195 kW or Bust:
Watauga County, NC Landfill Gas Project

Jason W. Hoyle

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Appalachian STATE UNIVERSITY energy

PROJECT INTRODUCTION

Watauga County Landfill Timeline

- ‘72-’94 accepted 546,000 tons of waste
- ‘96 passive solar flares installed on 22 vents
- ‘05 active LFG collection system, voluntary
- ‘06-’11 flared >100,000 mmBtu, +/- $600,000

Landfill Gas Project Basics

- 2.6 mmBtu/hour
- 186 kW combined nameplate capacity
  - 2x GM Vortec engines from KSD Enterprises
- 950,000 kWh/year (est.) generation
- 130 kW effective capacity output

8.1 L GM Vortec Engines from KSD Enterprises

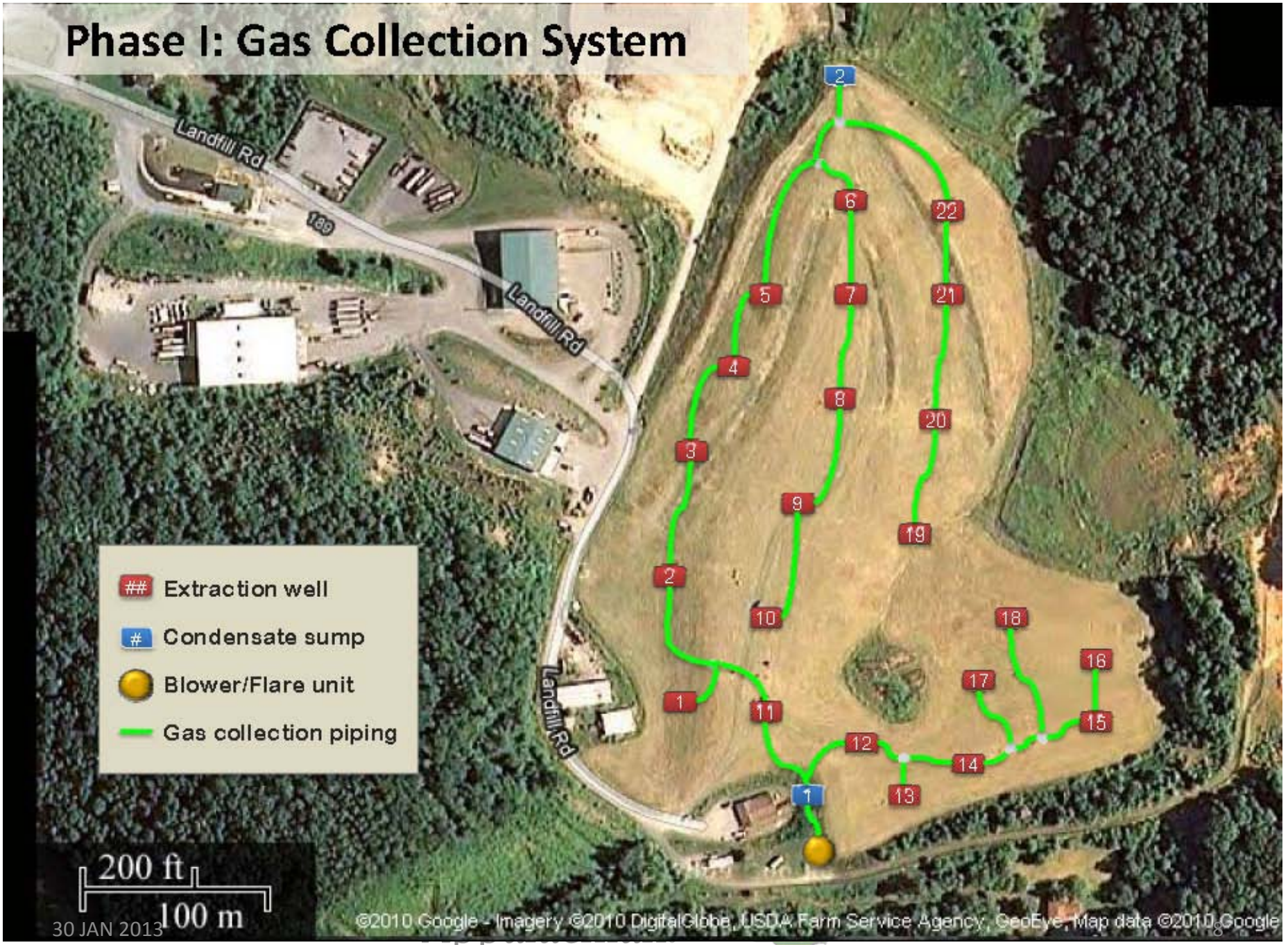
Mar. 20, 2012 start of electricity generation

Other Accomplishments & Benefits

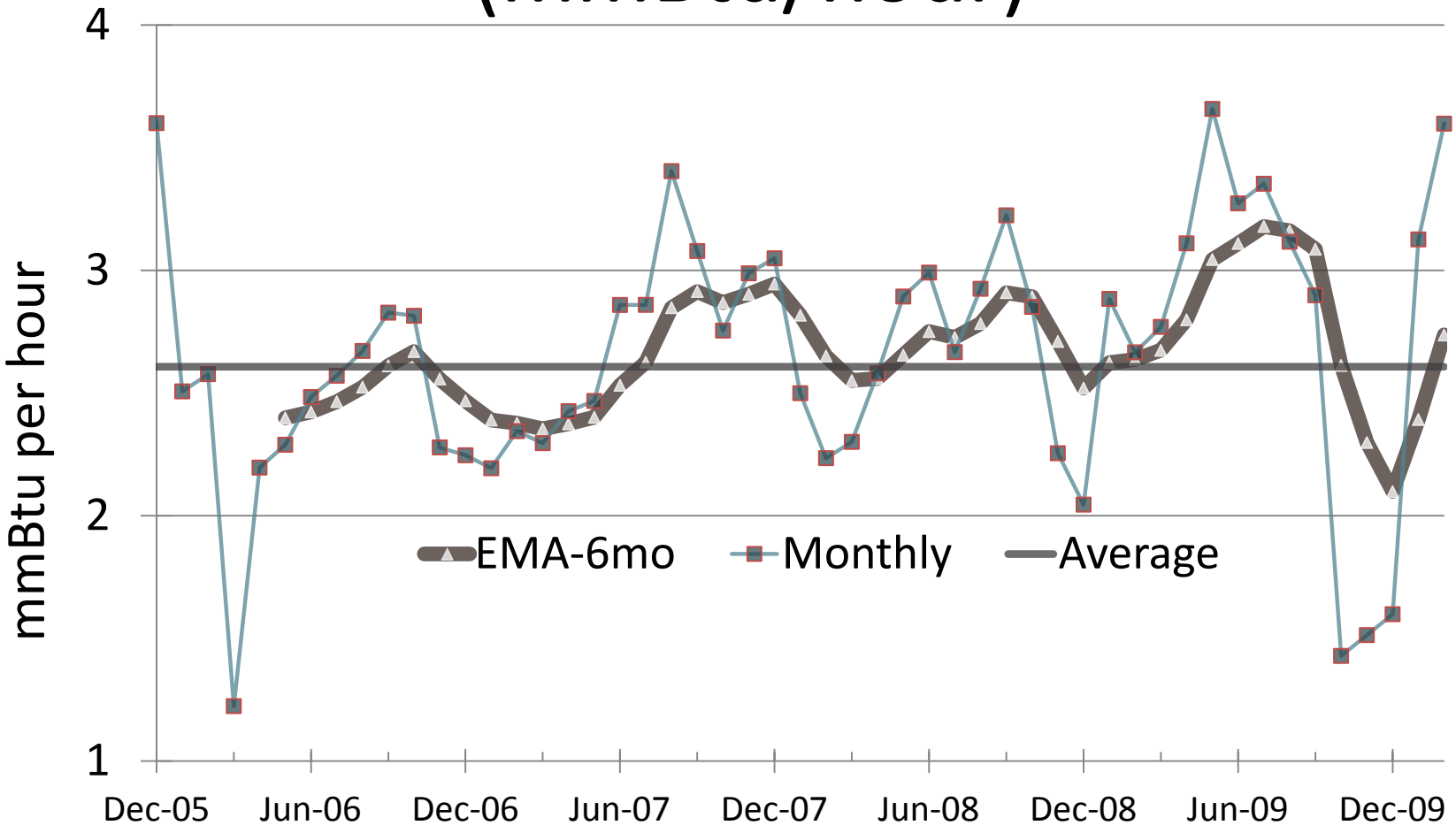
- Watauga County: use waste heat from engines
  - Savings on propane and heating energy
  - Drying paint for disposal
- Research: Appalachian State programs
  - Generator testing on 3rd pad
  - Development of real-time monitoring technology
  - Biofuels and horticulture in greenhouses
- Community Leadership: project being replicated in at least 4 other counties at present
- Industry: product and business model development
  - PowerSecure, Inc. now offers 100kW-scale turnkey generator package in partnership with KSD Enterprises at price near $1,000/kW price
  - Concepts for component improvement

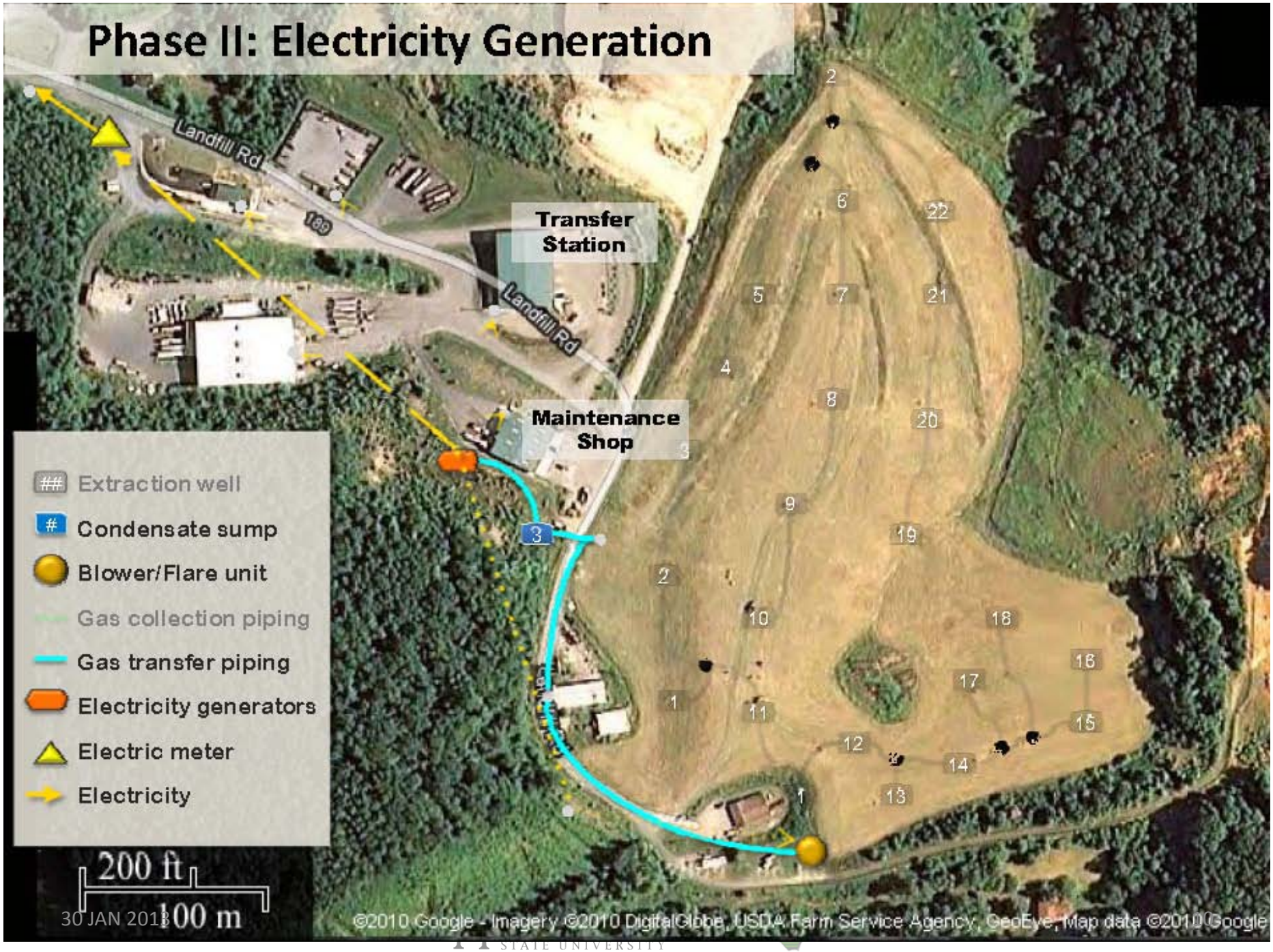
PROJECT DEVELOPMENT

Phase I: Gas Collection System



Historical energy available from LFG (mmBtu/hour)




Phase II: Electricity Generation
Landfill Rd
189
Transfer Station
Landfill Rd
Maintenance Shop
Extraction well
Condensate sump
Blower/Flare unit
Gas collection piping
Gas transfer piping
Electricity generators
Electric meter
Electricity
200 ft
100 m
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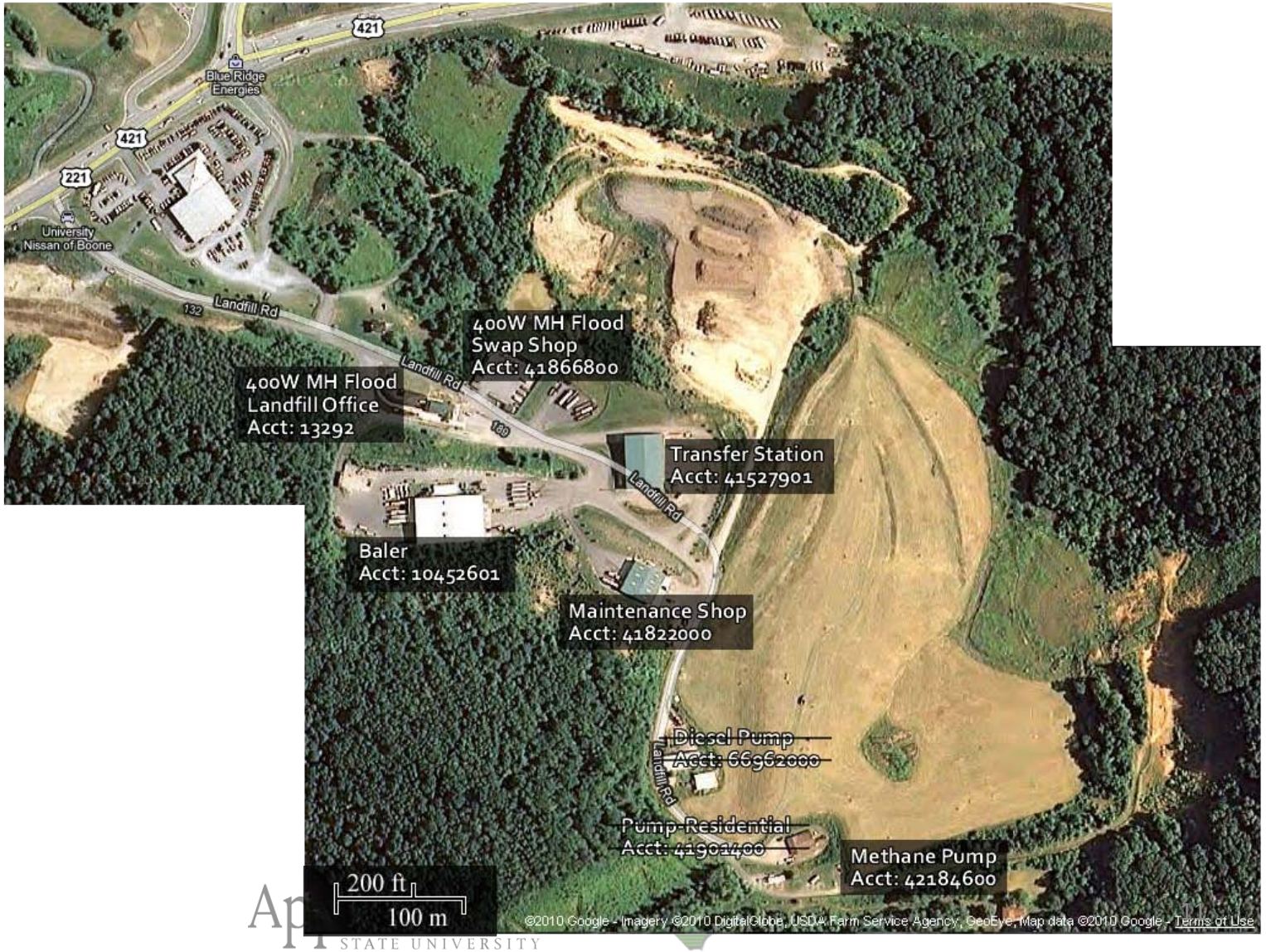
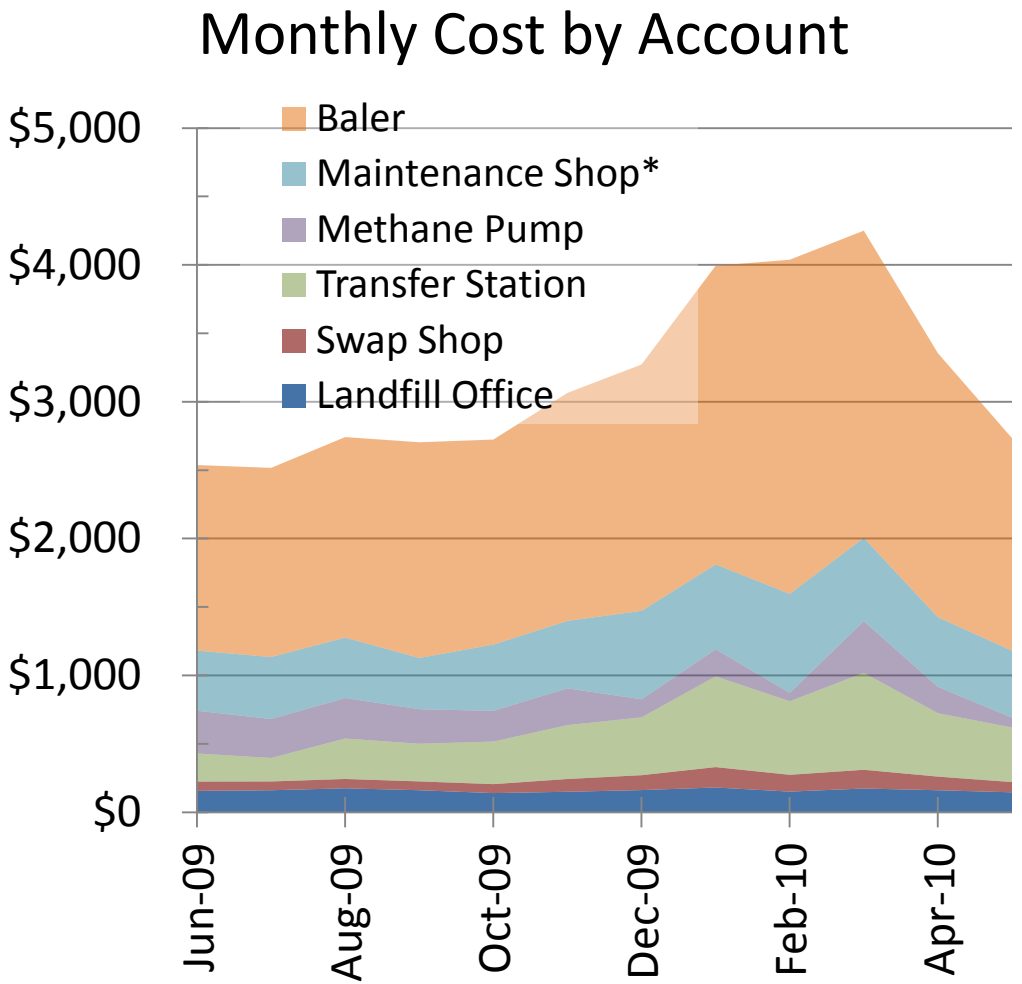
Electricity Accounts: Landfill Facility



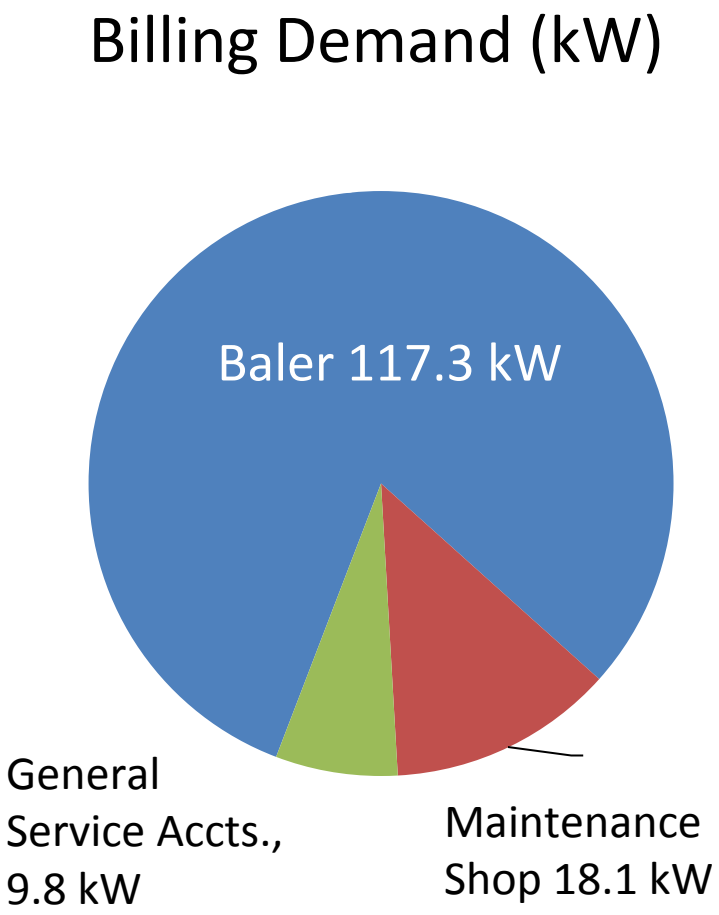
Electricity Use at the Landfill

- 6 separate accounts
- 4 rate schedules
- 262,365 kWh/year
- 145 kW ave. billing demand
- $38,000 annual electricity expense



Demand-based Inverted Block Rate

- Block size = 200 kWh * 145 kW billing demand = 29,000 kWh block
- 21,860 kWh/month ave.
  - All in first block @ 8.65¢/kWh = $1,891
- 70 kW billing demand = 14,000 kWh block
  - 14,000 kWh * 8.65¢
  - 7,860 kWh * 5.95¢
  - Total $1,679 = 7.68¢/kWh = 11.2% savings



On-site Electric Use Challenges

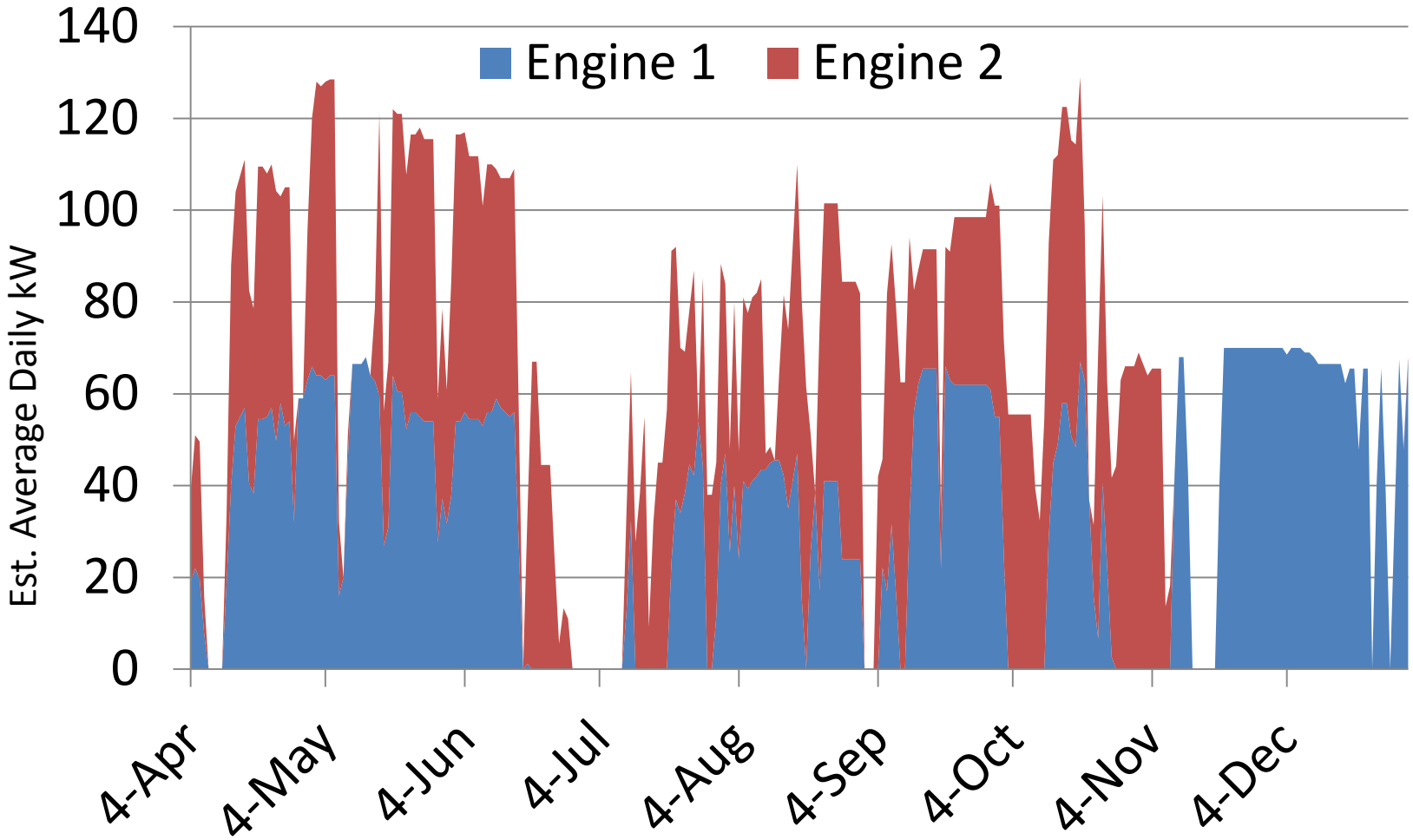
- No single account would maximize on-site use of generator output and project value
- Negotiate with Blue Ridge Electric to combine accounts behind single meter on one rate
  - Aggregated electricity use = 27% kWh generation
  - Aggregated peak billing demand = 165 kW, about 30% more than maximum generator output
- Coordinate large equipment use with generator operation and peak hours
  - Maximize value for selling excess generation
  - Reduce billing demand -> reduce average $/kWh price for purchased electricity

Project Revenue from Sales

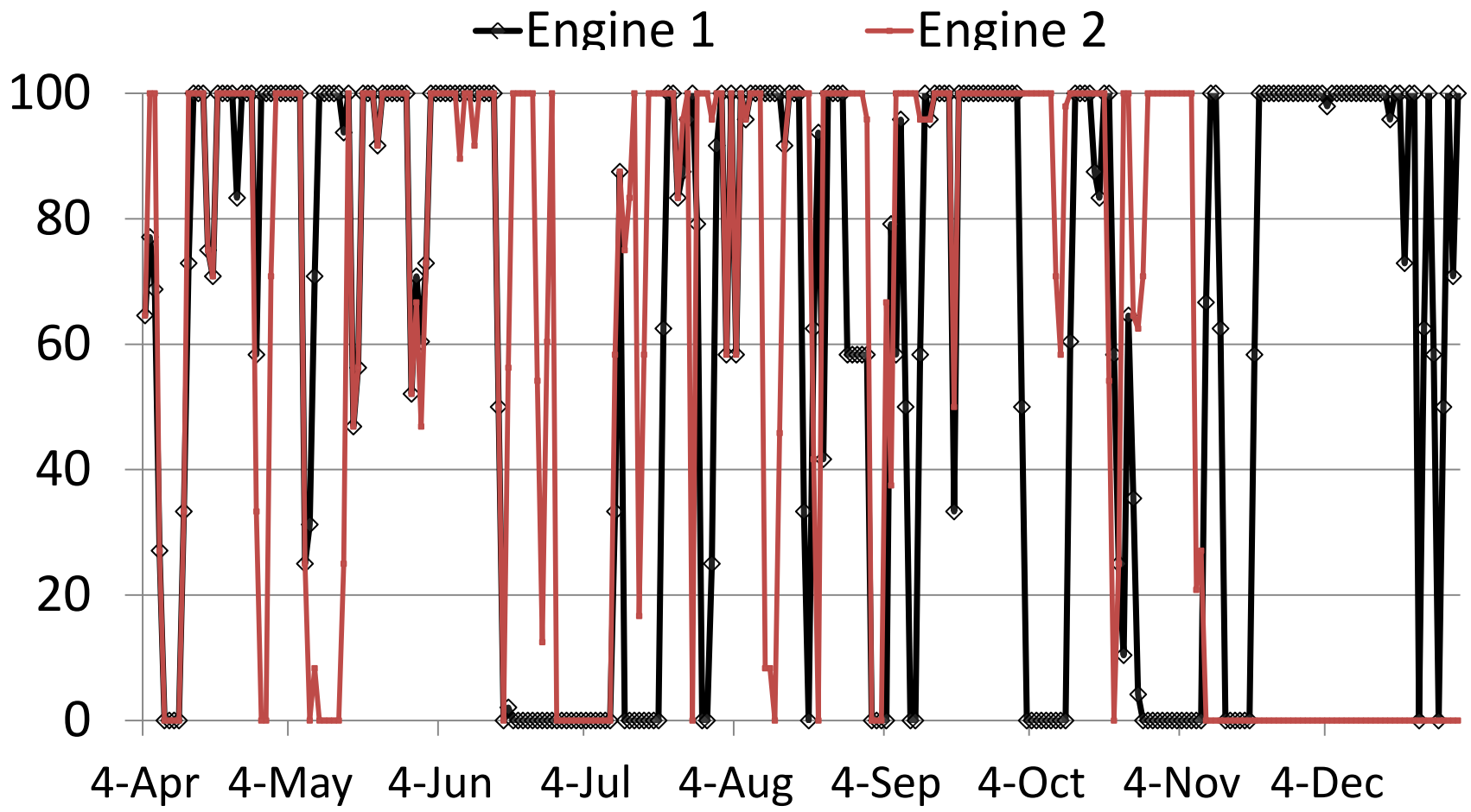
- Interconnection to LSE Blue Ridge Electric (BRE)
- Duke Energy (BRE's all-req. supplier) purchases electricity delivered to grid (i.e., not consumed on-site) and instantaneously re-sells electricity to Blue Ridge Electric
- Originally considered selling to BRE at avoided cost rate of ~4.5¢/kWh, but negotiated deal with Duke for sale at ~5.53¢/kWh (23% gain)
- For electricity delivered to grid, RECs sold to N.C. Green Power for more than 1¢/kWh – County retains RECs for electricity used on-site

OPERATIONAL RESULTS

Daily Project Output, kW



Uptime Percent per day, by engine

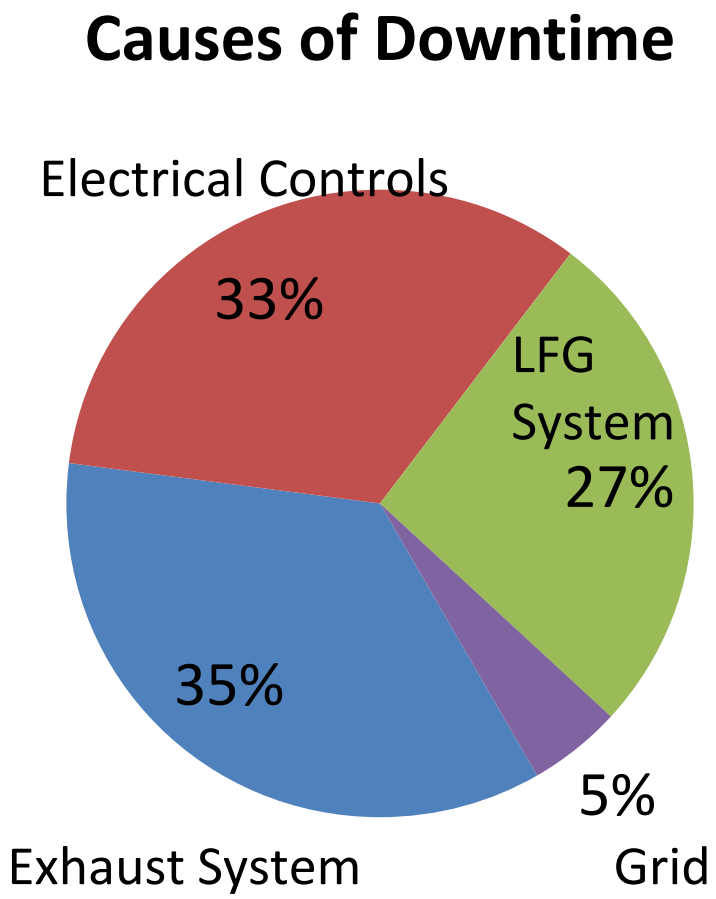


Engine Operating Stats

- 272 days between 4/4/12 - 12/31/12
- Days engines down: Engine 1 - 73 days, Engine 2 – 85 days, Both – 28 days (10%)
- Median kW output (operating): Engine 1 – 54.5 kW, Engine 2 – 48 kW, Combined – 70 kW
- Max kW output when operating: Engine 1 – 70 kW, Engine 2 – 69 kW, Combined – 129 kW

Operating Issues

- Exhaust System:
  - Siloxanes plugged catalytic converter – recently tested within NSPS limits w/out catalytic converter
- Electrical Controls:
  - heat damage and reverse power flow
- LFG System:
  - Loose belts, pipeline pressure, N_2 auto-shutoff
- Result: Future uptime projected at 87.5%

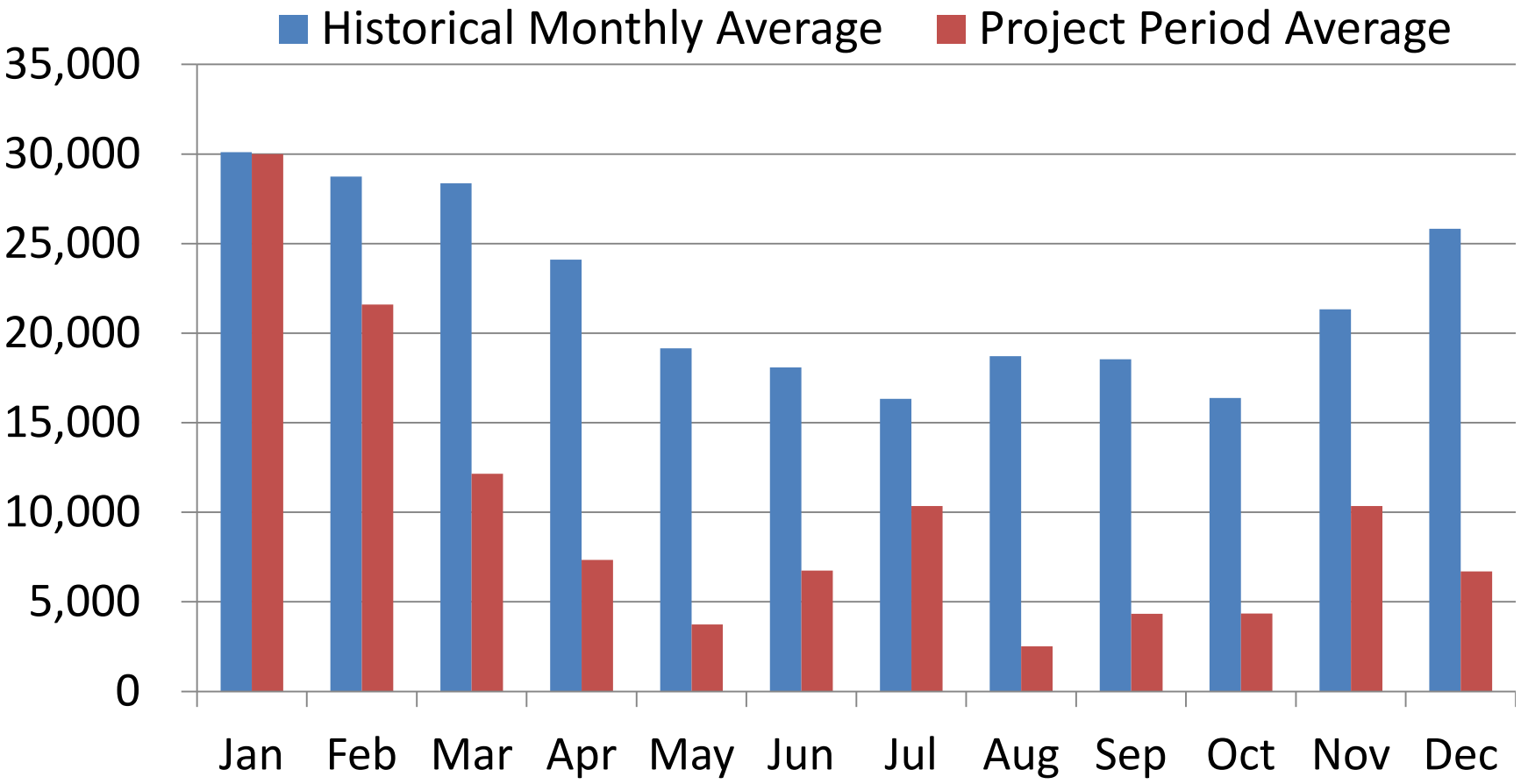


Using Automotive Engines for LFG-fueled Electricity Generation

- Cost & Size
  - Low-cost per kW of capacity
  - Easily fit within shipping container enclosure
  - Highly adjustable output over wide range (<30kW – 80kW+)
- Maintenance – a blessing and a curse
  - High number of operating hours under load relative to typical vehicle use -> oil changes/consumption, alternator
  - Landfill staff can perform most regular maintenance with a bit of training
- Development of “genset” product
  - Incorporating remote-start capability
  - Lightening storms can disrupt monitoring equipment and/or knock generators off grid
  - Placement of electronic controls and components away from high-heat areas

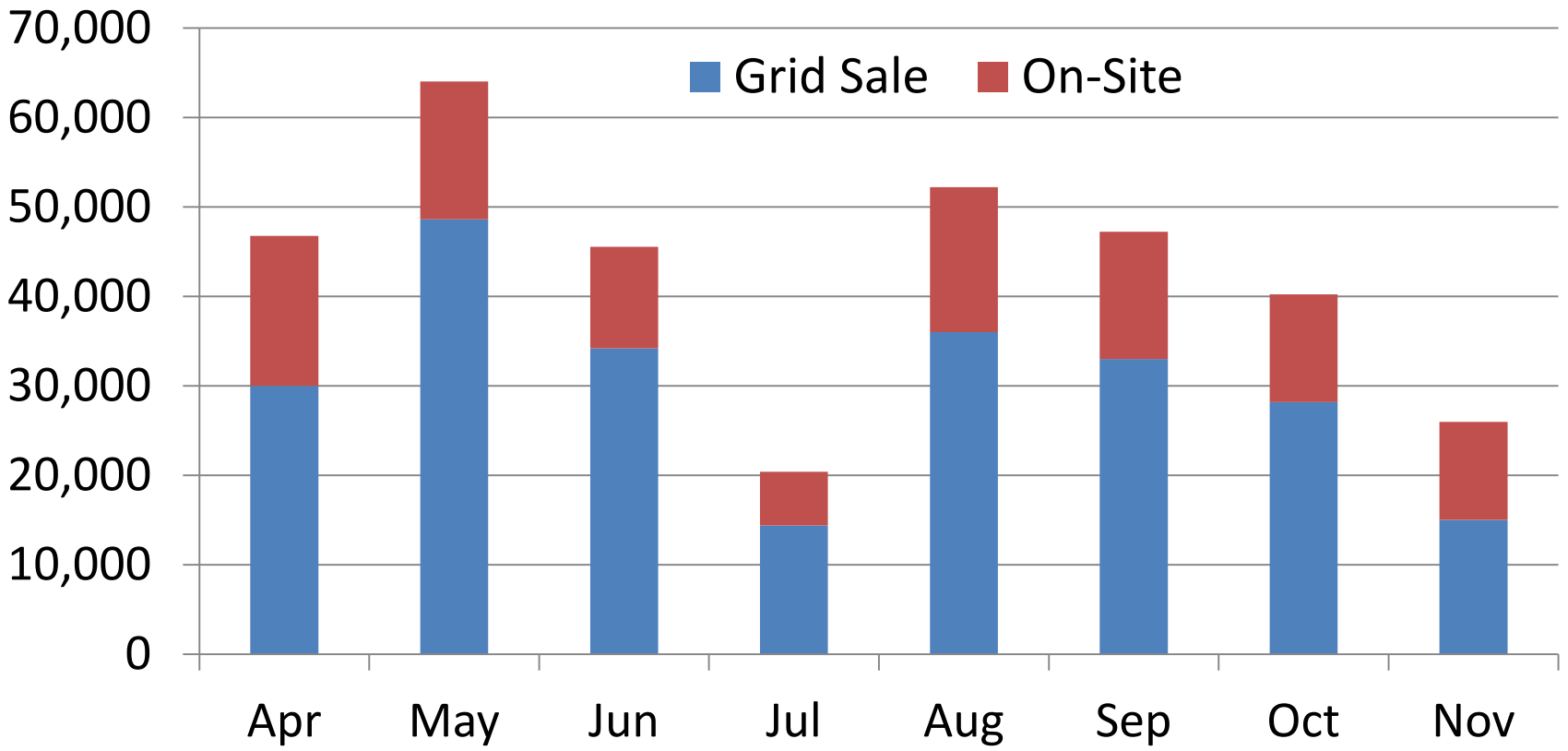
Electricity Purchases Pre- and Post-Project

67% reduction in kWh purchased (Mar-Dec '12)



Disposition of Generated kWh

1/3 portion of kWh consumed on-site

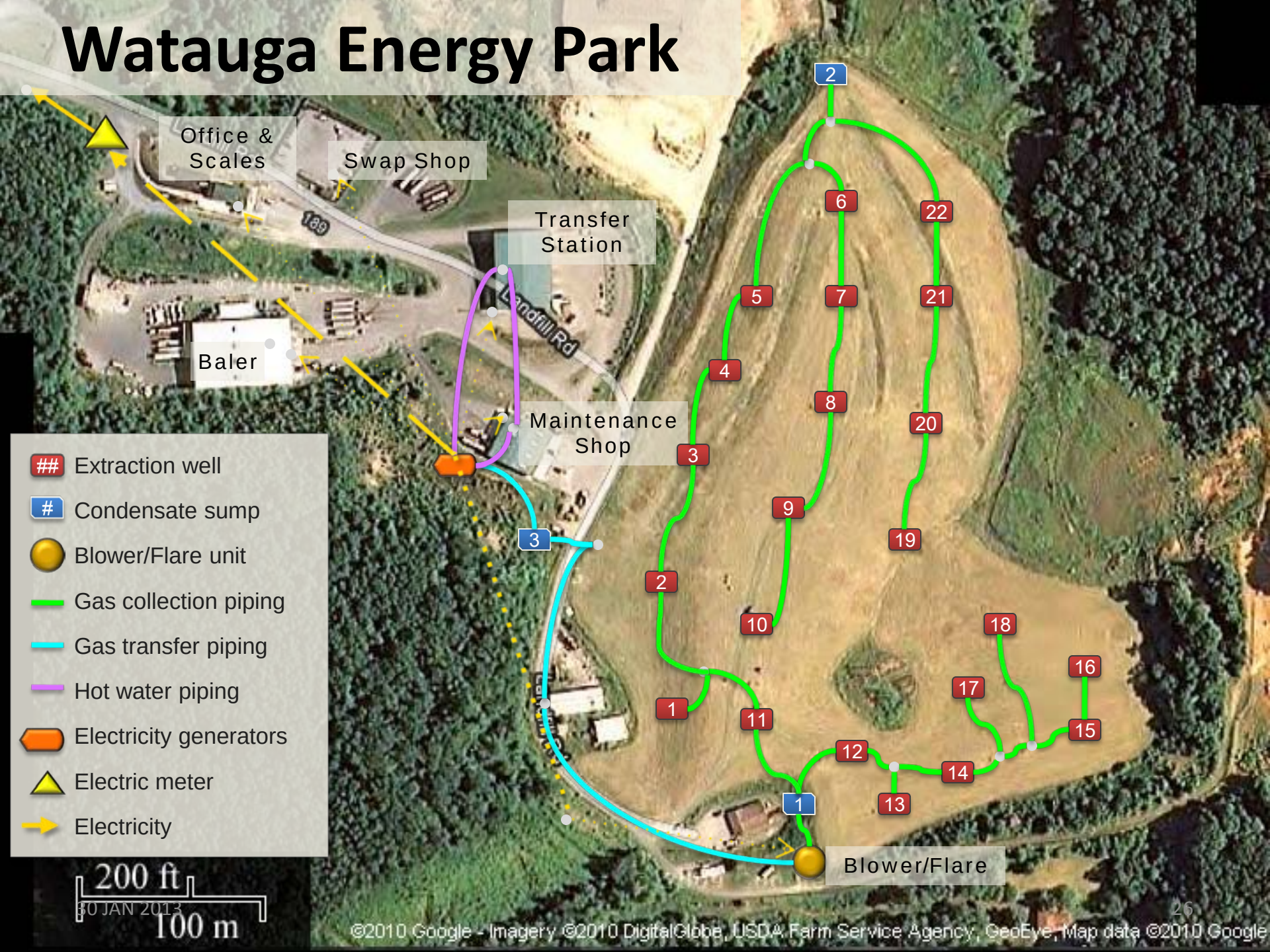


OUTCOMES & CONCLUSIONS

Project Outcomes (Apr-Dec '12)

- 70% reduction in kWh purchased
- 48% reduction in electricity expenditures
- $17,800 in revenue from sales of electricity and green power
- $1.48 in revenue per $1 of electricity bill
- $31,250 total benefit over 9 month operating period = $41,665 annualized
- IRR = 7% with NO tax credits, subsidized financing, or other incentives available to private developers (based on past year's performance)

Watauga Energy Park



Project Future

- Improve uptime ratio -> increased generation, higher sales revenue
- Continue to reduce billing demand -> reduce electric bill and electricity purchase price
- Capture waste heat to displace electricity and propane used for heating [space and water] -> ~$6,500/year in additional savings
- Implement real-time wellhead monitoring and continue innovating small-scale LFG electricity generation systems technology

Future Performance Targets

- Project uptime of >87.5%
- Net capacity output of 120 kW
- Net generation of >900,000 kWh/year
- Billing demand <65 kW
- Electric bills of ~$7,500/year (81% savings)
- Savings + Sales = $74,000/year (no CHP)
- 10-yr IRR = 19%; NPV (3%) = $304,842

Thank You!

QUESTIONS?

Jason W. Hoyle
P.O. Box 32131
Appalachian State University
Boone, NC 28608
Ph. +1.828.262.7934
hoylejw@appstate.edu