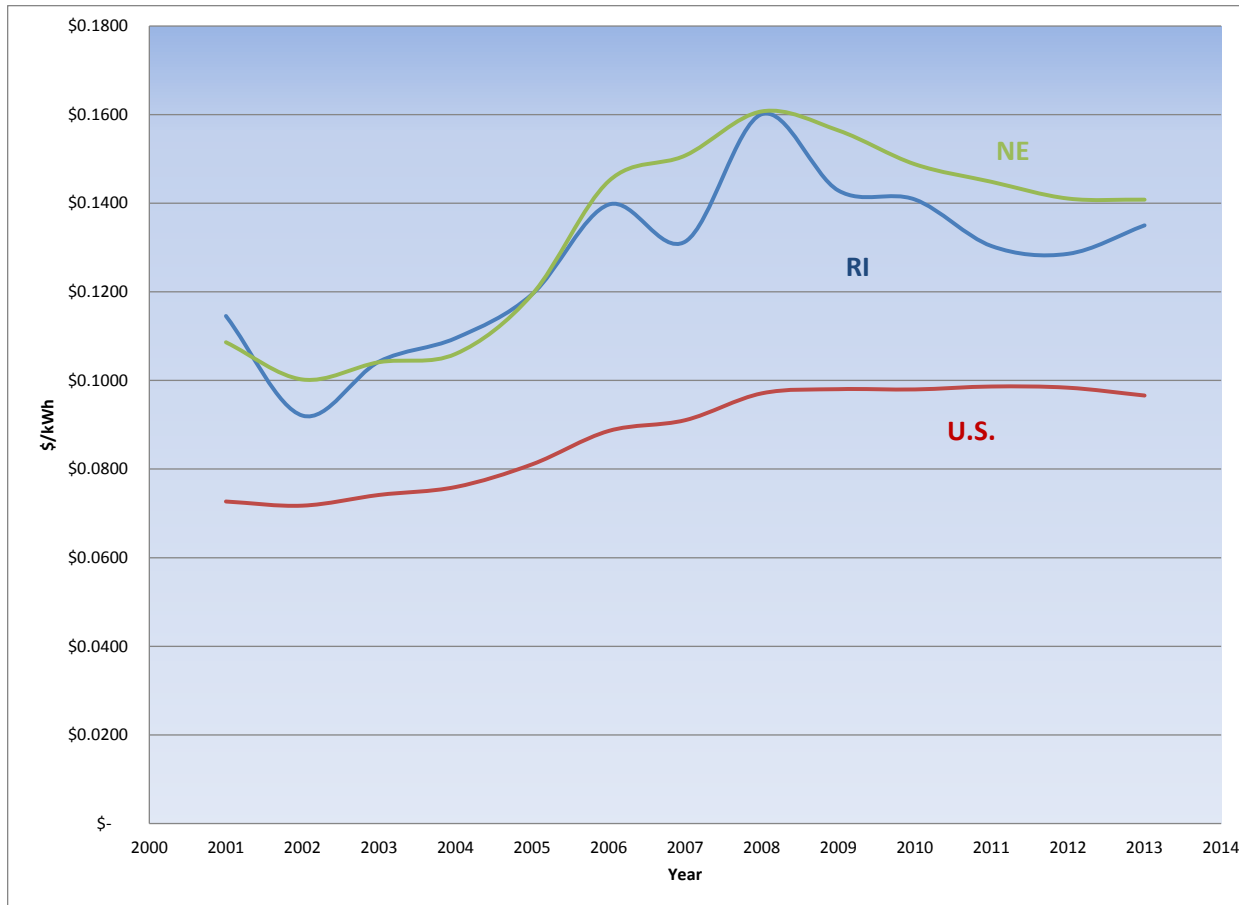
Sustainable Energy Management Program for WWTF

Project Partners

- ▶ **Narragansett Bay Commission**
- ▶ University of Rhode Island
- ▶ Rhode Island Department of Environmental Management
- ▶ Rhode Island Manufacturing Extension Services
- ▶ EPA Region I
- ▶ National Grid
- ▶ RIOER

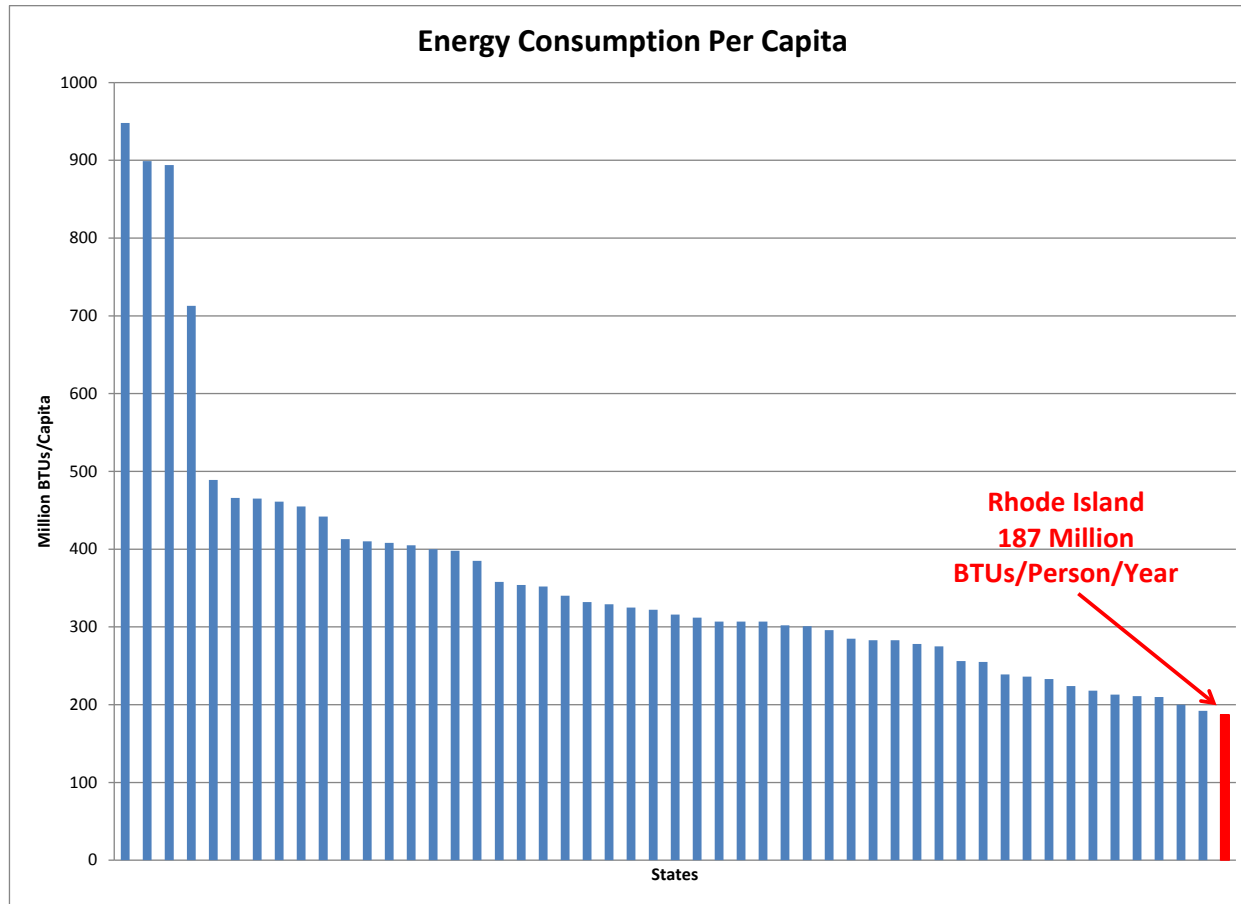


Electricity Costs US-NE-RI



Energy Information Administration - www.eia.doe.gov

US Per Capita Energy Consumption



Energy Information Administration - www.eia.doe.gov

WWTF Sustainability Project Tasks

Rhode Island

39 Cities and Towns

5 Counties

Population \approx 1,053,000

3,144 sq km (1,214 sq miles)

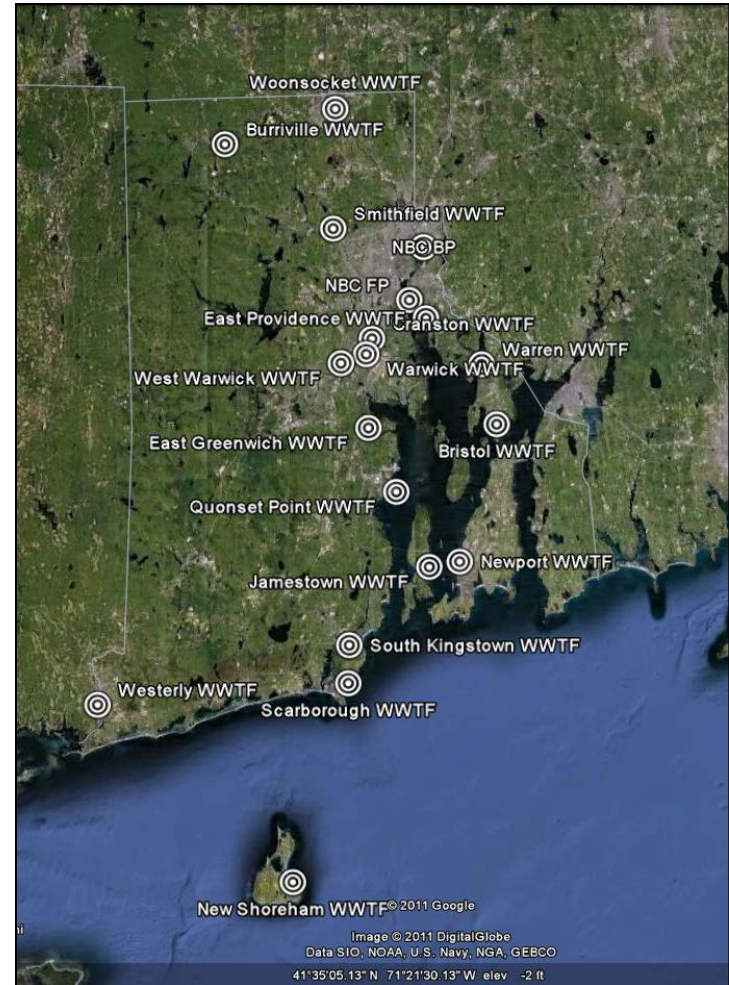
Nineteen Municipal WWTF

620 MLD (165 mgd)

63,000,000 kWh/yr

\$8.8 M/yr

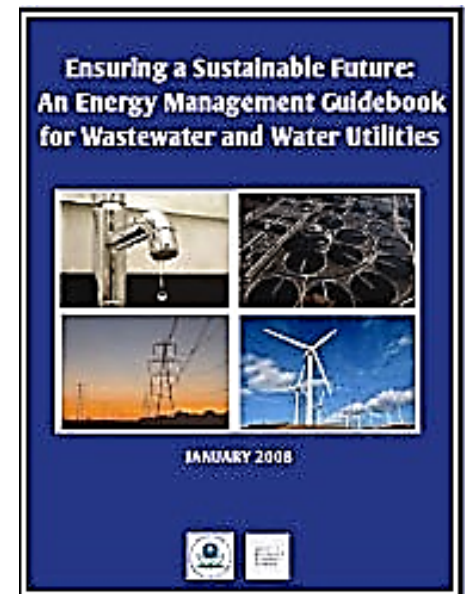
1 M Metric Tons CO_{2(e)}/yr



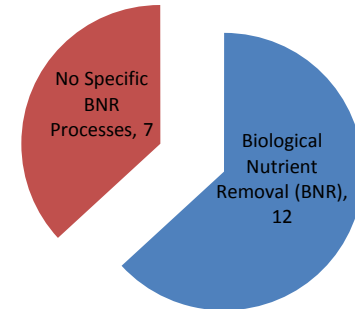
Sustainable Energy Management Program for WWTF

A **Sustainable WWTF Energy Management Program** is recognized as consisting of practices, procedures, policies and technologies that put in place today will continuously support and sustain WWTF operations into the future.

- ▶ Improve Energy Management Practices at all 19 RI WWTFs
- ▶ Utilize EPA “Energy Guidebook”
- ▶ Establish energy–use baselines for each participating WWTF – using EPA’s Portfolio Manger
- ▶ Conduct energy use assessments for all 19 WWTFs
- ▶ Establish WWTF EF–EMS Roundtable



Rhode Island's 19 WWTFs



- Standard Primary/Secondary RAS - 10
- Extended Aeration RAS, No Primary - 2
- Rotating Biological Contactor - 3
- Fixed Film RAS with Primary/Secondary - 3
- Oxidation Ditch - 1

Sustainable Energy Management

▶ Plan

- Develop Energy Policy
- Form Energy Team
- Conducted Energy Use Assessments
- Establish Energy Goals
- Track and Benchmarking Energy Use
- Identify Objectives, Targets and Indicators
- Develop Energy Management Plans

▶ Do

- Implement Energy Management Plan

▶ Check

- Monitor and Measure

▶ Act

- Review Progress and Make Adjustments
- Document and Communicate Success



The screenshot displays a 'PORTFOLIO MANAGER' dashboard. It includes a 'Portfolio Average Rating' section with 'Baseline Rating: 25' and 'Current Rating: 41'. Below this is a table of facility data:

Facility Name	Current Rating (1-100)	Adjusted Percent Energy Reduction	Total Floor Space (Sq. Ft.)	Energy Use Alerts	Current Energy Period Ending Date	Eligibility for the ENERGY STAR	Last Modified
68th Street ES	100	0.0%	45,981	Data > 120 days old	12/01/2006	Not Eligible: Current period ending over 120 days (ENERGY STAR Data_Rule)	04/12/2007
Abraham Lincoln School HS	47	30.3%	68,276	Data > 120 days old	11/03/2006	Not Eligible: Rating must be 75 or above (ENERGY STAR Data_Rule)	02/09/2007
Akron Linnets ES	27	34.9%	43,000	Data > 120 days old	04/30/2006	Not Eligible: Rating must be 75 or above (ENERGY STAR Data_Rule)	06/22/2006

Other P-D-C-A Approaches

- WEF Energy Road Map
- ISO 14001 EMS
- ISO 50001 – Energy Standard
- ANSI/MSE
- Asset Management
- National Bio-Solids Partnership

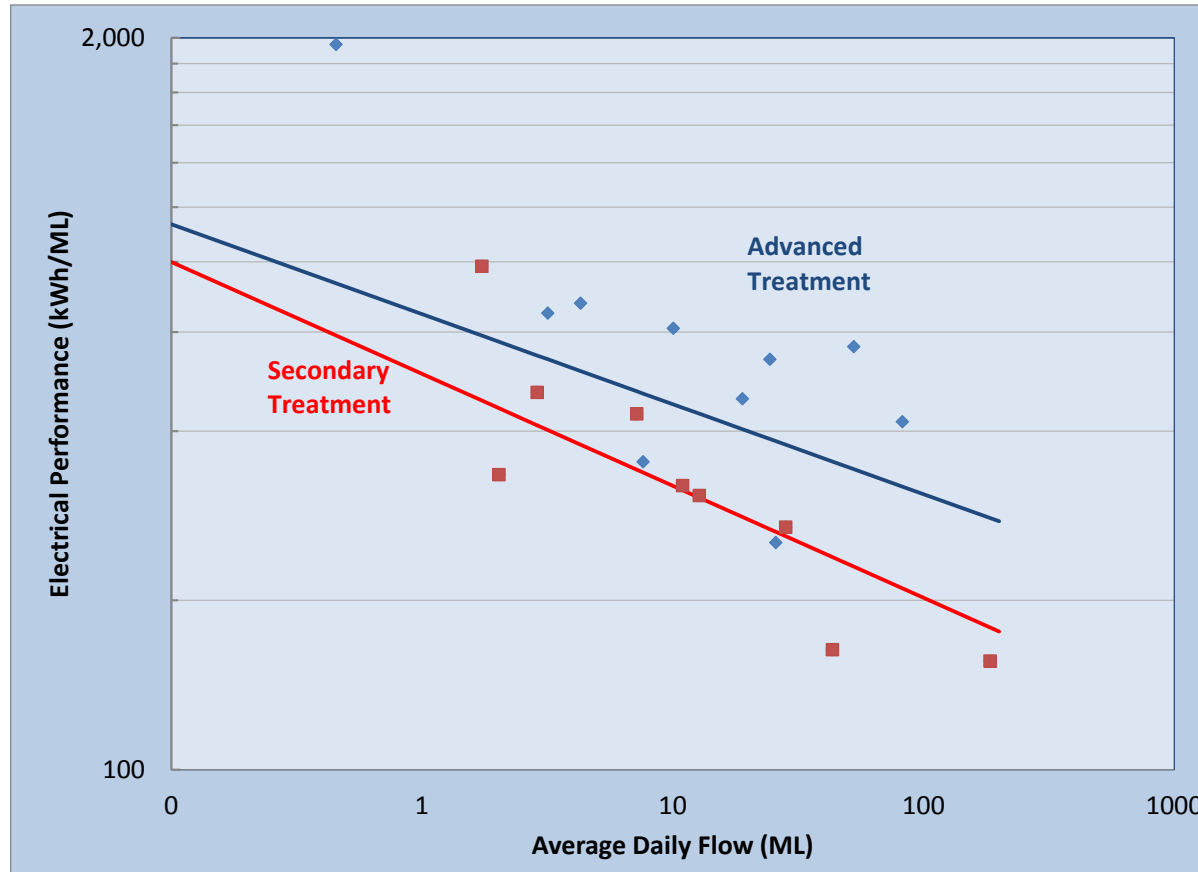


Rhode Island WWTFs

WWTF ID	Population	Electricity kWh	Gas therms	Oil gallons	Energy Mbtu	Flow MGD	Volume MG/Yr	Electric kWh/MG	Heat kBtu/MG	Total kBtu/MG
RI-WWTF-2	1,720	247,300	0	3,000	1,324	0.54	195	1,266	2,150	6,777
RI-WWTF-1	750 / 8500	322,418	0	0	1,100	0.11	38	8,378	0	28,586
RI-WWTF-4	16,361	492,600	2,790	1,900	2,288	0.70	255	1,932	2,137	8,973
RI-WWTF-3	6,000	496,534	0	2,000	2,014	0.54	196	2,532	1,428	10,269
RI-WWTF-5	8,000	750,700	0	7,158	3,707	0.84	306	2,453	3,274	12,111
RI-WWTF-8	13,000	979,874	0	9,427	4,852	2.01	734	1,335	1,798	6,609
RI-WWTF-6	2,500	1,051,878	20,350	0	5,624	1.08	393	2,676	5,177	14,307
RI-WWTF-7	8,000	1,095,268	0	16,018	6,300	1.90	694	1,579	3,234	9,084
RI-WWTF-9	25,396	1,277,575	0	17,500	7,159	2.89	1,056	1,210	2,321	6,782
RI-WWTF-10	16,900	1,431,124	10,569	1,112	6,118	3.65	1,333	1,073	909	4,588
RI-WWTF-19	10,000	2,234,168	0	4,800	8,391	2.70	986	2,267	682	8,514
RI-WWTF-15	38,385	2,703,613	23,758	0	11,601	11.83	4,318	626	550	2,687
RI-WWTF-13	47,935	2,776,279	48,531	0	14,326	7.42	2,710	1,025	1,791	5,286
RI-WWTF-11	28,000	3,159,000	27,469	0	13,525	5.01	1,829	1,727	1,502	7,395
RI-WWTF-12	30,000	4,776,225	0	19,411	19,402	6.45	2,354	2,029	1,154	8,242
RI-WWTF-16	77,000	7,874,578	58,735	0	32,742	13.92	5,079	1,550	1,156	6,446
RI-WWTF-14	52,200	8,716,754	4,195	3,085	30,655	33.14	12,097	721	70	2,534
RI-WWTF-18	208,743	10,486,807	74,004	0	43,181	48.67	17,765	590	417	2,431
RI-WWTF-17	119,809	12,507,940	39,883	0	46,665	21.75	7,938	1,576	502	5,879
	709,949	63,380,636	310,284	85,411	260,973		60,276	1,052	713	4,330

Electricity Costs

RI WWTF Electrical Energy Performance



Trend Lines from: Water Environment Federation - MOP No. MFD-2

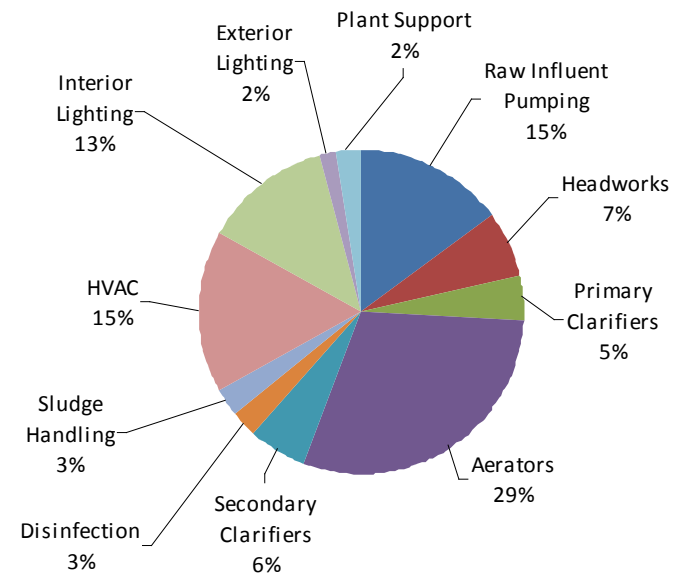
Energy Focused Environmental Management System

Energy Use Assessments

Distribution of Energy Costs



ASPECTS	IMPACTS			
	Process Operation	kWh/day	kWh/MG	lb CO ₂ /MG
Aeration (Diffused Air)	26,600	532	450	\$53.20
Wastewater Pumping	6,030	121	102	\$12.06
Lighting for Buildings	2,000	40	34	\$4.00
Return Sludge Pumping	1,627	33	27	\$3.25
Belt Filter Press	1,164	23	20	\$2.33
Primary Clarifiers	776	16	13	\$1.55
Secondary Clarifiers	776	16	13	\$1.55
Aerated Grit Removal	600	12	10	\$1.20



Energy Focused Environmental Management System

Energy Use Assessments

Potential Energy Efficiency Measures



EEM No.	Description	Comments
1	Nitrate Sensors	Installation of nitrate sensors for automatic termination of aerobic phase operation would need to save at least 23,000 kWh annually to qualify for an incentive worth \$12,404. Measure costs are \$30,190 and demand savings during summer months would need to be 5.9 kW on average. It may be possible for this degree of savings to be achieved.
2	Primary Sludge Pump Drive Retrofit	An existing slip drive could be replaced with a single-speed gear drive and save approximately 1.3 kW and 1,900 kWh. Costs are estimated to be around \$3,000. This measure may qualify for incentives.
3	Plant Water Pump VSD	Installation of a 5-hp VSD could qualify for a \$1,700 prescriptive incentive.
4	Lighting Fixture and Controls Retrofit	DMI recommends that National Grid send a project expediter to the site to review lighting retrofit opportunities. There are many T12 and low-bay metal halide fixtures that could be changed. Occupancy /vacancy sensors could be installed in many areas.
5	HVAC Controls Retrofit	The plant may be able to participate in the prescriptive EMS program and the Cool Choice program if modifications are made to the HVAC systems.

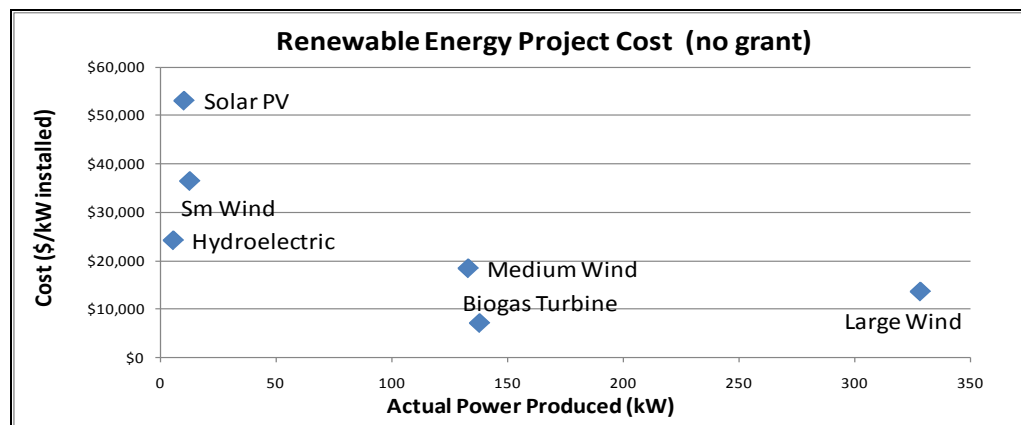
Energy Focused Environmental Management System

Energy Use Assessments

Renewable Energy Opportunities



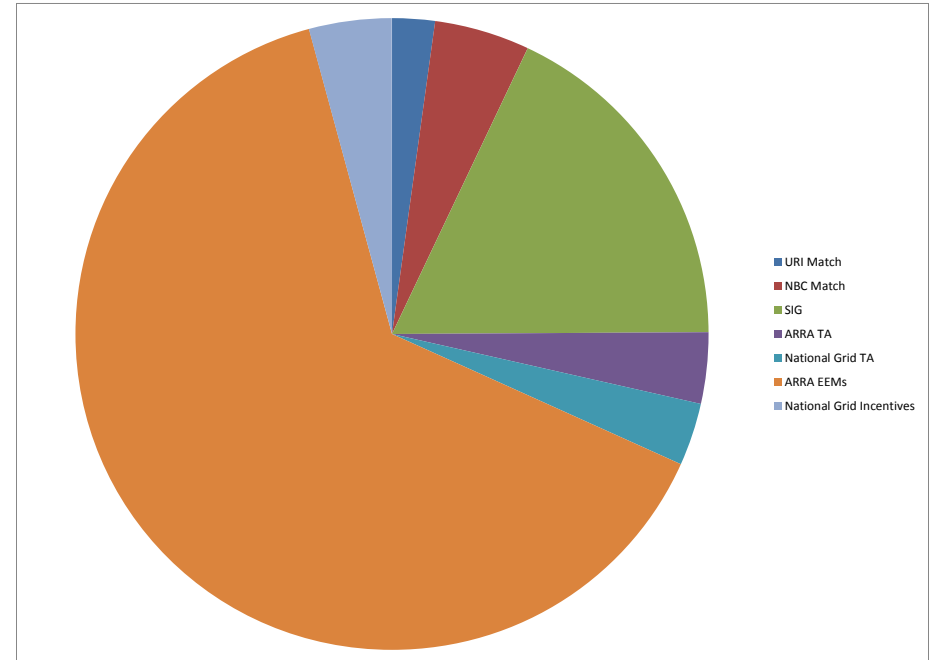
Renewable Resource	Actual Power (kW)	Percent of WWTF	Total Project Cost
Hydroelectric	5.4	10%	\$129,961
Solar	10	18%	\$530,560
Biogas	138	246%	\$970,287
Small Wind	12	22%	\$455,000
Medium Wind	133	237%	\$2,442,000
Large Wind	328	586%	\$4,455,000



WWTF Sustainability Project Outcomes

Projects Outcomes

- Energy Assessment of all 19 WWTFs
- 4,470,000 kWh/year of potential energy savings
- 11,000 kWh/year of clean renewable energy opportunities
- Leveraged 1.2 M in additional funding
- Heightened energy use awareness
- Improved energy related communications

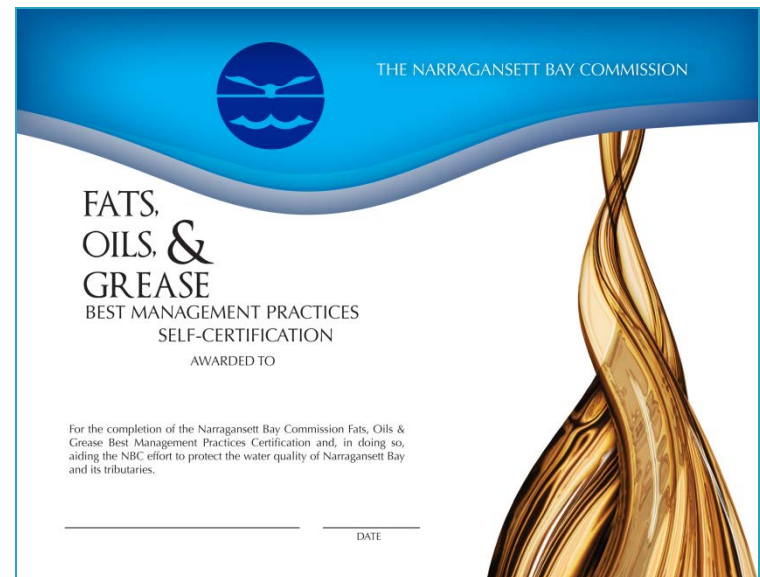


URI Match	\$33,512
NBC Match	\$75,000
EPA SIG	\$275,000
ARRA TA	\$55,904
National Grid Energy TA	\$49,147
ARRA EEMs	\$985,460
National Grid Incent.	\$65,000
Total:	\$1,539,023

Sustainable Energy Management Program for WWTF

Fats Oils and Grease Environmental Results Program (FOG-ERP)

- ▶ Improve Management of FOG using BMPs at Restaurants and Food Service Facilities
- ▶ Reduce the Discharge of Waste Oil and Grease to the Sewer System, and
- ▶ Promote the Use of Waste Oil and Grease as a Source of Renewable Energy

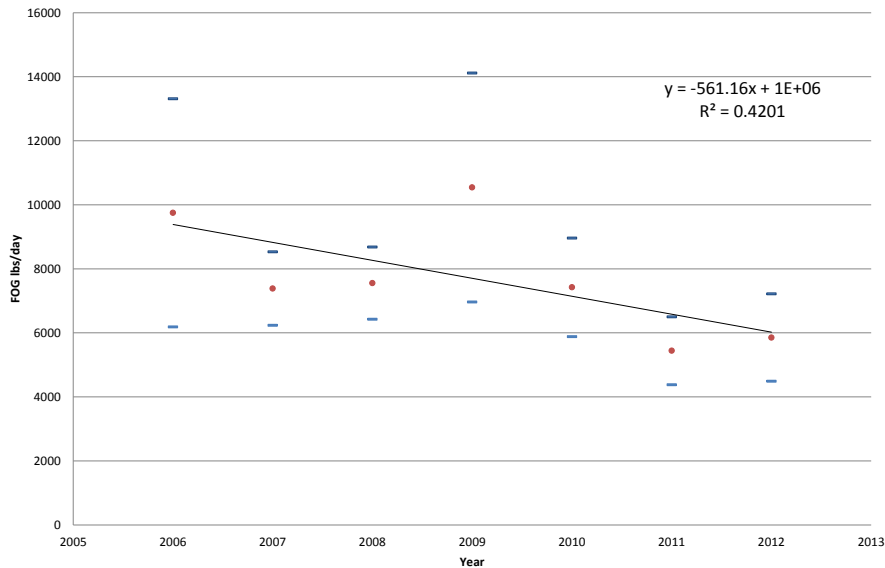


FOG Loadings Down Biodiesel Production Up

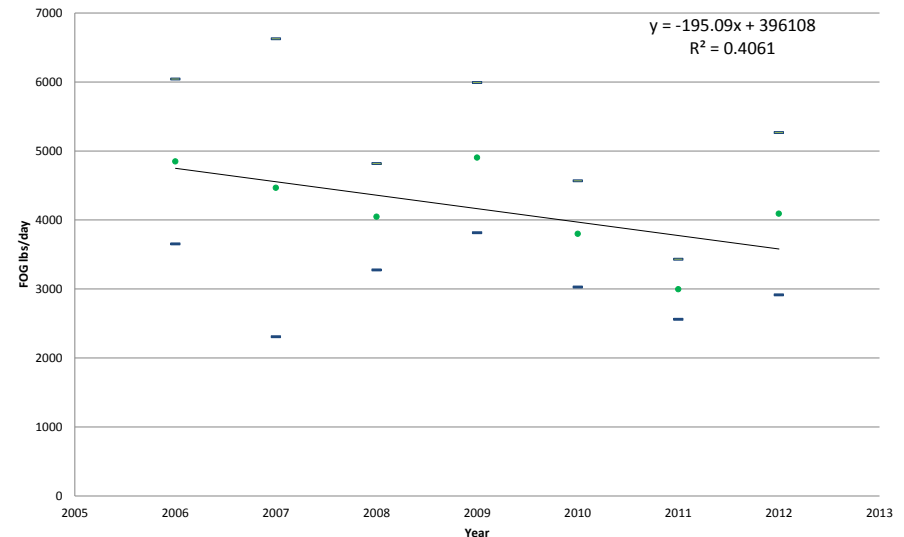


Newport Biodiesel boosts production to 1.5 million gallons in 2013

Average Daily
FOG Loadings at the FP WWTF



Average Daily
FOG Loadings at the BP WWTF



Biodiesel Production Process

Fuel	Specific Gravity	Heating Value (Btu/gallon)
No. 2 Diesel	0.850	129,500
Biodiesel (B100)	0.880	118,296
B20 Blend (B20)	0.856	127,259
B2 Blend (B2)	0.851	129,276

Pure Glycerin:

- Pharmaceuticals
- Cosmetics
- Medicines

Biodiesel Glycerin:

- Burned for energy/disposal
- Composting
- Refined for other uses
- Biogas Production
- **Carbon Source for WWTF Process**



100 gallons Yellow Grease -> 90 gallons biodiesel + 10 gallons glycerin

On-Going and Planned NBC Sustainability Projects

- ▶ Green Buildings
- ▶ Spartina Grass Plantings
- ▶ Osprey Cam System
- ▶ Bucklin Point Solar Energy
- ▶ Hydro-Electric at WWTFs
- ▶ GHG Emissions
- ▶ Wastewater Reuse



Green Buildings

New State of the Art
Laboratory Building – in
Design Phase
– Completion 2013



CDM

Narragansett Bay Commission
Field's Point
Regulatory Compliance Building

November 2, 2011
Perspective View



New Operations Building
Houses new Plant Computer
Control Center – Completed
Dec. 2011
LEED Silver Certified

Spartina Grass Planting – Bucklin Point May 18, 2013

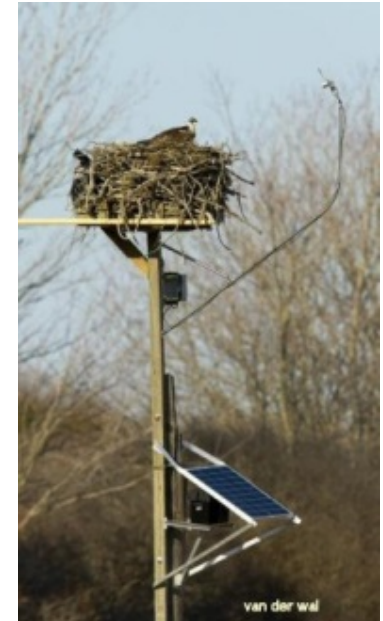


Bucklin Point Osprey Cam

Bucklin Point Osprey Nest

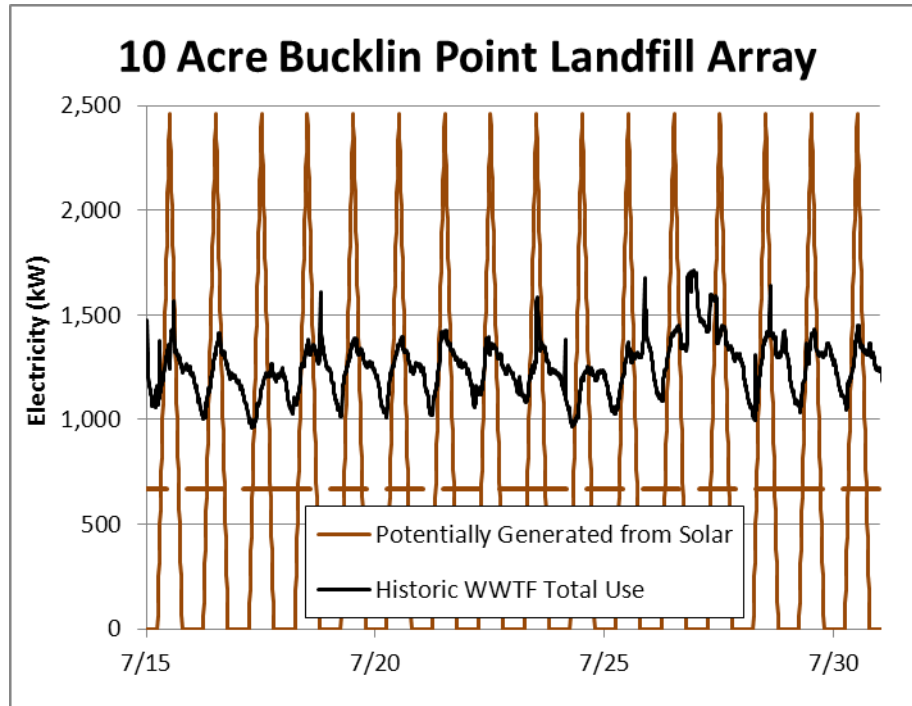


- Wireless solar powered system connecting a video camera to a computer
- Mounted on a pole adjacent nest
- Infra-red camera allows for viewing after dark without lights



Conanicut Island
Raptor Project

Bucklin Point 2.6 MW Solar Energy Project



11.4 acres – Former Landfill
\$8,348,470 Cost
2,864,646 kWh/year
28% of BP Load

Siphon Hydroelectric Turbines

Project Facts:

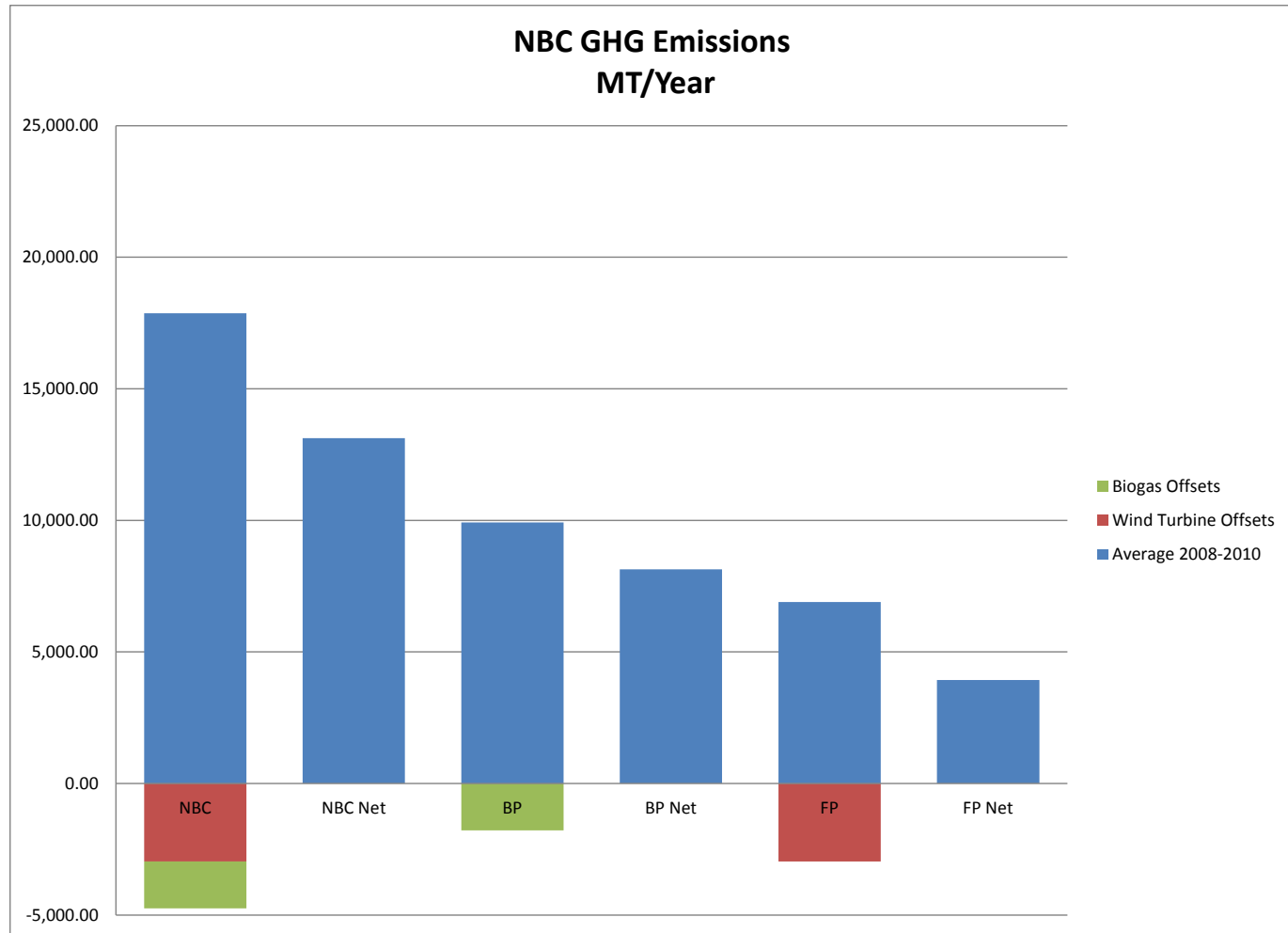
Location	Odra river, southern Poland near Wroclaw city
Customer	Elektrownia Wodna we Wloclawku Spolka z.o.o.
Project Type	On existing weir to supplement Francis turbine
Site Data	Head = 3.5 m Flow = 3.90 cms
Turbine	Three MT10 Siphon turbines
Total Power	300 kW (100 kW per unit)
Mavel Supply	Turbines Generators Inlet Draft tube Electric system Control system
Commissioning	2006



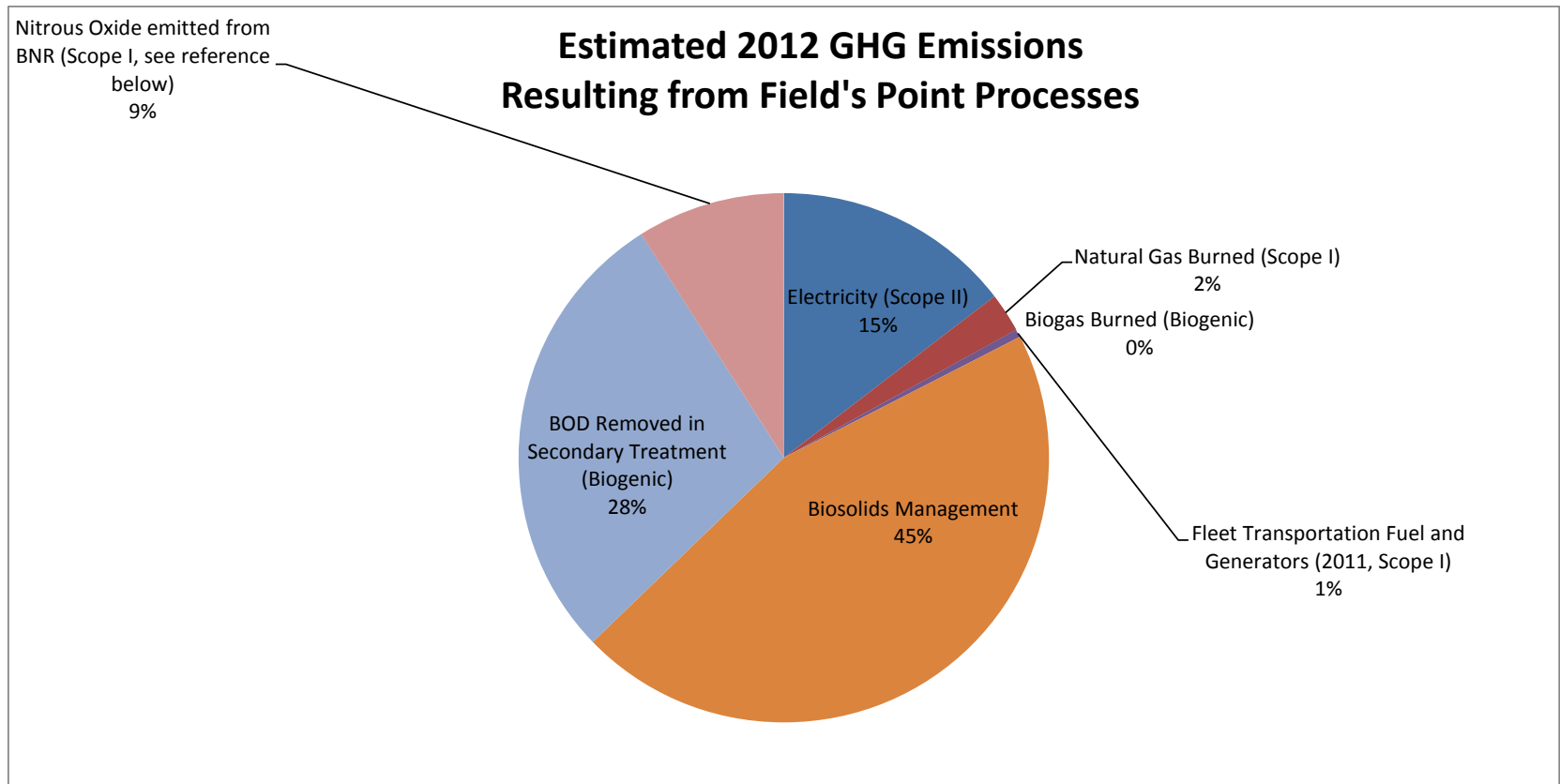
Mavel MT10 Performance

Head (m)	2.0	5.0
Flow (cms)	2.0	5.0
Actual Power (kW)	30	180

GHG Footprint 2010



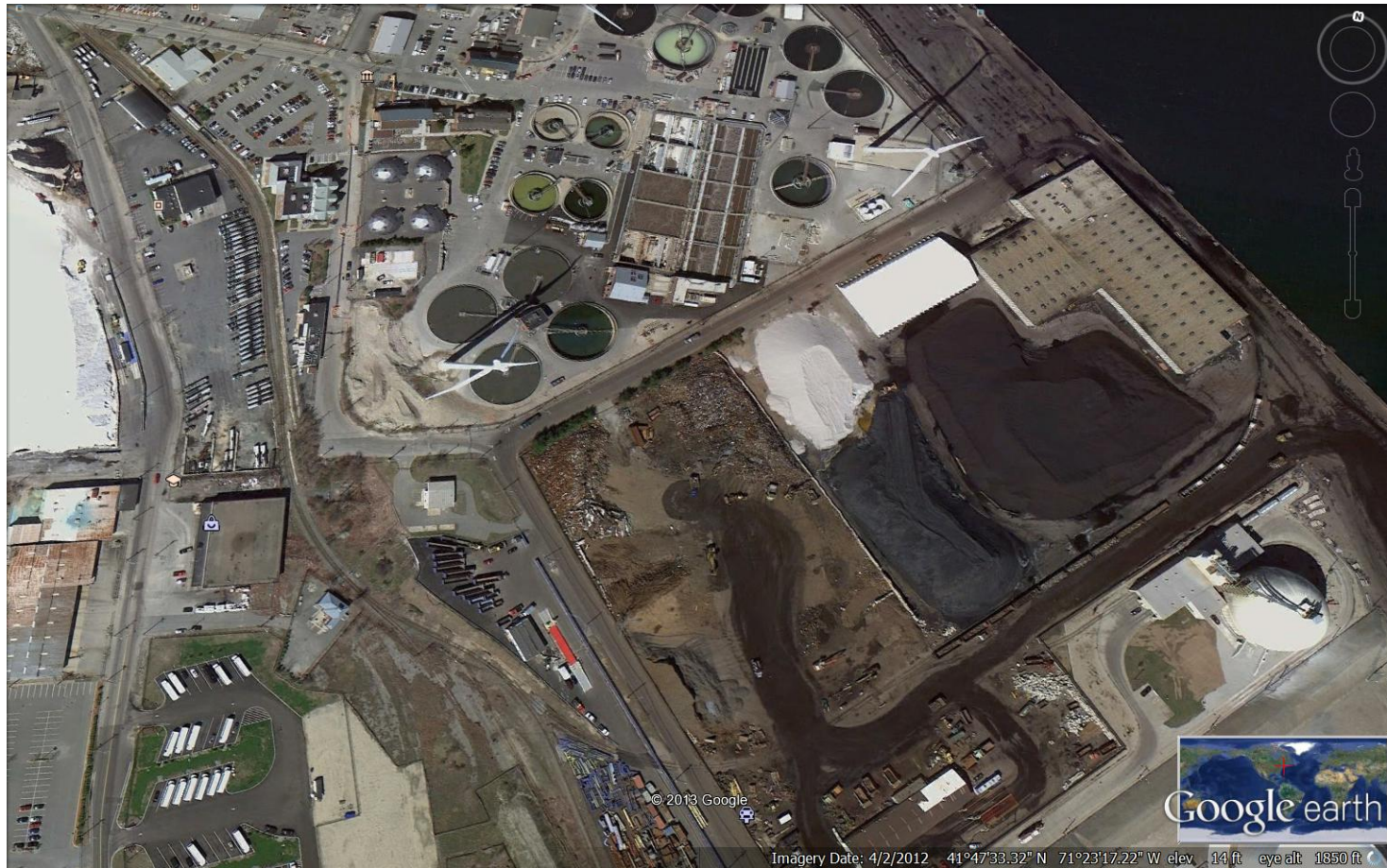
Future GHG Measurements



Water Reuse Opportunities



Water Reuse Opportunities





Questions