Massachusetts Water Resources Authority

Presentation to the

Wastewater Advisory Committee

Existing and Future Combined Heat and Power (CHP) at DITP

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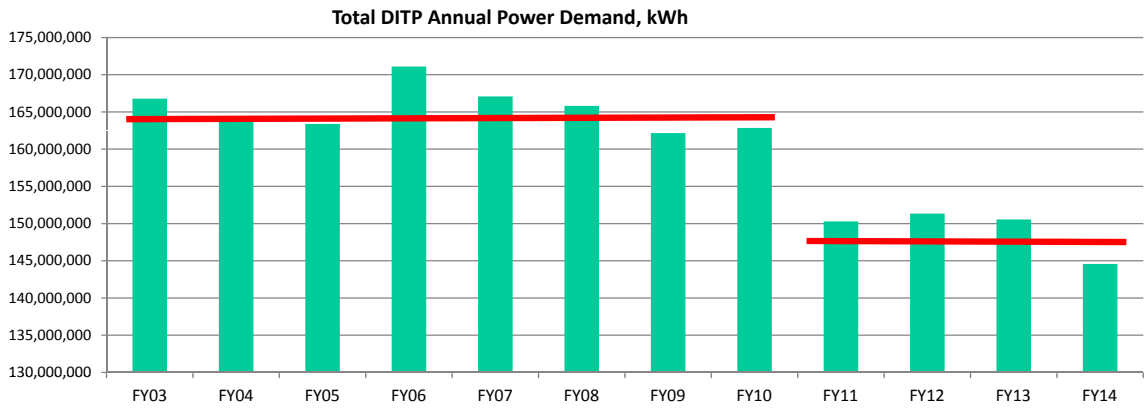
DITP – A Significant Energy User



Staff efforts have helped reduced plant electrical demand by 10%

- Process Optimization
- Installation of new energy efficient equipment

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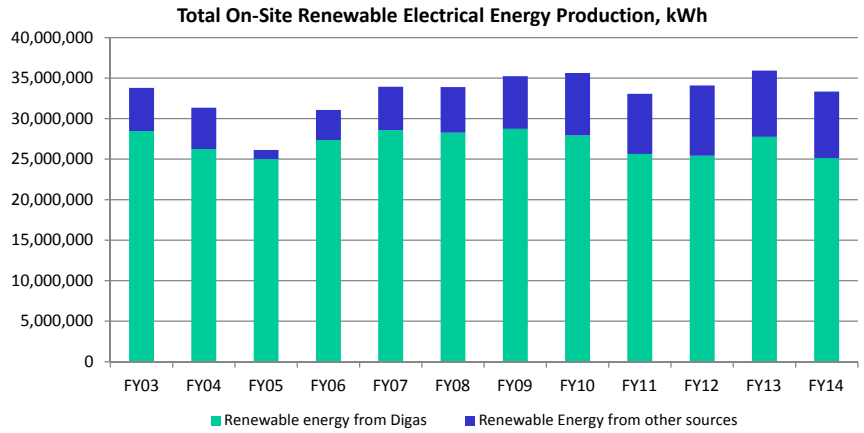
DITP – Green Energy Production (FY14)



Generation Assets:

- **Digas – STG/BPSTG – 25.1 M kWh – 17.4%**
- **Hydro Power – 5.89 M kWh – 4.1%**
- **Wind Power – 1.48 M kWh – 1.0%**
- **Solar – 0.86 M kWh – 0.6%**

Maximizing On-Site Green Energy Production is a priority for MWRA

- 23% of DITP's total energy demand met by green energy
- 60% of DITP's energy needs (heat + power) met by Digester Gas (62.5% for all)

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DITP – Digester Gas Generation & Use (FY14)

- Anaerobic Digestion:
  - 240 dtpd solid in, 100 dtpd to FRSA for pellet conversion
  - Digas - 188 kscfh generated on average @ 60% methane
- OSTPP: Bottom-Cycle Generation
  - Digas – 95% utilized
  - 95% of heat demand met by Digas (remainder by Fuel Oil)
  - 25.1 M kWh generation from Steam Turbine

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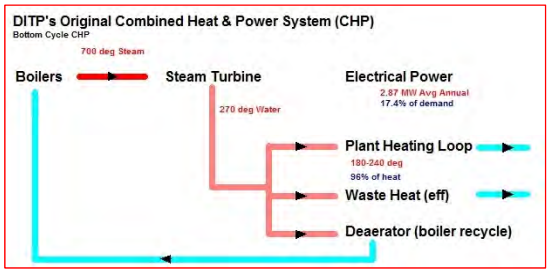
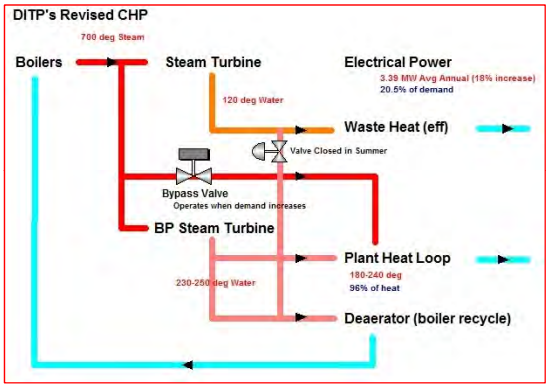
Combined Heat & Power Process – Currently Used by DITP



- **Bottom Cycle Generation**
  - Heat First – 60% efficient
    - Generate Steam then Hot Water
  - Power Second – 9% efficient
    - Generate Electricity from Steam
- New BPSTG / Steam Bypass Valve improves steam to electricity conversion process by extracting more heat per unit steam



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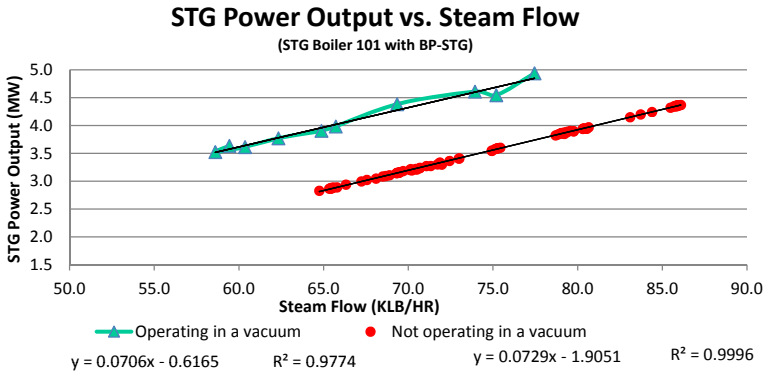
Combined Heat & Power Process – Improved Performance



- **New BPSTG / Steam Bypass Valve improve steam to electricity conversion process**
  - 18% improvement (10.6% efficiency overall)
  - +1.3 MW increase in generation from steam generators
  - Sustainable May - November
  - Should see an increase of +4.5 M kWh / year
  - ~30 M kWh total/year from steam (25.1 M kWh currently)

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CHP Study Objectives – CDM Smith Residuals Technology Assessment

- Develop engineering and economics for new CHP
- Compare and recommend more efficient generation technologies
  - Internal Combustion Engines
  - Gas Turbines
- Evaluate Payback / Economic benefits
- Evaluate implementation options

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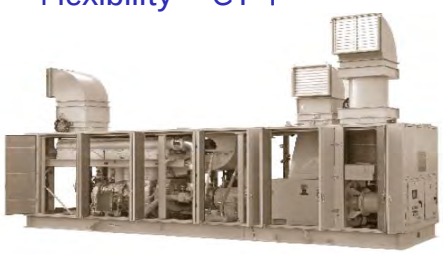
Internal Combustion Engines versus Gas Turbines

- Exhaust emissions (NOx, CO) – GT ↓
- Space required (Capacity) – GT ↓
- Capital and operating costs – GT ↓
- Energy efficiency (Electricity and Heat) ↔
- Flexibility – GT ↑



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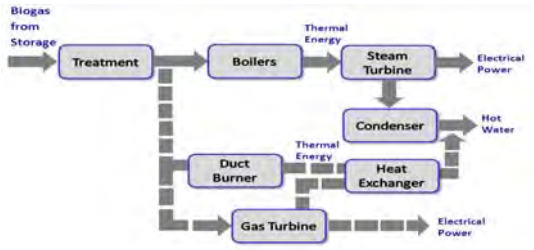
CHP Technology Change

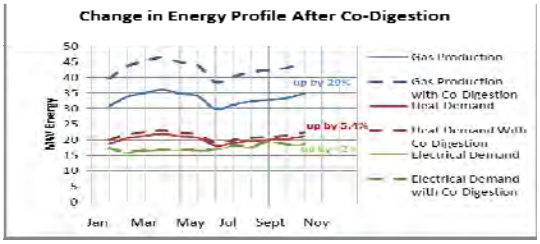
CHP Technology Change

- Change from Bottom to Top cycle generation
- Improve efficiency
- Increased electrical production
- Better use of all digas - summer months
- Continue to meet plant heating needs



CHP Benefit from Co Digestion

- Expected 29-42% increase in biogas
- Results in more electrical output
- Heat demand increase 5-10%
- Electrical demand increase <2%



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Cost Benefit Analysis

Payback With & Without Co-Digestion

Parameter	OSTPP with 1 Gas Turbine*	OSTPP with 1 Gas Turbine* With Co-digestion	3 Gas Turbines*	3 Gas Turbines* With Co-digestion
Capital Cost	$24.9 M	$24.9 M	$75.0 M	$75.0 M
Annual O&M Cost	$2.2 M/yr	$2.2 M/yr	$1.6 M/yr	$1.6 M/yr
Annual Electrical Savings	$5.2 M/yr	$7.0 M/yr	$11.4 M/yr	$14.7 M/yr
Net Annual Savings	$3.0 M/yr	$4.8 M/yr	$9.8 M/yr	$13.1 M/yr
Simple Payback Period	8 years	5 years	8 years	6 years

- Single Gas Turbine capacity: 4.6 MW
- Payback does not include potential funding for green energy projects to pay for the capital.

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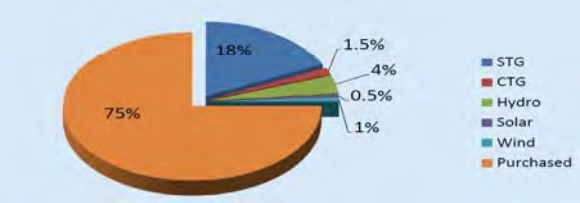
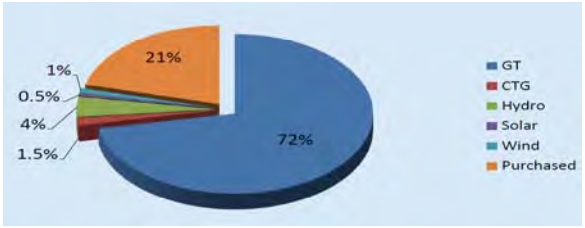
Potential Electricity Benefit with New CHP & Full Scale Co-Digestion

Existing Thermal Plant



- 23% green generation* (18% w/digas)
- 75% purchased electricity

CHP with 3 Gas Turbines – Co-Digestion (Potential)



- Can reverse energy profile
- More sustainable
- 77% green generation* (72% w/digas)
- 21% purchased electricity

*Note: 1.5% generation by CTG backup power.

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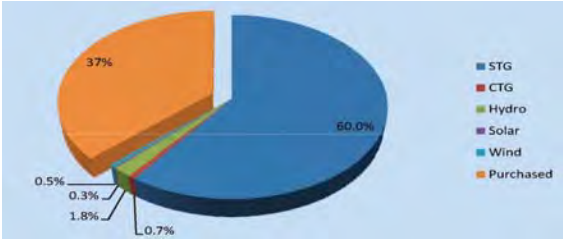
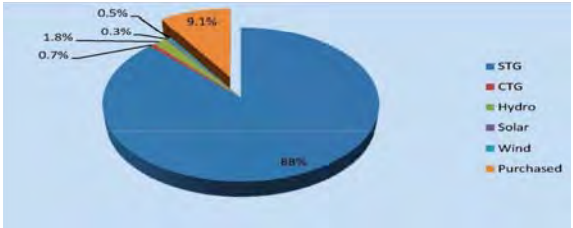
Potential Energy (Heat + Electricity) Benefit with New CHP & Full Scale Co-Digestion

Existing Thermal Plant



- 62.5% green energy* (60% by digas)
- 36.8% purchased energy

CHP with 3 Gas Turbines – Co-Digestion (Potential)



- Nearly Energy Neutral
- More sustainable
- 90% green energy* (88% by digas)
- 9% purchased energy

*Note: 0.7% generation by CTG backup power.

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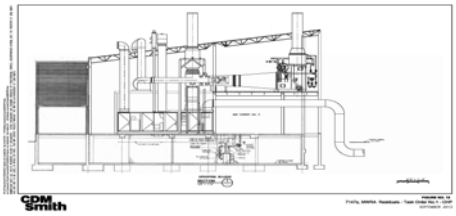
Recommendation

- Gas Turbine CHP is recommended technology
- Staff are moving forward with design to
  - Further define economics
  - Investigate additional equipment needed
  - Review economics with and without co-digestion
  - Investigate full implementation approach
  - Develop specific gas system changes



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