Energy Conservation and Production at Waste Cleanup Sites

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Research and Development at EPA

- 1,950 employees
- $700 million budget
- $100 million extramural research grant program
- 13 lab or research facilities across the U.S.
- Credible, relevant and timely research results and technical support that inform EPA policy decisions
Making decisions with sound science requires:

- Relevant, high quality, cutting-edge research in human health, ecology, pollution control and prevention, economics and decision sciences
- Proper characterization of scientific findings
- Appropriate use of science in the decision process

Research and development contribute uniquely to:

- Health and ecological research, as well as research in pollution prevention and new technology
- In-house research and an external grants program
- Problem-driven and core research
High Priority Research Areas

- Human Health
- Particulate Matter
- Drinking Water
- Clean Water
- Global Change
- Endocrine Disruptors
- Ecological Risk
- Pollution Prevention
- Homeland Security
ORD’s Office of Science Policy

• Serves as a link between the ORD labs and EPA regulatory programs through:
  ▪ research planning
  ▪ technical support and
  ▪ sponsoring training and workshops

• Me - ORD Hazardous Substances Technical Liaison to Region 9
Energy Conservation and Production at Waste Cleanup Sites

- Most waste cleanup sites (RCRA, Superfund, Brownfields) cleanup systems use electricity.
- Some are energy intensive for years.
- Some waste sites offer energy production opportunities.
- EPA’s Superfund Engineering Forum supported investigating this issue through “Issue Paper.”
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• In recent years, energy issues have been raised to forefront:

  ▪ EO 13123 - Greening the Government Through Efficient Energy Management (June ‘99) “…Each agency shall strive to expand the use of renewable energy…”

  ▪ Western U.S. energy crisis of 2001 (outages, cost increases, charges of market tinkering….)
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- Top Ten Dumb Guy Ways To Conserve Energy

10. Quit drinkin' gas
9. Keep your television on a low setting, no higher than Ch. 5
8. Recycle Top Ten List entries
7. Recycle Top Ten List entries
6. Host late-night talk show that causes millions of Americans to turn off their television sets

(Courtesy David Letterman)
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- Top Ten Dumb Guy Ways To Conserve Energy

5. Crap, that's a hard question... is wrestling on?
4. Instead of motor oil, lubricate your car's engine with Oil of Olay
3. Turn off the lights at Shea Stadium -- would it really matter?
2. Say goodbye to your electric razor -- get yourself some Epil-Stop & Spray
1. Become President -- ignore the problem completely

(Courtesy David Letterman)
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• Today’s Goals:

  ▪ Make project managers aware of energy use at waste cleanup sites by:

    • Reviewing existing data on conservation and production at waste sites
    • Providing information on existing tools
    • Discussing where we need to go: (recommendations, future work)
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EXISTING DATA

• Observed limited case studies:
  • 2 groundwater cleanup sites
  • 2 landfills

• Many EPA/DOE/State websites on energy savings. Most are for facilities, appliances, solar, wind, geothermal, fuel cells, etc. Few directly related to remediation systems, but could be adapted.
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• Energy Savings - Groundwater Sites

• Site 1

- UV/oxidation remedy for treating VOCs
- Effective for treating high concentrations
- Energy-intensive operation (e.g. 350 gpm system used about 3000 KwH/day as opposed to 750 KwH to operate an air stripper) (3000KwH/day = 150 homes)
- Energy saving idea dropped because ROD amendment necessary to make change
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UV / Oxidation System
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- Site 2

- VOCs in groundwater
- UV/hydrogen peroxide remedy
- System “incrementally” designed (inefficient)
- Designed for semi-continuous operation at high flow rates
- Energy-intensive space heating for buildings
- Thought given to energy use during design??
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• **Findings?**

  - One should consider energy during design and O&M processes
  - In one case, facility energy use (space heating), not just system design, can offer savings in energy use
  - Process, institutional, administrative barriers exist and may make design changes difficult
  - Energy issues probably not considered at these two sites
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- **Energy Production - Landfills**
  - Landfills create methane gas
  - Gas can be collected and used to create electricity with microturbines
  - Microturbines are tolerant of lower methane content fuels (need >35%)
  - At some sites, this power allows operation *off-the-grid*
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• Site 1 Landfill

- 190 acre landfill in So. California
- Estimated 38M cubic yards of municipal solid waste and 330M gallons of liquid industrial waste
- Gas collection systems installed
- 2500 cfm of methane collected
- Higher BTU-valued gas used to power a microturbine system for electricity generation
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Plumbing into Landfill Microturbines
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Landfill Microturbine System
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- **Site 2 Landfill**
  - Power company installed energy recovery system at landfill site
  - Landfill generates methane gas at 1150 cfm
  - Four internal combustion engines use methane to produce a max total of 3200kW of power
  - Systems require >51% methane (BTU content)
  - Project won 1 of 4 national EPA Landfill Methane Outreach Program (LMOP) awards
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• Findings...

- Long term costs of systems are approx 25% of purchasing power. Translated into savings of $400K per year in power costs for Southern California landfill.

- Logistics hurdles do exist - local utilities, environmental regulations, DOT.

- Capital and O&M costs do exist for microturbines; it takes time to “break even”.

- Not all microturbines accept all fuels - must find a fit.
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• ...More Findings

  - Important to research the microturbine company and “turnkey” systems are preferable
  - Consider maintenance contracts
  - Energy generation can be preferable alternative to offgas treatment
  - Energy generation can provide energy self-sufficiency for the site and perhaps profit
  - Government grants are available (FEMP/LMOP) for landfill gas generators
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- Other Energy Production Options at Waste Sites:
  - Photovoltaic Arrays on open area waste sites
  - Windpower on open area waste sites
  - Windpower/Solar/Geothermal for remote power needs (e.g. well pumps)
  - Tire / Medical waste recycling (CoGen plants)
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Photovoltaic Arrays

(Courtesy of Australian National University)
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Windpower

(Courtesy of University of Colorado)
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Geothermal Plants

Courtesy NREL
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CoGeneration Plants

(Courtesy of Stanford University)
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• Energy Web Sites

  ▪ There are many energy websites - most concentrate on energy as related to facilities management, renewable energy options or consumer issues

  • Optimization site (energy indirectly considered): http://www.epa.gov/oerrpage/superfund/action/postconstruction/optimize.htm

  • EPA’s Landfill Methane Outreach Program: http://www.epa.gov/lmop
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EXISTING TOOLS

- Energy Saving Performance Contracts (ESPCs)
- Sankey Energy Flow Diagrams
- Evaluations for Modifying Energy Use
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• **Energy Saving Performance Contracts (ESPCs)**
  
  - Energy saving contract company (ESCO) identifies and evaluates energy-savings opportunities
  - Waste sites can enter into agreements with ESCOs
  - In contract, ESCO guarantees that savings measures will work, or they pay difference
  - Common in Europe; US DOE has program through Federal Energy Management Program (FEMP)
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Energy Saving Performance Contracts (ESPCs)

(Courtesy US DOE FEMP)
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- **Sankey Energy Flow Diagrams**
  - Graphic used to visualize energy balance in systems
  - Explains relative “quantitative” relationships within the process
  - Provides easy identification of areas where maximum consumption occurs and where impacts can be reduced
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Example of Sankey Diagram (De Miclen Levice Slovakia)

(Courtesy Atom Prague, 2000, translated and modified by Katarina Mahutova, EPA Region 10)
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• Evaluations for Modifying Energy Use
  - EPA and US ACE optimization tools exist; called Remedial Systems Evaluation (RSE) checklists
  - In process of incorporating more energy specific issues indirectly into these optimization processes
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Evaluations for Modifying Energy Use: Checklist

<table>
<thead>
<tr>
<th>Pumps, Motors &amp; Other Equipment Used</th>
</tr>
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<tbody>
<tr>
<td>Major Component Type</td>
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<td>----------------------</td>
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• General Ways to Reduce Energy

  ▪ Determine if the system in place is over-specified or lacking in efficiency
  ▪ Modify time of system operation to take advantage of:

    • system off-peak rate
    • cyclic pumping
    • batch processing
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• Specific Ways to Reduce Energy
  ▪ Air Stripping
  ▪ Advanced Oxidation
  ▪ Groundwater Extraction Systems
  ▪ Activated Carbon Adsorption Units
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Air Stripping
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• Air Stripping

  ▪ Are liquid and vapor flow rates the same as in the design spec? The air rate can often be reduced if the water rate is reduced.

  ▪ Compare the present air emissions to the regulatory limits. Perhaps the offgas treatment can be reduced or discontinued.
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Advanced Oxidation
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• Advanced Oxidation
  - Determine whether any UV lamps can be turned off without reducing the treatment efficiency.
  - Do any of the lamps need replacement? They could be drawing energy, but not reducing the contaminant concentrations.
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Groundwater Extraction Systems
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- **Groundwater Extraction Systems**
  - Are the groundwater wells properly distributed to capture the plume most efficiently?
  - If natural attenuation is part of the remedy, are interim goals met whereby the pumping can be shut down?
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Activated Carbon Adsorption Units

(Courtesy JB Systems, Inc.)  (Courtesy - County of Maui, HI)
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- **Activated Carbon Adsorption Units**
  - Are the carbon beds monitored for contaminant breakthrough to determine when changeout is necessary? (early changeout means more energy use)
  - If spent carbon is regenerated onsite, can energy be saved?
  - Are influent concentrations low enough to allow carbon units to be shut down?
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**Recommendations / Future Work**

- Develop customized software tools for energy conservation and production (examples follow)
- Develop model contracting terms implementing energy efficiency incentives, metrics and procurement guidelines
- Recommend incorporating these items into existing EPA guidance and training
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Energy Calculator Home Page


CALCULATOR

WHAT CALCULATOR IS

This model has been prepared for the Danish National Railway Agency and the Danish state railways by: HOH Water Technology A/S NIRAS Consulting Engineers and Planners A/S Rinsorsanvæket / Pannell Kerr Forster ScanRail Consult

The model is part of the EU LIFE Project no. 96ENV/CZ/0016 and is supported by the EU LIFE programme and the Technology Development programme of the Danish Environmental Protection Agency's Programme for Development of Technology, Soil and Groundwater.
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Calculator - Demo Entry Screen
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Calculator - Selecting Site Parameters
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Calculator - Thermal Desorption page

THERMAL DESORPTION

- contaminants
  - contaminant concentration (ppm)
  - clean up goal (ppm)

- soil characteristics
  - soil moisture (%)
  - soil organic content (%)
  - soil classification

- thermal desorption
  - temperature (°F)
  - feed

Address: http://iris.fn.unl.edu/calculator-pvtd/tcl.html#
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• Summary...

- Waste cleanups at RCRA, Superfund and Brownfields sites are sometimes energy intensive for years
- It makes sense to consider energy efficiency in their design and operation
- Some sites may also offer energy production opportunities
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- …More Summary

  ▪ Tools exist; more are being developed
  ▪ Important to consider energy issues during design and O&M together because operator is likely to be different than designer and may have no contractual interest in saving energy
    - http://www.epa.gov/tio/tsp/issue.htm
    - http://www.clu-in.org
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Q&A????