



NEW ENGLAND WATER ENVIRONMENT ASSOCIATION

NEWWEA

WORKING FOR WATER QUALITY



Energy & Operations Specialty Seminar

Update on the Narragansett Bay Commission Energy Management Program

Barry Wenskowicz, Environmental Sustainability Engineer

Links for information on awards:

<https://ebcne.org/news/award/climate-change-project-2/>

<https://www.dropbox.com/s/ca5f1yink1gby93/NBC%20Utility%20of%20the%20Future.mp4?dl=0>

Field's Point WWT Facility – 2022 Averages

Field's Point (FP) Operations

- ✓ 43 MGD Avg Daily Flow
- ✓ 77 MGD Secondary Treatment with IFAS Biological Nutrient Removal (BNR)
- ✓ 200 MGD Primary
- ✓ Chlorination/De-chlorination
- ✓ Sludge Gravity Thickeners

FP Average Energy Values

- ✓ 1.6 MW Demand
- ✓ 14.3 million kWh/yr



Renewable Energy (RE) considered:

- ✓ Wind turbines are RI's first Wind Farm
- ✓ Small hydro-electric potential
- ✓ Small onsite solar potential

Bucklin Point WWTF -2022 Averages

Bucklin Point (BP) Operations

- ✓ 20 MGD
- ✓ 46 MGD Secondary Treatment with BNR
- ✓ 116 MGD Primary
- ✓ **UV Disinfection**
- ✓ Anaerobic Digestion

BP Energy Values

- ✓ 1.3 MW Demand
- ✓ 11.4 million kWh/yr



Renewable Opportunities:

- ✓ CHP Engine Project Being Completed to run on Digester Gas
- ✓ 2+ MW Solar LF Project possible

Energy Management Program Elements

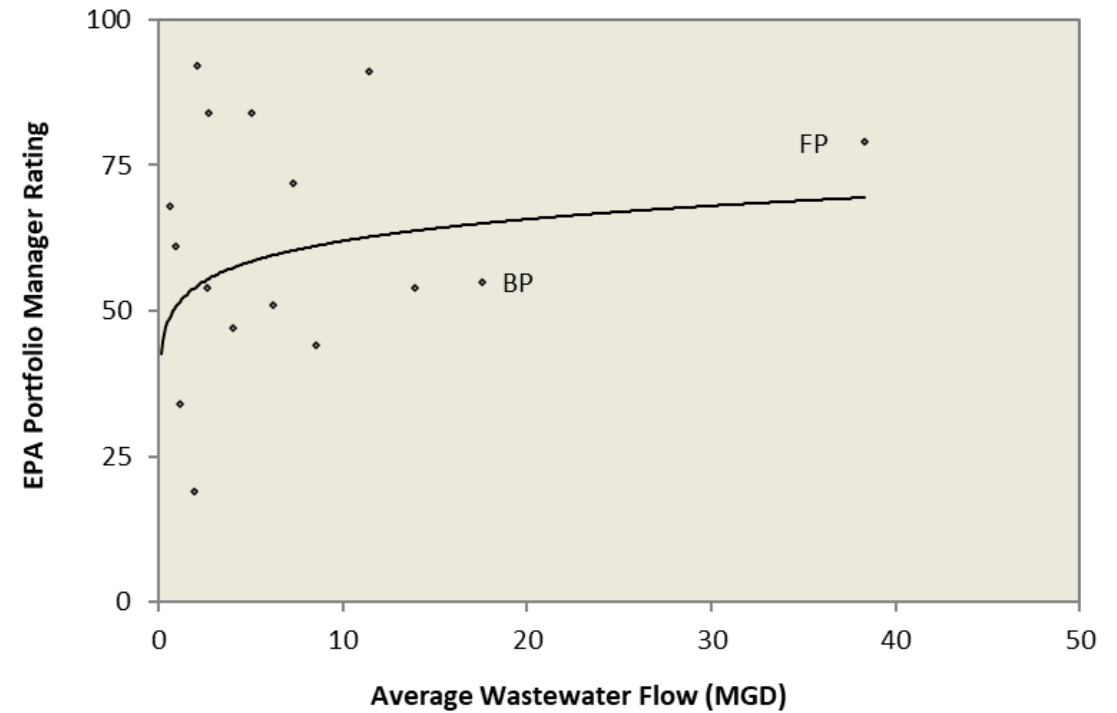
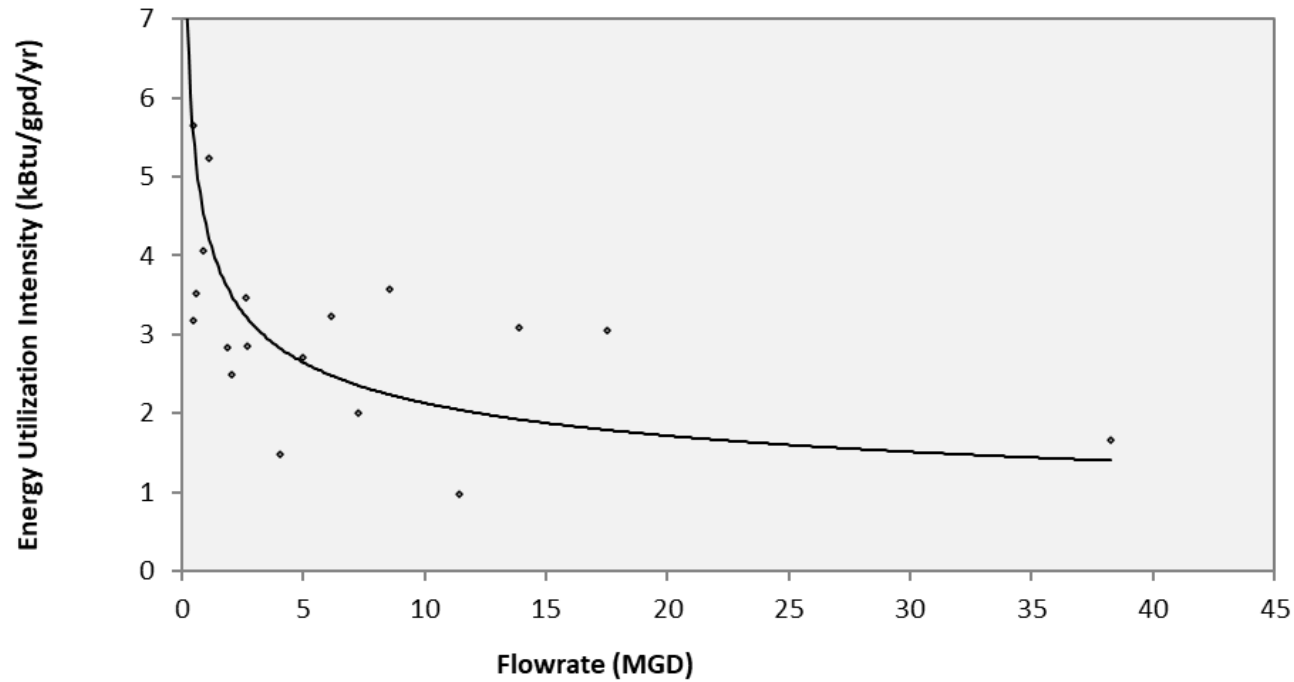
- Establish Team, Commit Long Term
- **Set Goals then track progress**
- Improve Continuously or know why not
- Communicate Regularly (weekly)
- Educate , Train & Share Knowledge
- Upper management supports **voluntary** program, incorporated energy elements into Strategic Plan



- **Audit, Track & Report Regularly**
- Provide positive recognition for progress

Benchmarked RI Sewer Plants (2009)

Rhode Island WWTFs



NBC Energy Program Drivers

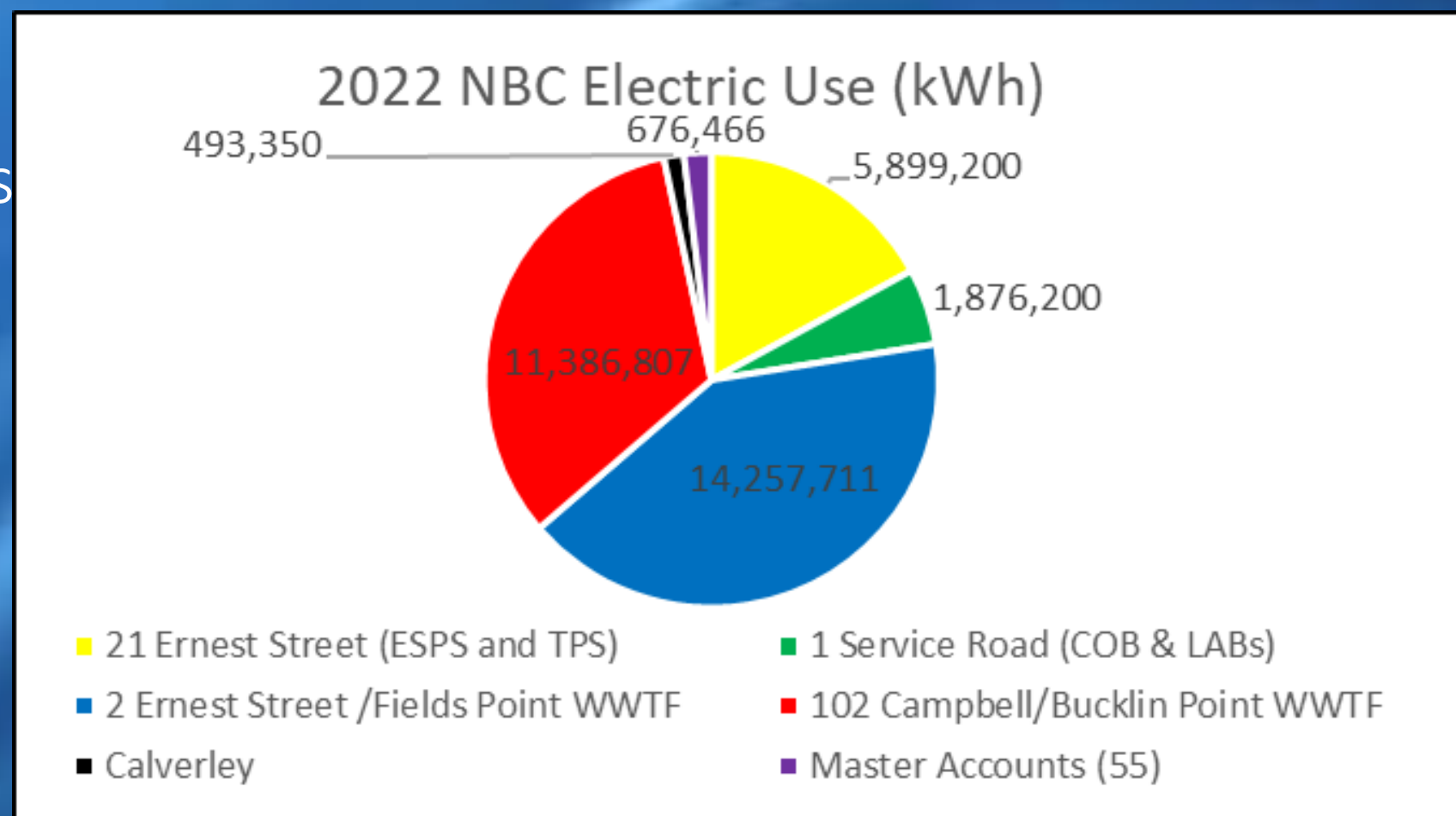
- Save Money by:
 - Reduce kWh use, kW demand
 - Secure grants & **incentives**
 - **Garner new revenue & savings from self-supply by generating projects**
 - Demonstrate net positive benefit from energy project investments
- Demonstrate Leadership by prioritizing feasible goals from authorities:
 - RI Executive Order 15-17
 - RI Executive Order 23-06
 - Consider sustainability in all future planning including solids management, construction, resilience, etc.

RI Executive Orders, Acts and Standards

- **Lead by Example EO 15-17 of 2015** directs state government agencies to reduce their energy use by 10% by 2019 and;
- Reduce the use of energy derived from fossil fuels and reduce emissions associated with such consumption;
- 25% of new vehicles purchased must be a zero-emission vehicle (i.e. battery or certain plug-in hybrids).
- **EO 23-06 of 2023** further requires a 20% reduction in state-owned building normalized energy use by 2030;
- 25% of vehicle fleet to be plug-in ZEV by 2030 (necessitating more charging stations);
- Encourages strategic electrification;
- Prioritizes participation in demand response and energy storage programs.
- **RI RES of 2022** mandates that statewide electricity supply be 100% renewable by 2033
- **RI Act On Climate of 2021** has enforceable mandates to reduce RI GHG emissions from all fossil fuel use (45% by 2030 and 100% by 2050) and is one of the strongest climate policies in the nation

Electric Use -All Accounts

- 34.6 million kWh used last year
- Would have cost >\$5 million if from utility with comp supply
- 4 Largest Accts are 97% of use
- They get NMCs from several diverse projects
- NMCs lowered bills \$2.8 million
- May transfers extra dollars from one account to another
- Now self-supply 80% of use with plans to supply 100% soon



From 2022 Electric Bills:	Annual Cost if Grid Supplied	Savings from Credits on Bills
Fields Point WWTF	\$2,223,275	\$1,358,487
Bucklin point WWTF	\$1,528,363	\$1,130,005
21 Ernest Street	\$916,129	\$236,207
1 Service Rd	\$261,648	\$79,561
Master Accounts	\$149,234	\$0
Calverly Street	\$85,546	\$0
Sum	\$5,164,195	\$2,804,260

Equipment & Approaches Considered

- **Efficient Diffusers** and Blowers
- LPHO UV Disinfection
- **Automatic Controls**
- Centrifugal Pumps
- **Add booster pump to lower PSP**
- Air Compressors
- Heat Pumps
- Electric Vehicles, Chargers
- **Self -supply by net metering**
- Use best practices (i.e. calibrate DO meters as part of SOP, identify inefficiencies using submetering, automate controls where possible)
- A.I. machine learning can recommend lowest DOSP to meet permit; can **pair multiple pumps to ensure BOP as flow varies**
- NFPA 820 has requirements for lowering ventilation in Class 1 Div 2 spaces to save energy when unoccupied
- Consider comprehensive accounting to track the lowering of GHG emissions by 45% by 2030 compared to EO's 1990 BY
- Know your energy bills and save

Wind Turbines Offset Fields Point Electric Bill

BNR upgrade to remove more nutrients increased electric use

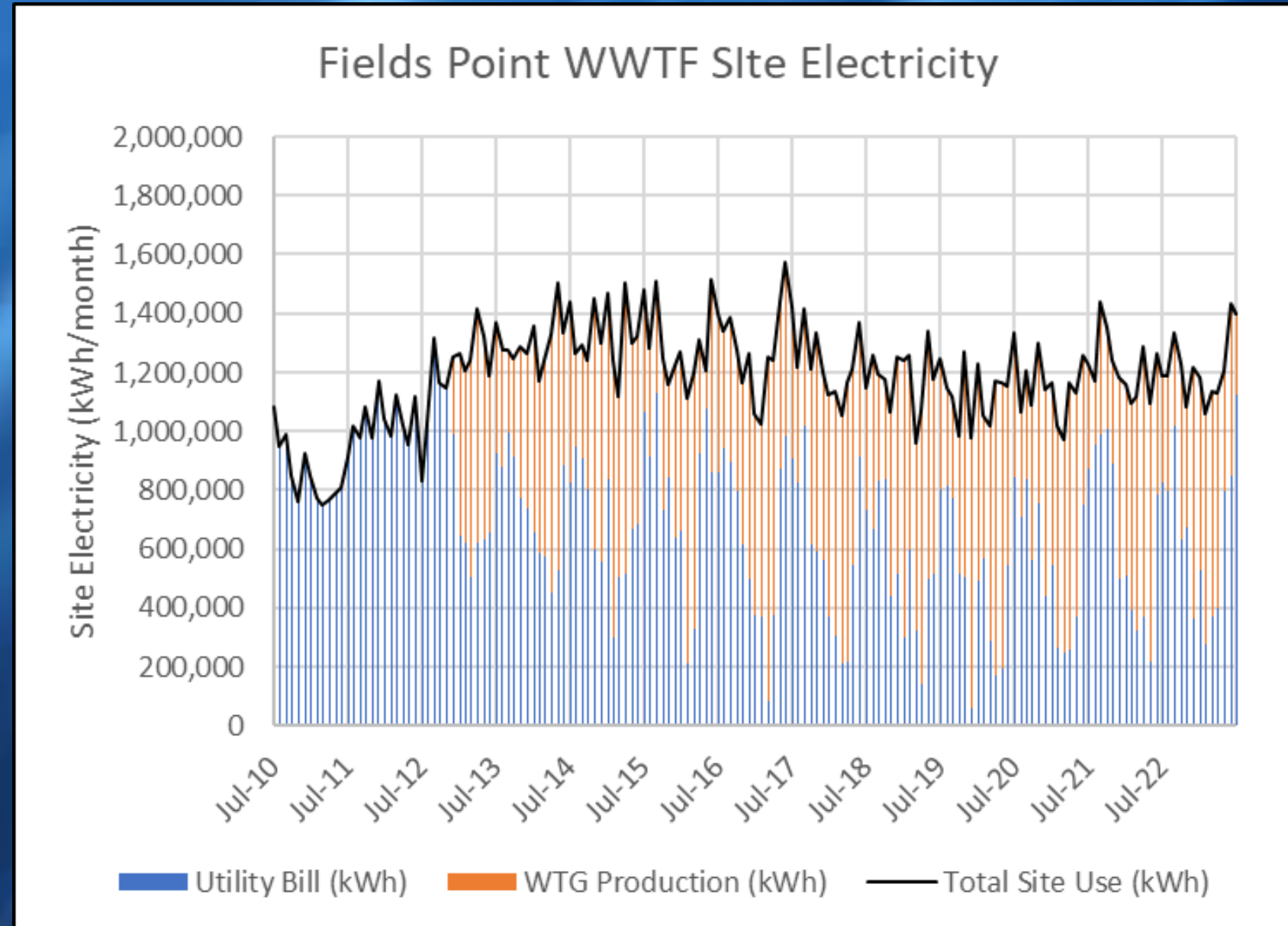
Wind Turbines offset the increase on the electric bill

They supply the WWTF and export when its windy

Thru bi-directional utility meter, NBC is billed on the net

Bill savings are at nearly the retail rate

Added benefit is sale of RECs to help pay off capital investment (conveys environmental attribute of emission reduction to buyer)



Better Plants
U.S. DEPARTMENT OF ENERGY

2017 Better Project Award
Presented by the U.S. Department of Energy
May 15, 2017

Narragansett Bay Commission
For installing three 1.5 MW wind turbines that offset \$400,000 in annual electricity costs and yield hundreds of thousands more in renewable energy credit sales

Mark Johnson
Mark Johnson
Director, Advanced Manufacturing Office

U.S. DEPARTMENT OF ENERGY

Fields Point WWTF Energy Data - USDOE Better Plants Program (BPP)

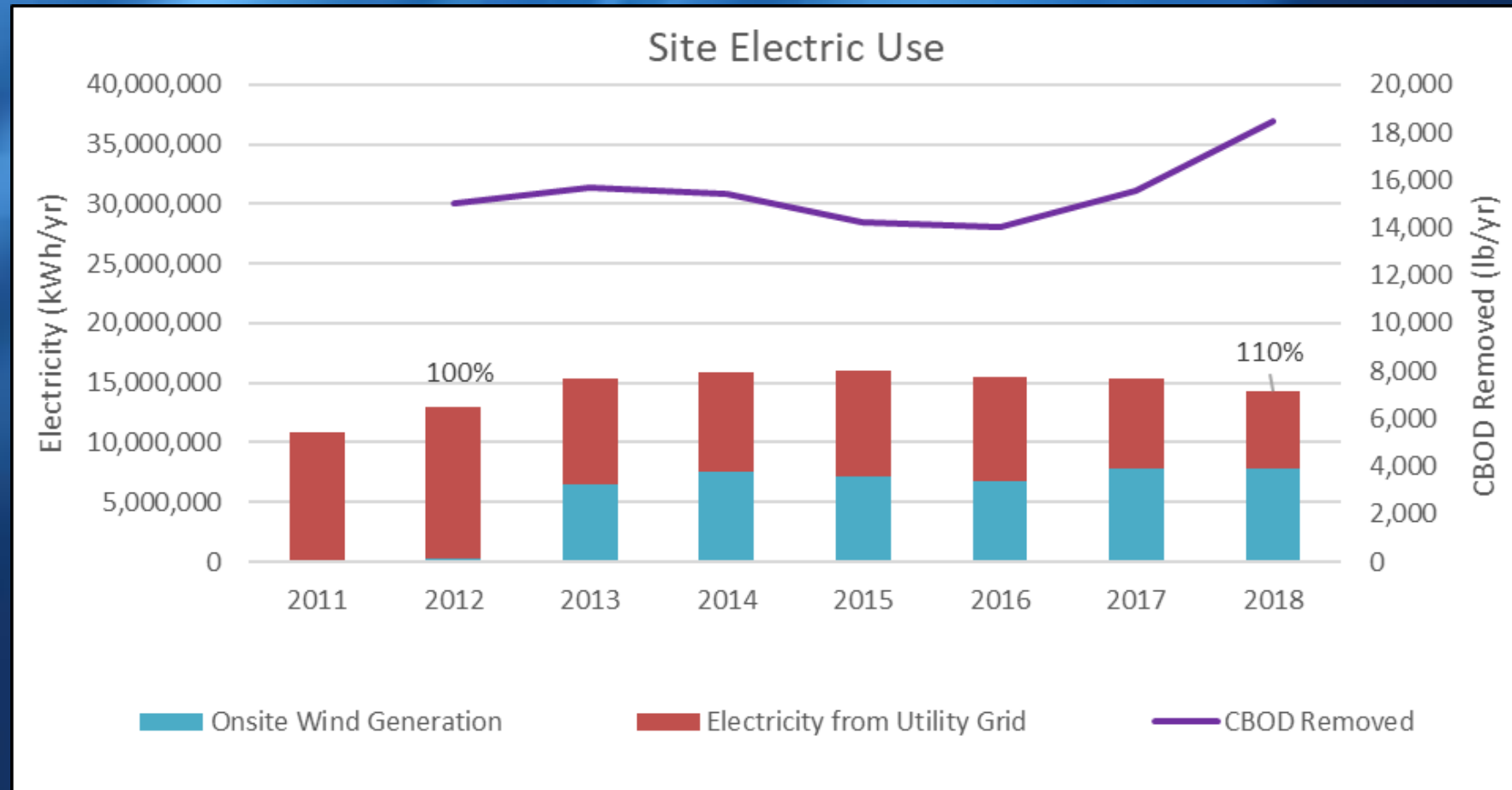
IFAS media loaded into tanks in 2012

Energy use increased

23% more CBOD removed in '18 vs '12

Wind Turbines started producing in 2013

BPP recognizes efficiency from renewable distributed generation behind site's meter even though RECs sold



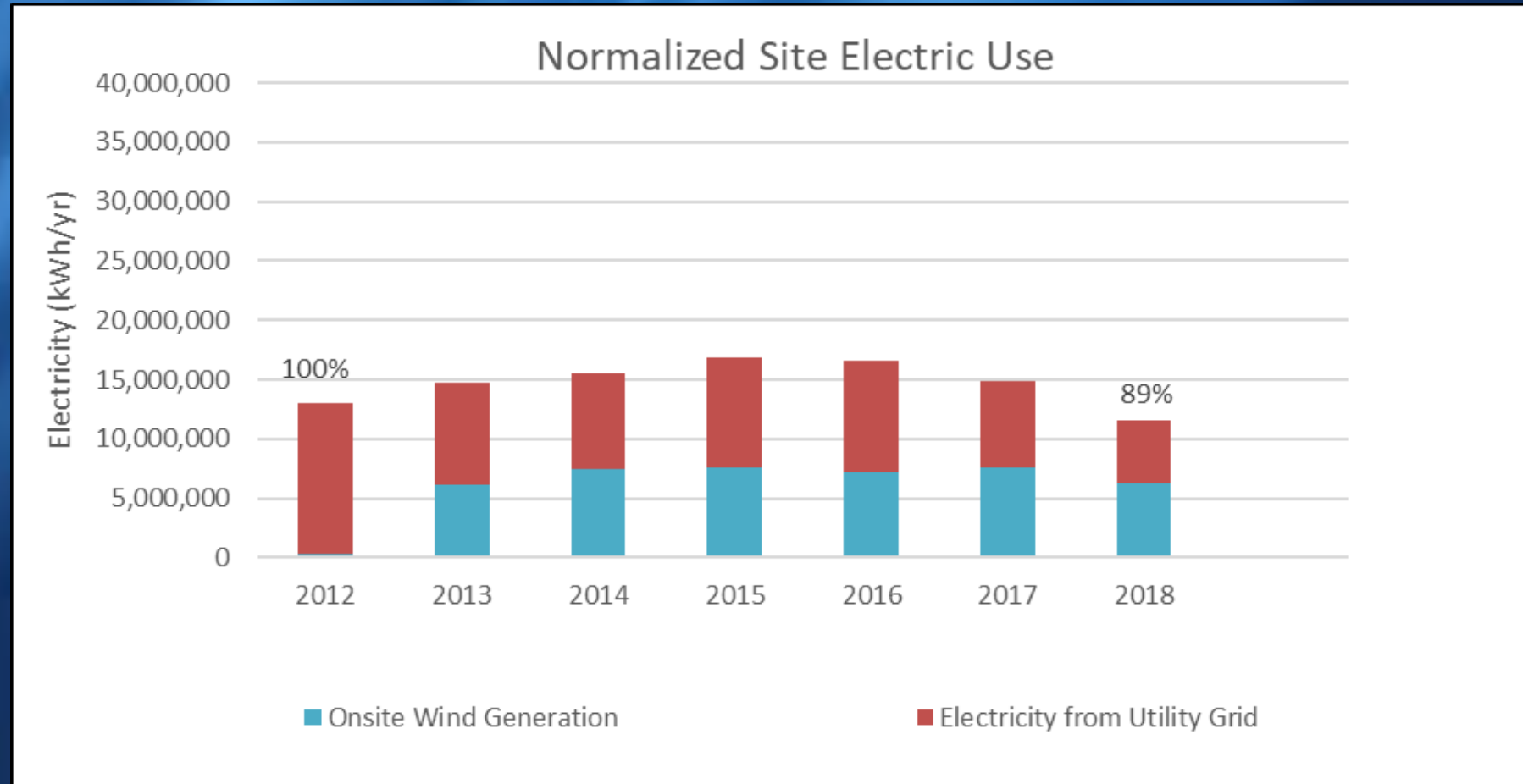
FP Site Energy - USDOE BPP

Data is normalized to proportionately reflect effectiveness of operations

Accounts for doing more with less, etc.

Approved normalizing factor is CBOD Removed

Normalized site use was reduced



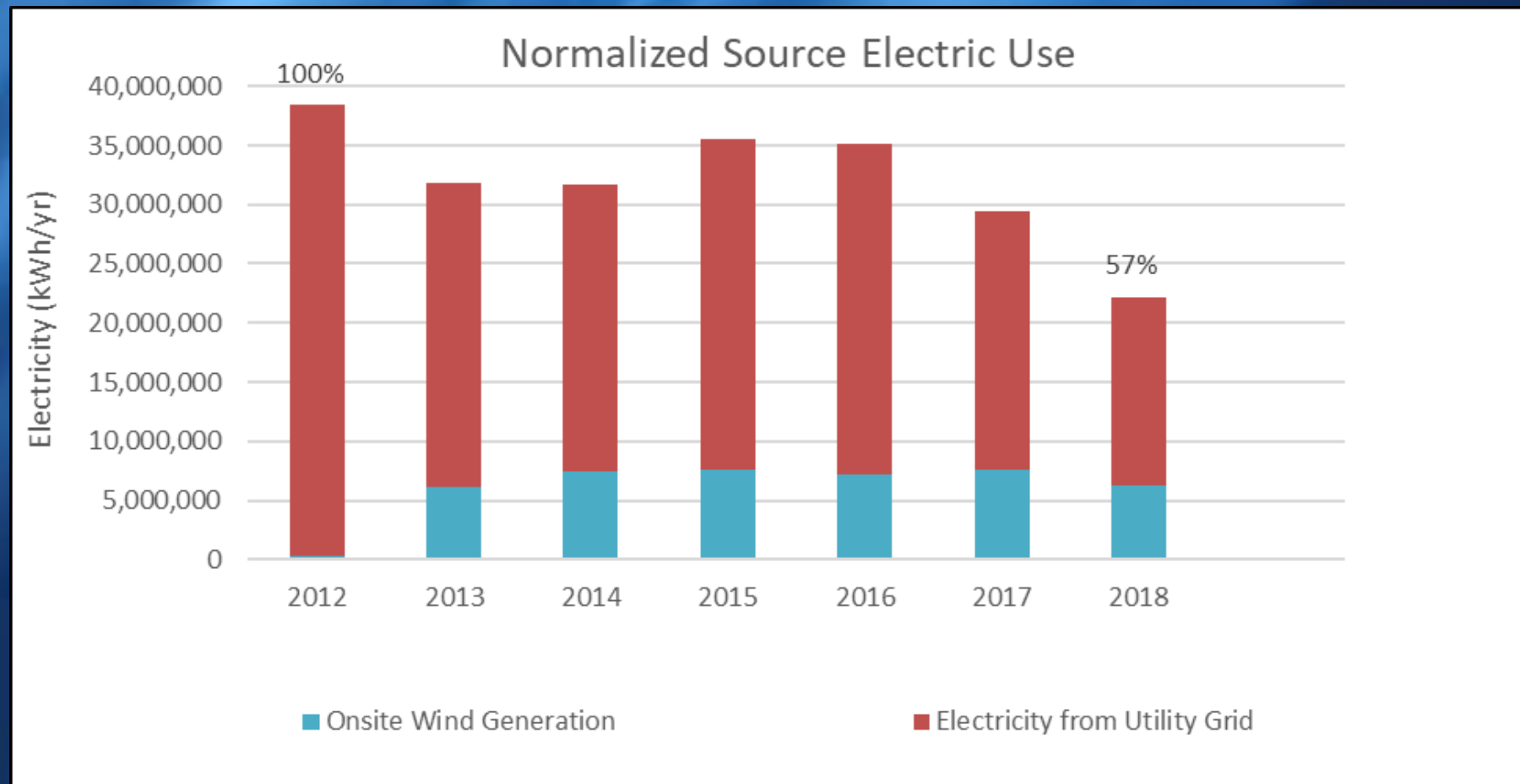
FP Source Energy - USDOE BPP

Site multiplied by a program factor to determine source use

Factor depends on how it was produced and accounts for losses

Multiplier is 3 for conventional centralized power plant and 1 for wind/solar

Normalized source energy efficiency improvement is significant for region



National Grid Continuous Energy Improvement Program Results

Equation based on uncontrolled variables was developed to predict daily energy use in 2018

Model accounts for base load and varying power the plant chooses to use to meet permit

Predicts subsequent years use based on the same variables, effectively normalizing it relative to BY

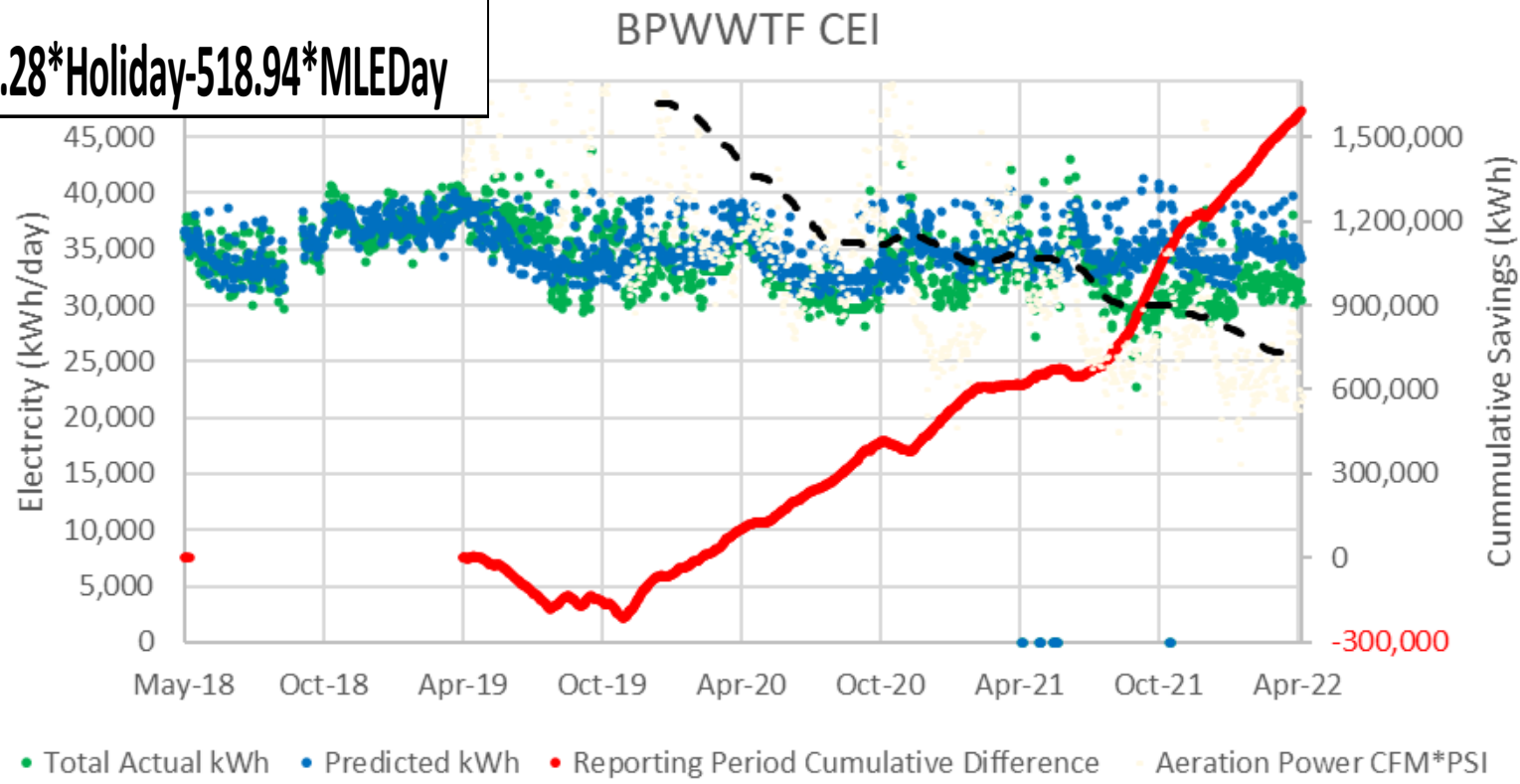
Accounts for all daily energy savings and losses in CUSUM (plotted in red)

Savings can be from improved behavior or ECMs not elsewhere incentivized by National Grid

Only ew improvements that are continued receive the 3 cents per kWh bonus incentivize

$$\text{kWh/Day} = 37,227.64 + .05 * \text{CBODLoad} - 374.91 * \text{Flow} < 29\text{MGD} - 1096.28 * \text{Holiday} - 518.94 * \text{MLEDay}$$

Bucklin Point WWTF Base Year Use=	12,264,665 kWh/yr		
Rebate Rate	\$0.030	\$0.030	\$0.030
Electric Savings Rate	\$0.13	\$0.13	\$0.13
For RY:	1	2	3
BP CUSUM Savings (kWh)	105,580	618,136	1,590,975
RY1 New or Cont' Savings	105,580	105,580	105,580
RY2 New or Cont' Savings	-	406,976	406,976
RY3 New or Cont' Savings	-	-	460,283
NBC Bill Savings over BY	\$13,609	\$82,004	\$212,304
CEI Rebate for non-cap ECM	\$3,167	\$12,209	\$13,808
Portion of BY Use Saved by CEI in 3 years	5%		



• Total Actual kWh • Predicted kWh • Reporting Period Cumulative Difference • Aeration Power CFM*PSI

Bucklin Point Reduced Average Power by Replacing Diffusers

2nd stage aeration diffusers clogged and reduced some aeration capacity

Diffusers were not at end of life but couldn't be cleaned economically

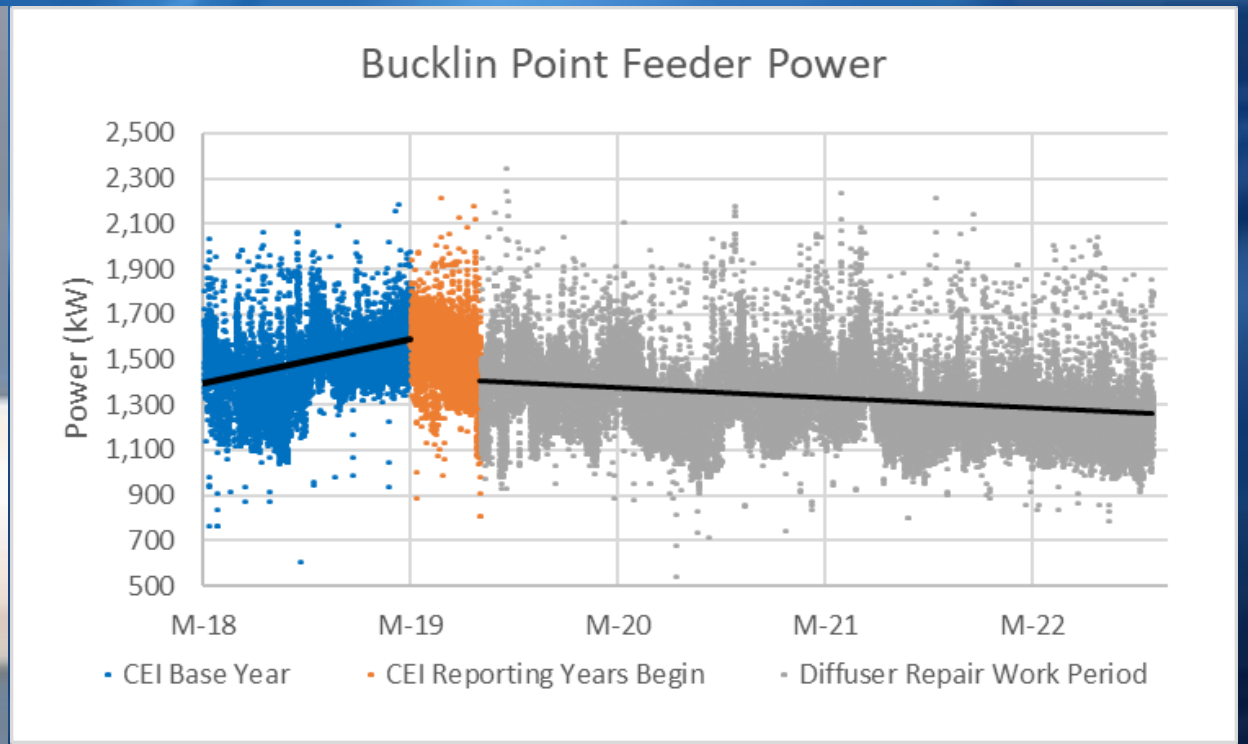
Blower operating pressure increased so much it caused blowoff

Work started in late 2019 to replace ceramic diffusers with new efficient membrane diffusers

Retrofit work done during the last 2 years of the 3-year CEI program in the off-seasons

Dollar totals were \$40k capital investment, almost \$130k bill savings and \$29k CEI bonus checks

Facility restored aeration capacity, met CEI goal to save 5% in 3 years and continues to save



Ernest Street Pump Station

5 pumps 300 hp each (30x36) and 3 pumps 200 hp each (24x24), half with VFDs

1 - 2 pumps most commonly operate at one time

Discovered large old gate valves are allowing backflow

When high voltage VFDs fail, replacements are no longer supported by manufacturer

Current pump system efficiency estimated from measured power and found to be low

Strategy - Repair leaking gates, replace a limited number of impellers and recheck

Change VFDs to 480-volt and install smart control software

Ernest Street Pump Station

2022 Electric Use = 2,952,996 kWh/yr **Electric Cost=** \$0.155 per kWh

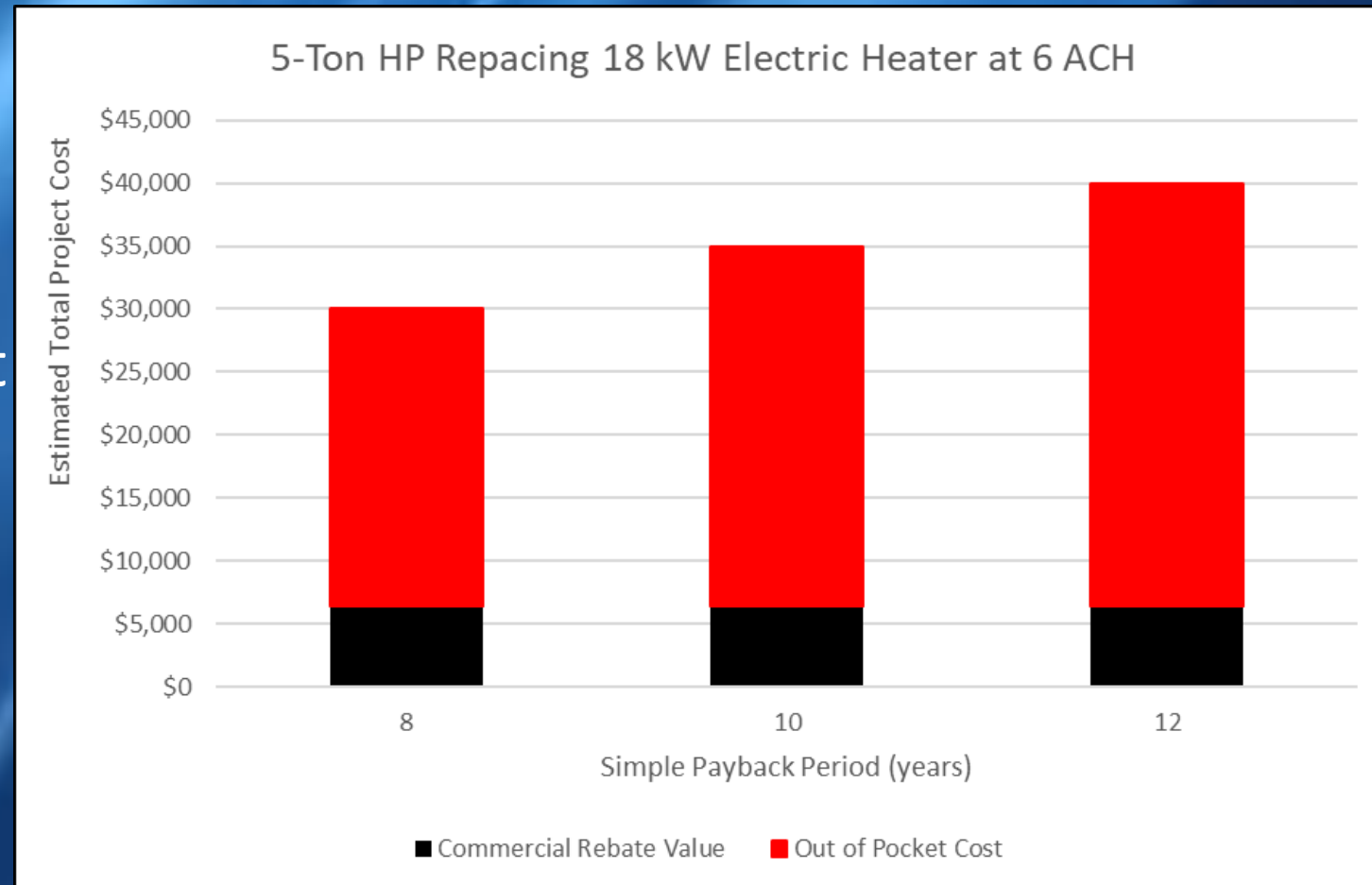
Design Point (1989) 27,780 gpm at 35.2 TDH (ft)

Pump	HP	Meas Flow	Meas kW	TDH (ft)	Calc Eff	Design Eff	kW if new	Wasted kW
1	300	25,774	270	30	53%	81%	179	91
4	300	28,993	246	27	60%	80%	185	61
8	300	27,597	262	29	58%	84%	182	80

Potential Annual Loss **\$105,180 per year** **kWh/yr= 677,285** **kW= 77**

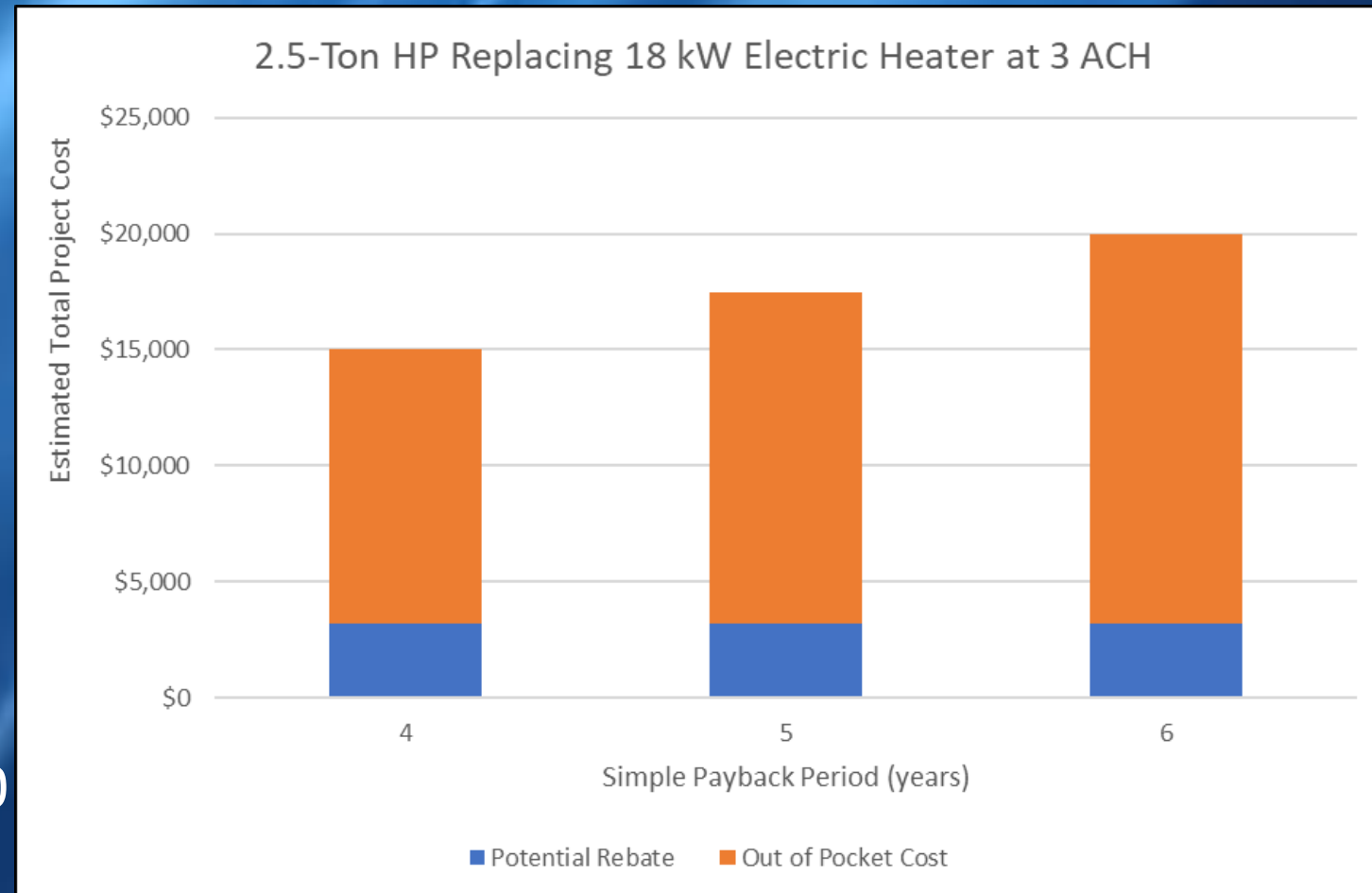
Strategic Electrification - Heat Pump

- Several opportunities to retrofit 18 – 60 kW electric resistance heaters
- Bigger natural gas heating system retrofit opportunities may also exist
- COP of 3 yields savings
- RIE currently offers rebate of up to \$1,250 per ton to commercial business
- PB is for Class 1 Division 2 space using 6 ACH and 1,750 hr/yr HP operation



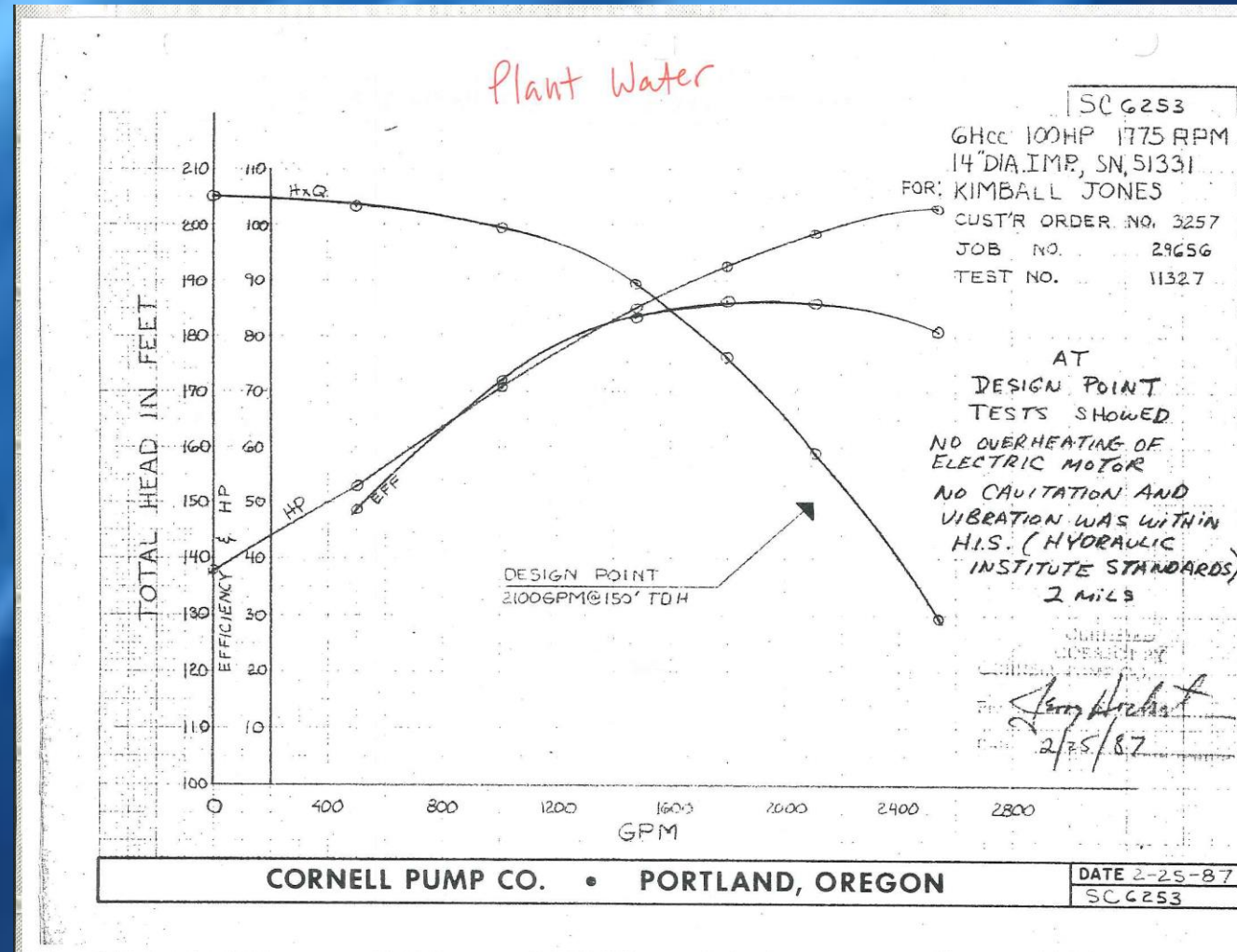
Strategic Electrification - Heat Pump

- PB is for Class 1 Division 2 space switching from 6 ACH to 3 ACH of outside air
- Comply with all NFPA 802 requirements (occupancy and LEL sensors, etc.)
- Existing heating system remains to operate when occupied or LEL sensor detects hazard
- PB based on HP cost of \$5,800 – \$7,800 per ton cost and 1,750 hr/yr operation



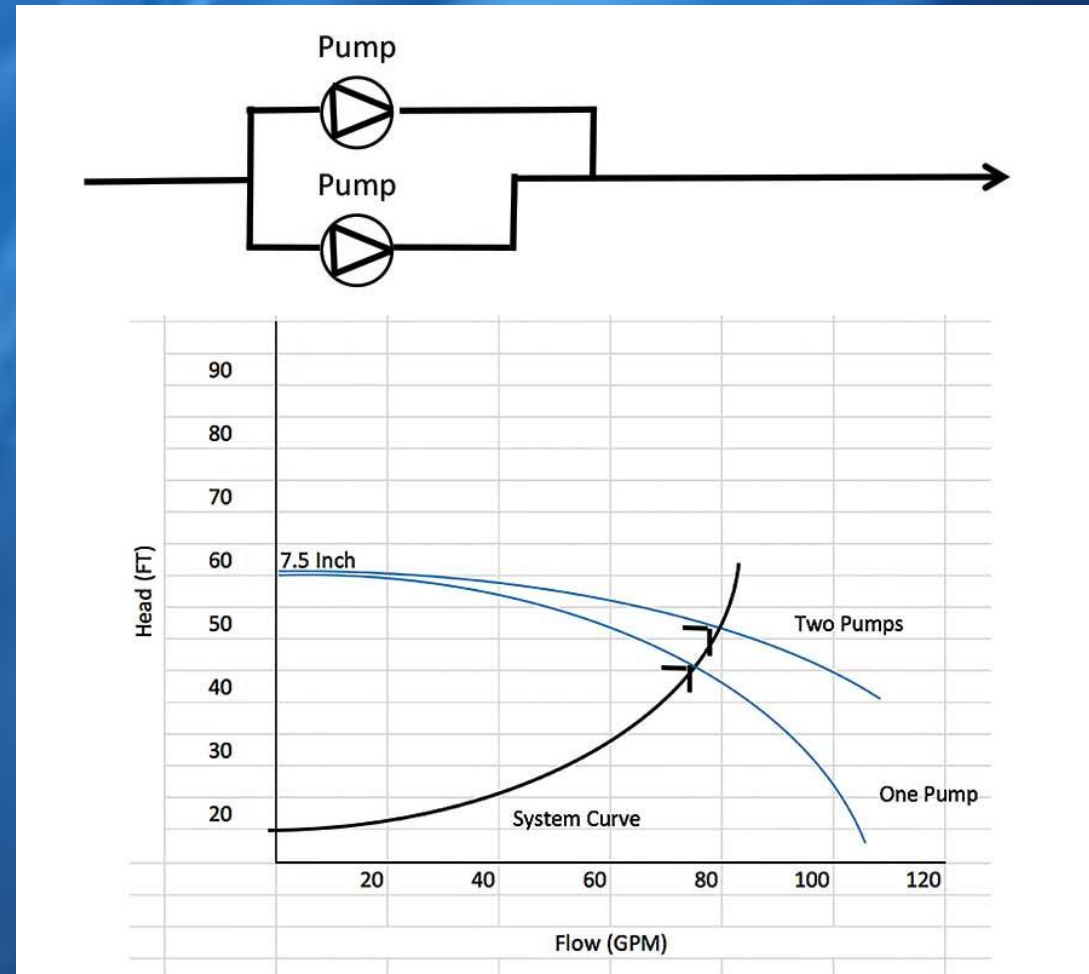
Fields Point Process Water Pump

- Smaller booster can theoretically lower pressure set point of larger supply pump (target is 20 psi reduction)
- Fine Screening demands highest (limiting) pressure from supply pump
- New booster pumps assessed to meet pressure and flow requirements of Fine Screening



Bucklin Point Process Water Supply

- 3 Centrifugal pumps each with 100 hp capacity and VFDs often run simultaneously and supply 80 psi at times
- Used for sprays, pump seals, tank wash, hoses, vortex separator, dust abatement, etc.
- Demand can vary greatly which leads to 3rd pump being left on much of the time
- One pump recently replaced in kind; now attempting to establish system curve for up to 3 pumps running
- Final goal is to try running 2 pumps at around 60 psi to meet most demand with 3rd automatically coming on only when needed and automatically turning off when not needed



Annual Generation for Self-Supply

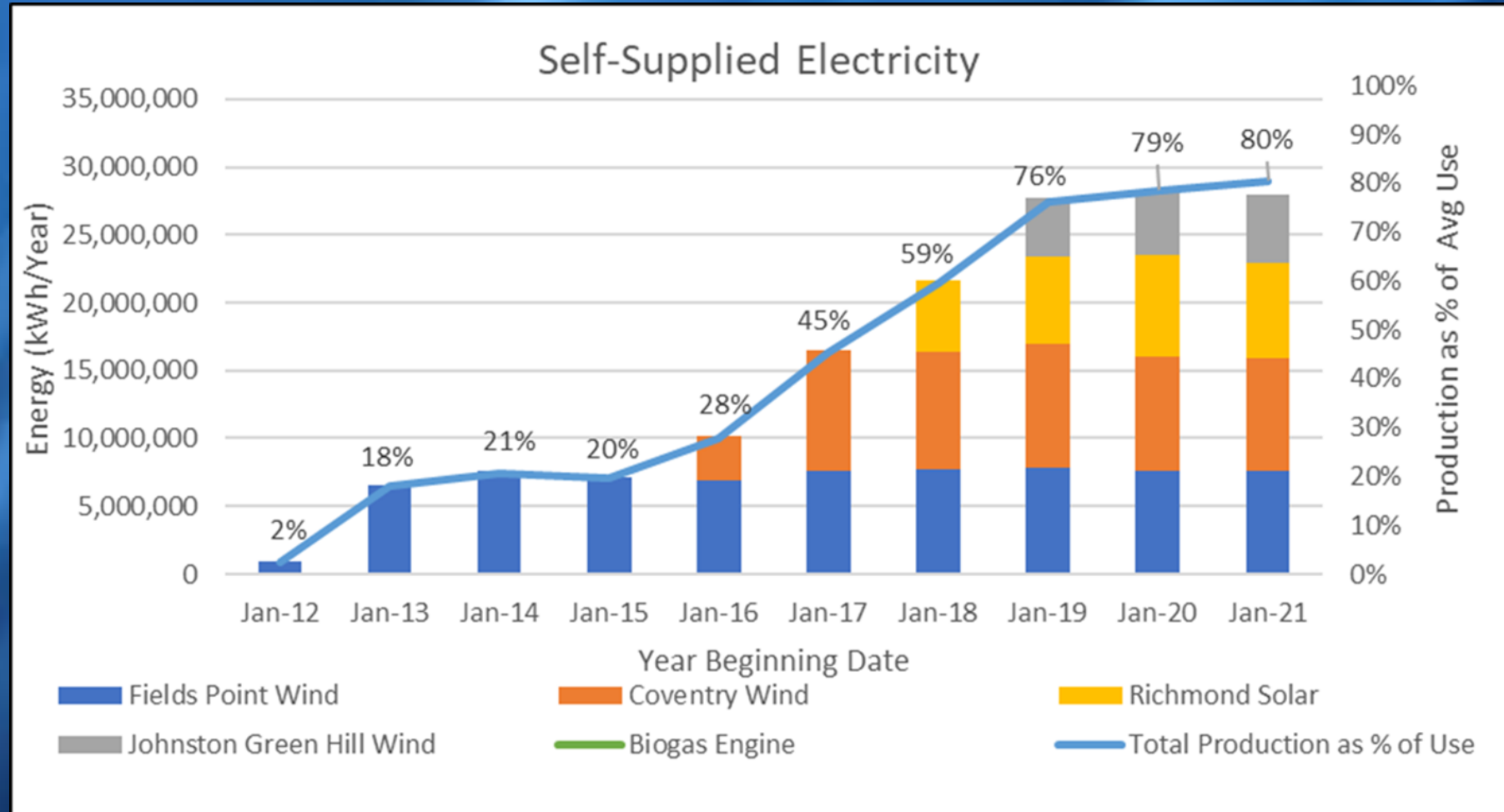
Generating projects were phased in over a decade

The first were capital projects costing about 12 and 18 million after subsidies and are owned by NBC

The next were discounted-NMC contracts with an independent 3rd party

Other projects not yet online are planned to bring NBC to 100%

Portfolio is intended to be a diverse blend that give benefits in a variety of ways



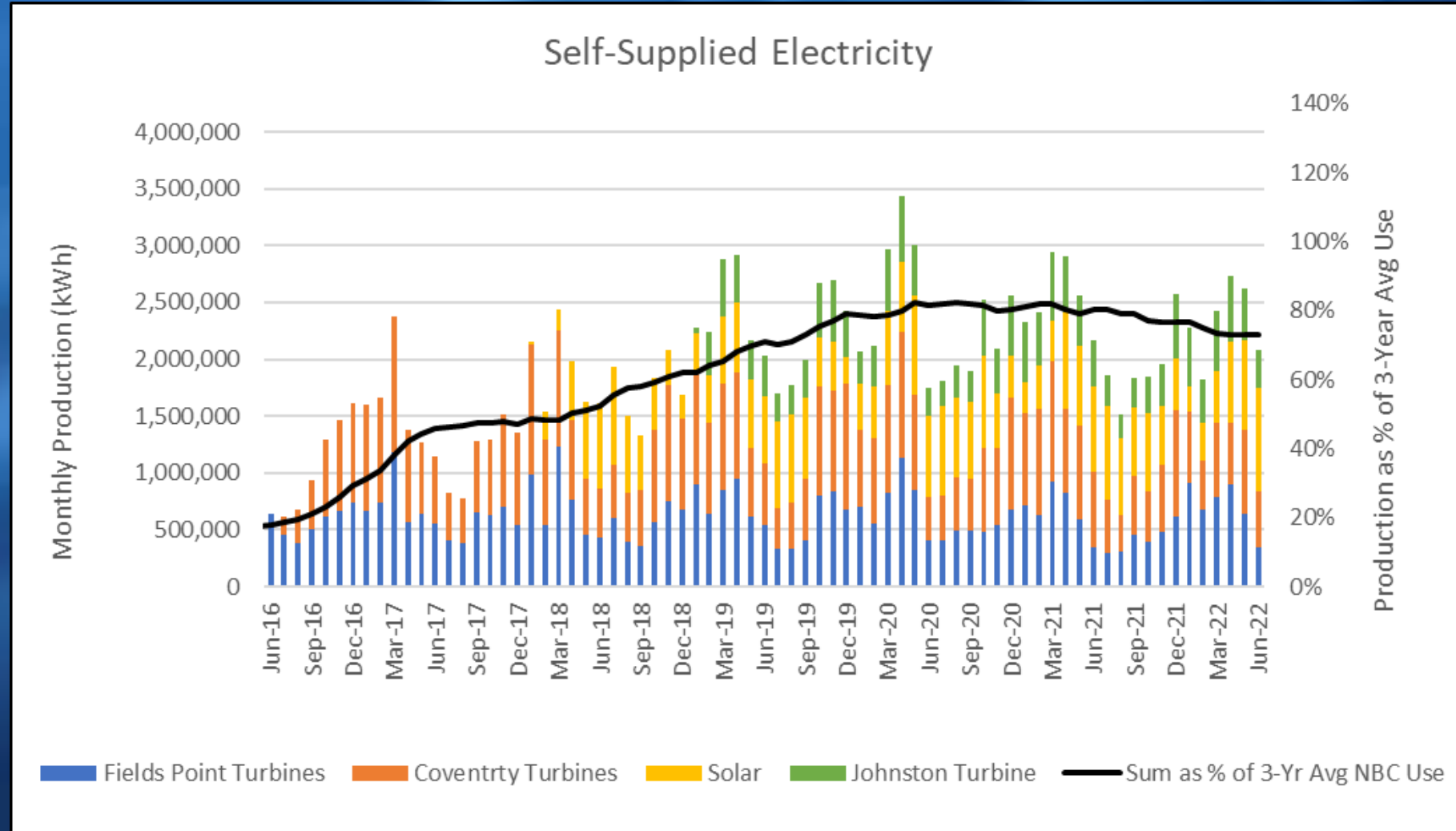
Monthly Generation

Mix was chosen to help produce steadier output

Each allocation to NBC is fixed by Schedule B submittal

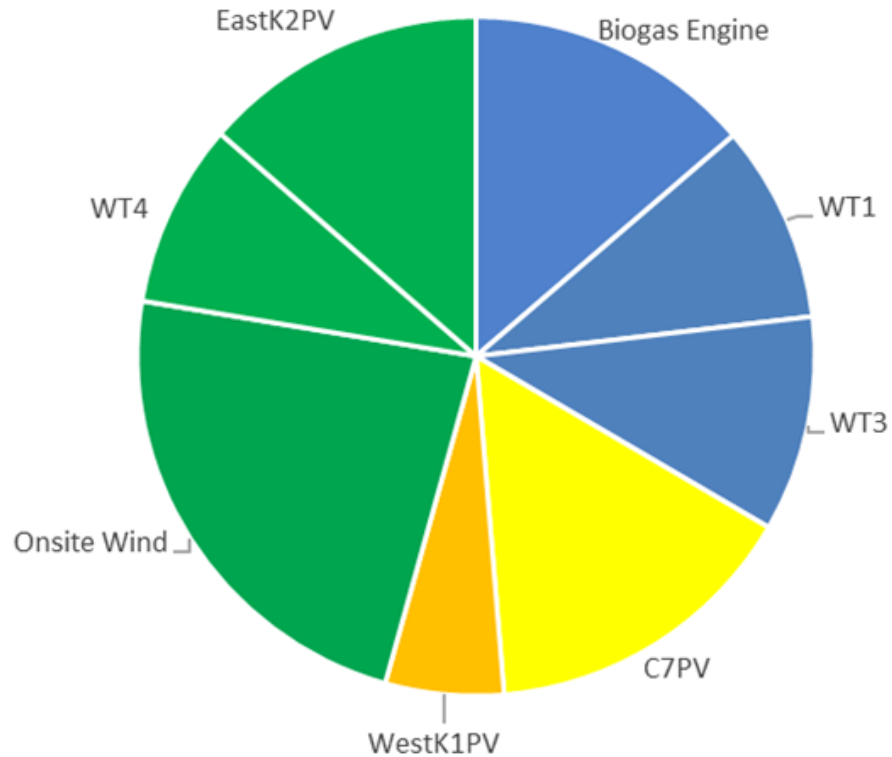
Generating up to 100% of use is valued at C-06 rate

Generation between 100% - 125% is valued at the avoided cost rate

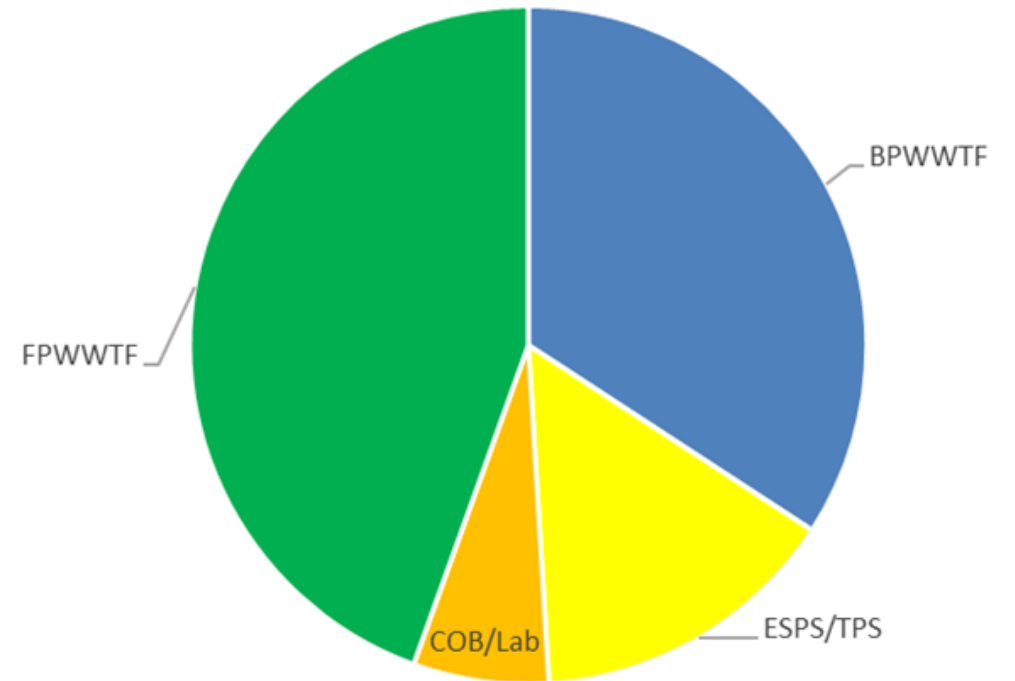


Initially Planned Allocations to NBC Accounts

Sustainable Energy Produced

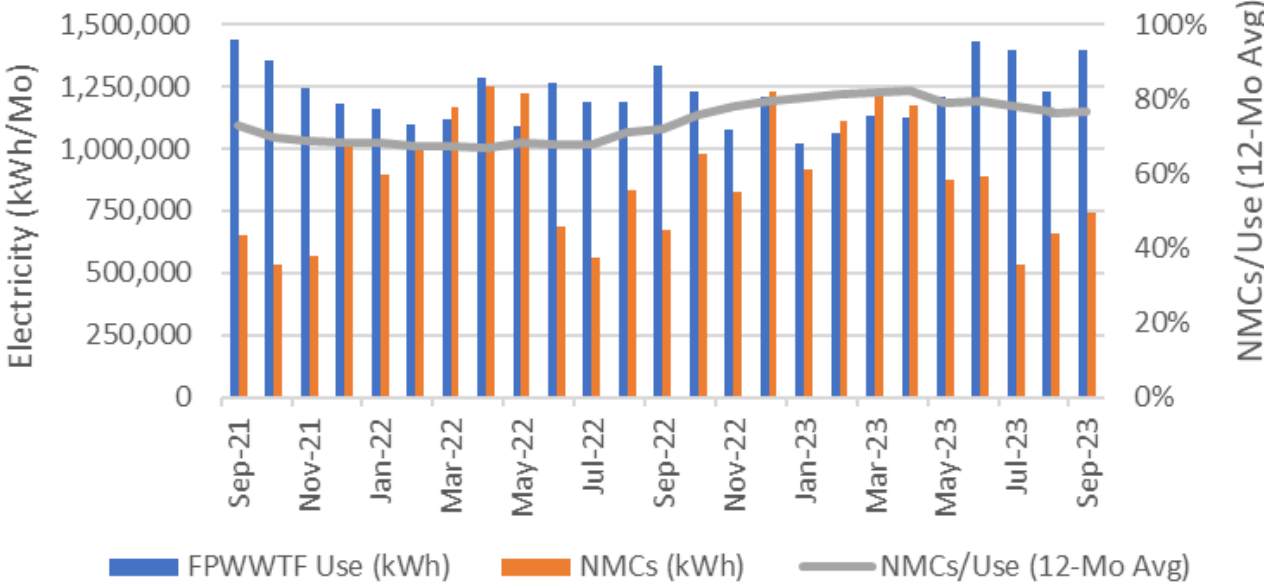


Allocated to Major Accounts

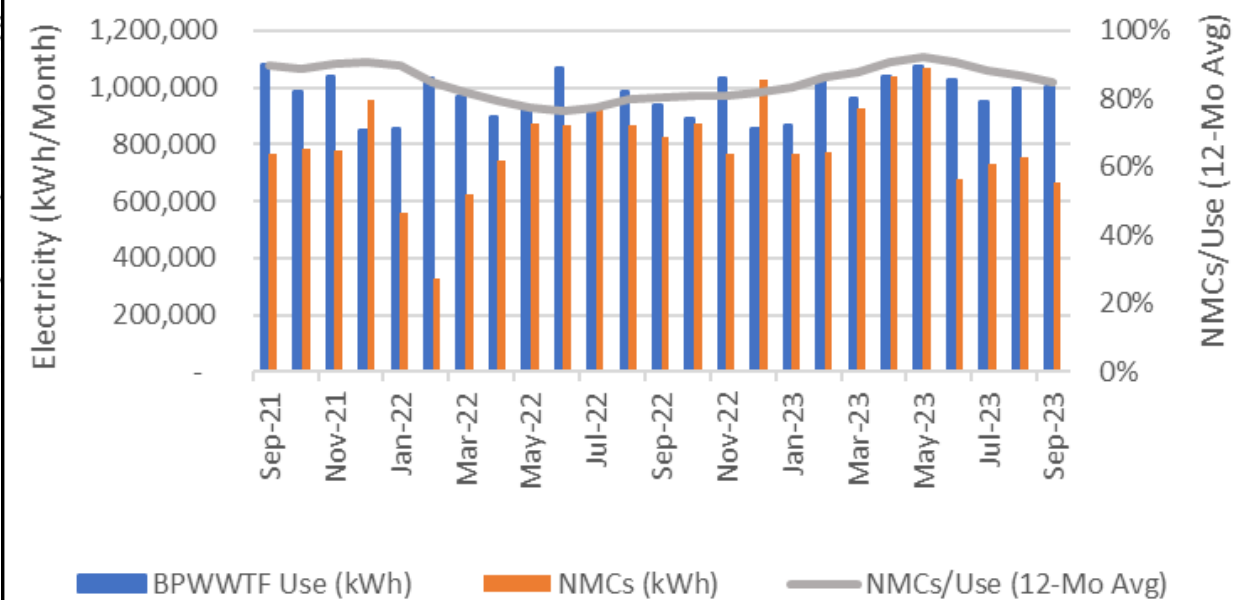


Consuming Accounts - Total Average Allocation

FPWWTF Electric Use and NMC Comparison with Rolling 12 Month Trend



BP Electric Use and NMC Comparison with Rolling 12 Month Trend



Fields Point Wind Turbines FY20

3 NBC-owned turbines each with 1.5 MW capacity

Exports over 3MW at times by Direct Net Metering

20% Annual capacity factor, Max Height 364 ft AGL

It cost NBC 8.6 ¢/kWh to produce the power (neglecting SRF interest)

Operates behind Bi-Directional facility billing meter savings 10.9 ¢/kWh

Produced 7.81 million kWh/yr in FY 202



Photo Credit – Peter Goldberg

Coventry Turbines FY20

3 NBC-owned turbines each with 1.5 MW capacity

Commissioned in 2015 and purchased in 2016

Exports power to Utility's Coventry Substation

22% Ann Capacity Factor, Max Height 413 ft AGL

Produced 8.94 million kWh/yr in FY2020

NBC spends 8.3¢/kWh to produce power (neglects interest)

Virtually Net Meters to NBC offsetting 13.8¢/kWh cost

Meets availability and power curve guarantees of 95%



Kingstown Road PV Arrays FY20

Third-Party owned and operated

Virtually Net Metered by contract

NBC buys the discounted credits

Estimated Capacity factor 1,190 kWh/kW_{dc}

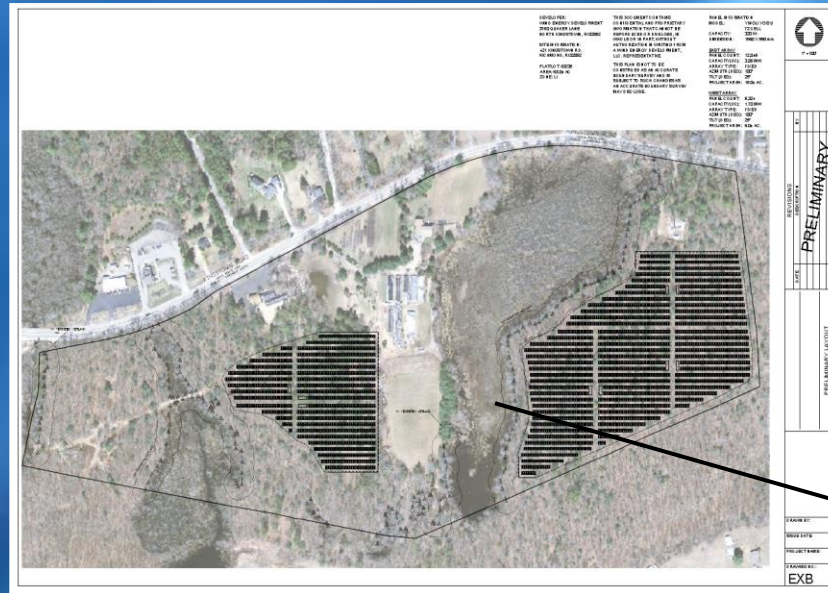
Average Production 6.89 million kWh/yr

Cost was 8.0¢/kWh accounting for REC sales while savings are \$13.8/kWh

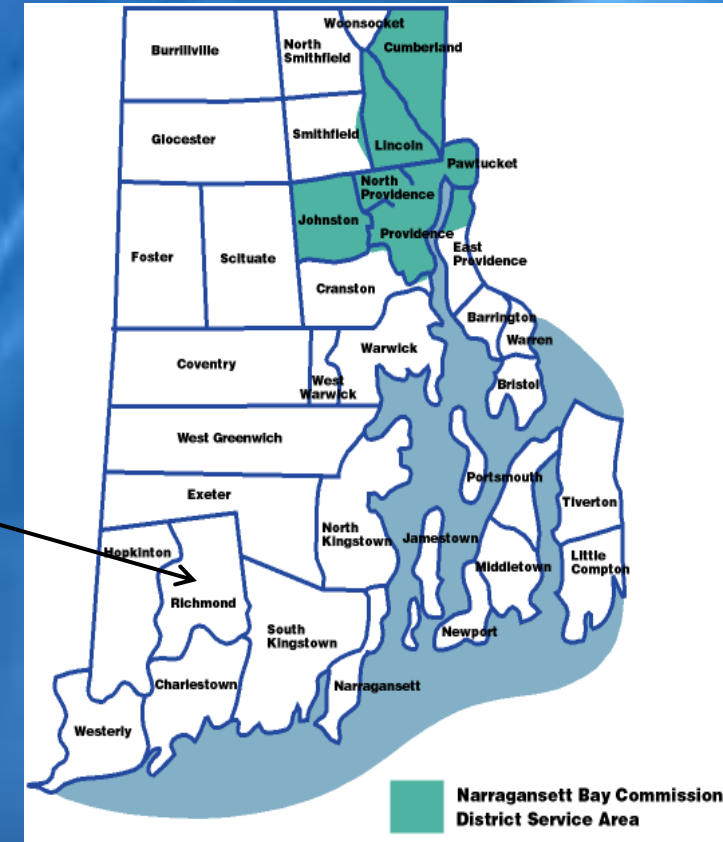
Annual Average Allocation Expected was 6.4 million kW/yr so 90% guarantee was met



Kingstown Road Arrays Located in Richmond, RI



Kingstown Road - Richmond



- 2 Solar Arrays separated by wetlands
- Total array area is about 15 Acres
- Each array has a separate grid interconnection
- Kingstown 1-West: 1,696.32 kW_{dc}
- Kingstown 2-East: 3,745.28 kW_{dc}
- Total Capacity 5.44 MW_{dc} (about 4.5 MW_{ac})
- COD: 12/31/2017

Johnston Green Hill Turbine

Third-Party owned and operated

Virtual net metered using discounted NMC contract

Turbine capacity is 3 MW

NBC contracts for 74.9% of production

Maximum height about 518 feet AGL

Annual Capacity Factor 24% (CY20)

5.1 million kWh/yr expected (2019-2021)

Cost to produce a kWh of power was 7.8 ¢ (FY20)

kWh offsets use that would have cost NBC 13.8¢

4.77 million kWh/yr allocated to NBC (met guarantee)



GDIM Solar



RI's largest comprised of 122,832 solar panels each producing up to 400 W

Occupies 162 acres footprint on Iron Mine Hill Road in North Smithfield

Total nameplate capacity is 49.3 MW dc, COD was Q4 2021

NBC receives 12.45% of production from GDIM1

Credits are received virtually via discounted net meter credit contract

Expected allocation is 2 million kWh in the first year

Same terms same as other NBC contracts

Bucklin Point Biogas Engine

CHP System with 644 kW gross capacity

Blends biogas with natural gas if needed

Operates behind conventional billing meter

Exports no power to local supply grid and offsets facility baseload by up to 1/3

Not operating continuously - oversized filter failed due to degraded digester rate



Standby Generators >200kW assessed for Demand Response in 2019

Most feasible may be Caterpillar Generator installed in 2011

Supplies only FP BNR with about 1,000 kW of connected load

FP is a Settlement Only Generator (SOG) making it ineligible for some programs

Turbines are designed to turn off when EG is on; frequent stops impact turbine wear and savings

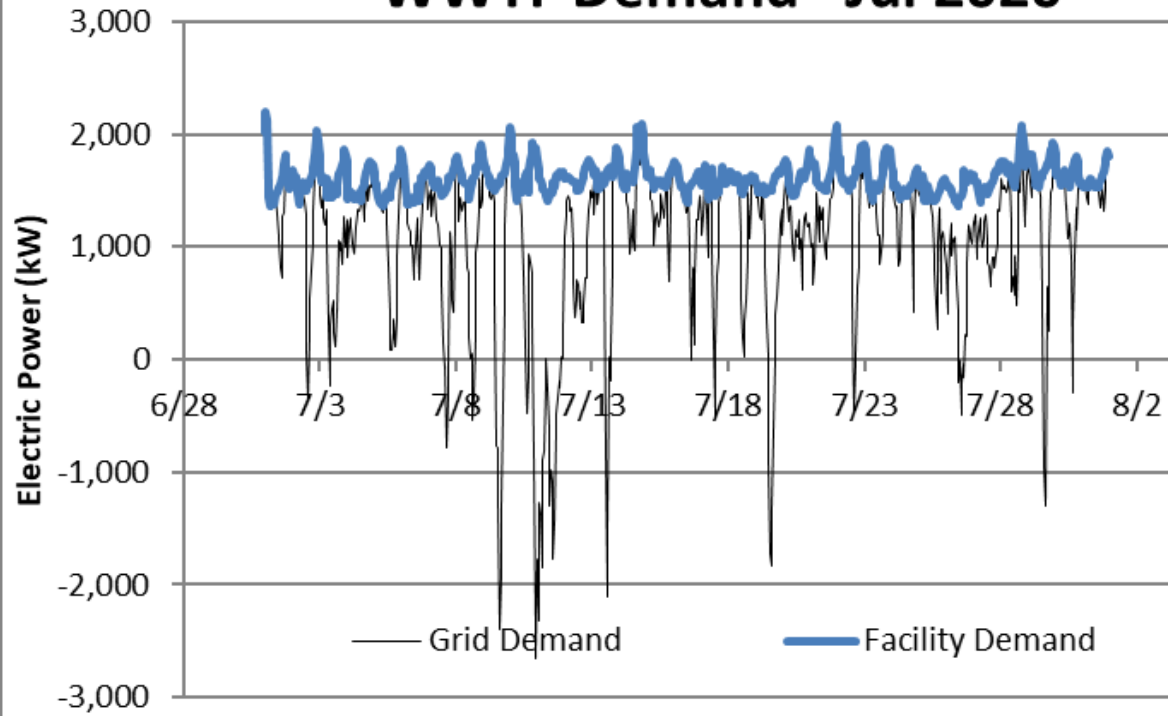
Net meter is not intended to export power derived from fossil fuels

Supply contract passes no capacity benefit to NBC during term

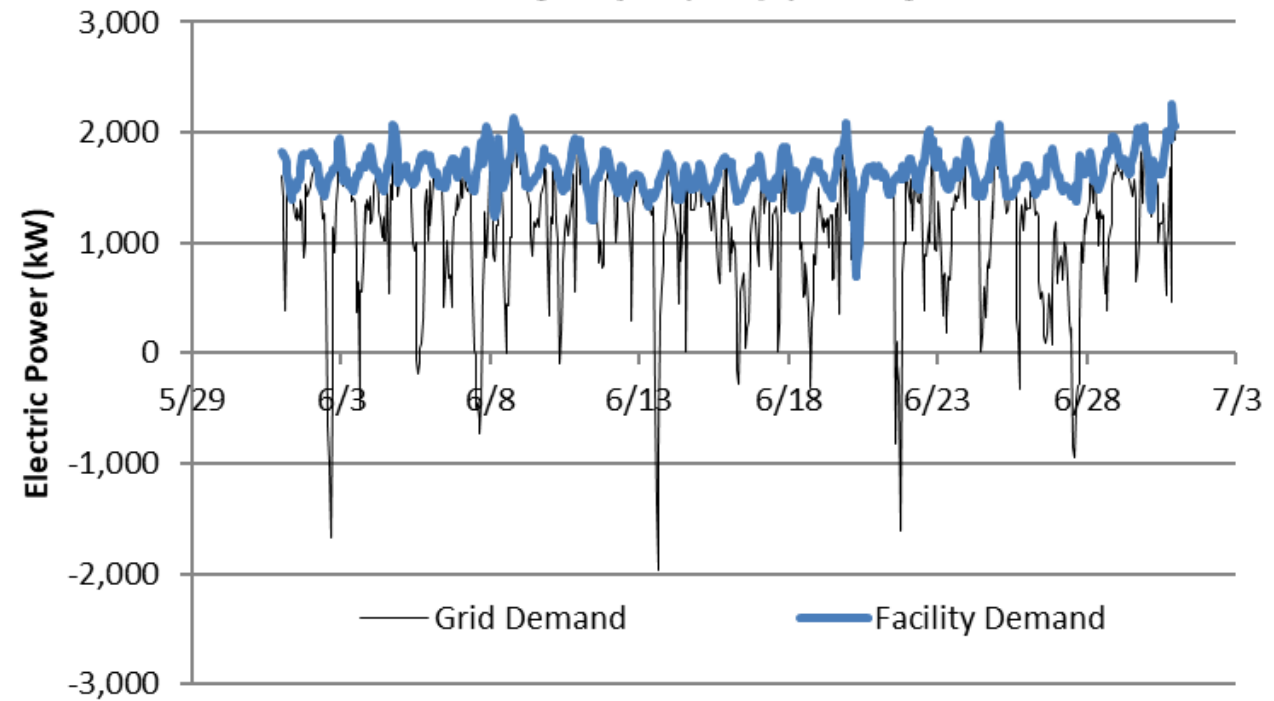
<u>Generators</u>	<u>DR eligibility</u>	<u>connected load (KW)</u>
BNR	Eligible for DR, no upgrade needed	1000
Bucklin	eligible for upgrade	1200
ESPS	eligible for upgrade	1300
TPS	eligible for upgrade	400
GRIT	eligible for upgrade	?
Blower Building	eligible for upgrade	?
Old Lab, COB IT, Washinton Park	eligible b/c of small size	?
COB/WQSB	Ineligible, 2015 Tier 2	400

ISO NE System Peak Days on 7/27/20 and 6/29/21

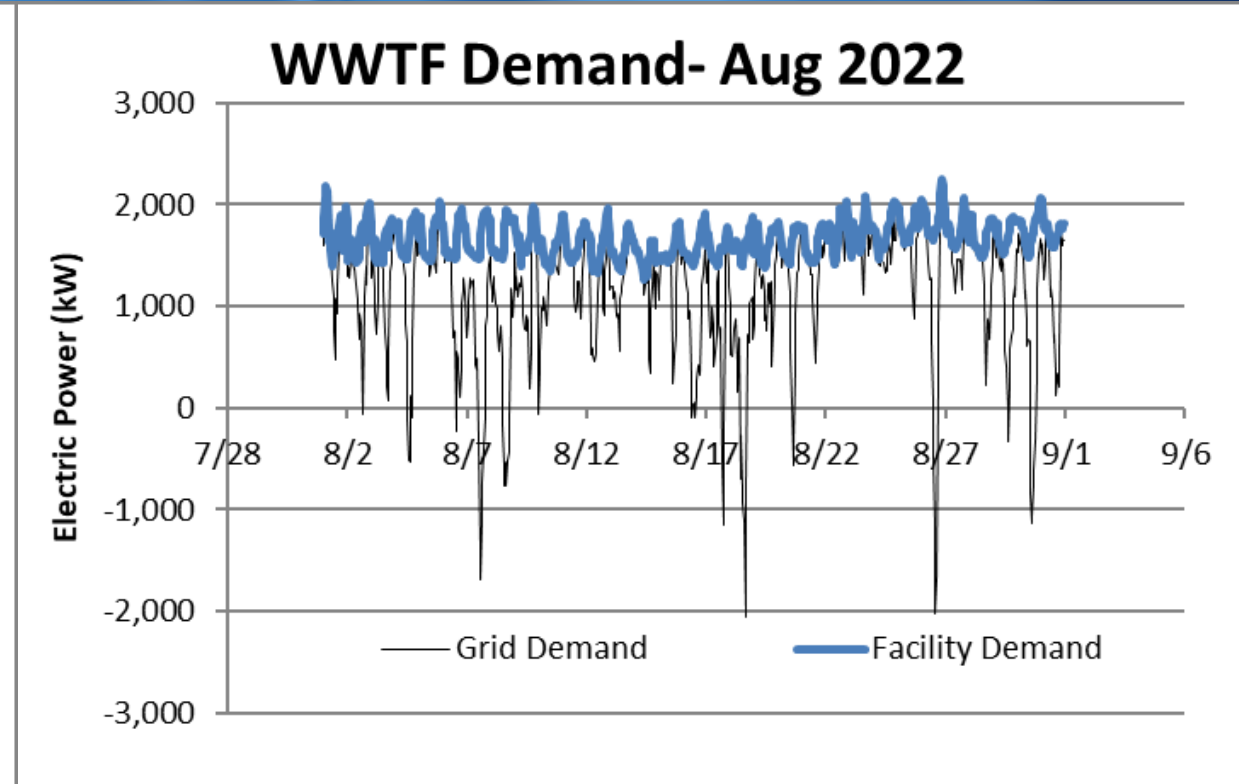
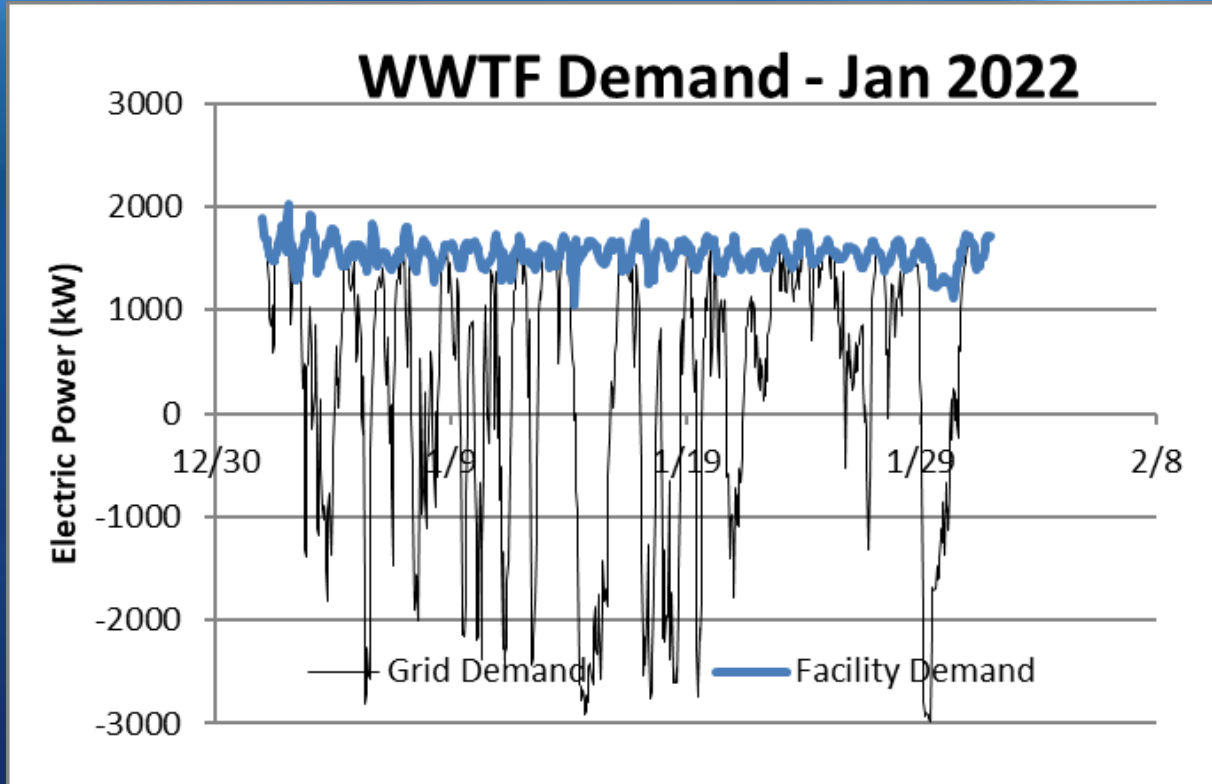
WWTF Demand - Jul 2020



WWTF Demand - Jun 2021



2022 FP Net Meter during Jan and 8/4 System Peak



Questions?

<https://ebcne.org/news/award/climate-change-project-2/>

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Narragansett Bay Commission

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<https://www.dropbox.com/s/ca5f1yink1gby93/NBC%20Utility%20of%20the%20Future.mp4?dl=0>

