Energy Conservation and Production at Waste Cleanup Sites

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RESEARCH & DEVELOPMENT

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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

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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

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High Priority Research Areas

- Human Health
- Particulate Matter
- Drinking Water
- Clean Water
- Global Change
- Endocrine Disruptors
- Ecological Risk
- Pollution Prevention
- Homeland Security

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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

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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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Energy Conservation and Production at Waste Cleanup Sites

- 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….)

Energy Conservation and Production at Waste Cleanup Sites

- 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)

Energy Conservation and Production at Waste Cleanup Sites

- 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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Energy Conservation and Production at Waste Cleanup Sites

- 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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Energy Conservation and Production at Waste Cleanup Sites

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.

Energy Conservation and Production at Waste Cleanup Sites

- 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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Energy Conservation and Production at Waste Cleanup Sites

UV / Oxidation System

Energy Conservation and Production at Waste Cleanup Sites

- 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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Energy Conservation and Production at Waste Cleanup Sites

- 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

Energy Conservation and Production at Waste Cleanup Sites

- 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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Energy Conservation and Production at Waste Cleanup Sites

- 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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Energy Conservation and Production at Waste Cleanup Sites

Plumbing into Landfill Microturbines

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Energy Conservation and Production at Waste Cleanup Sites

Landfill Microturbine System

Energy Conservation and Production at Waste Cleanup Sites

- 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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Energy Conservation and Production at Waste Cleanup Sites

- 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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Energy Conservation and Production at Waste Cleanup Sites

- ...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

Energy Conservation and Production at Waste Cleanup Sites

- 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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Energy Conservation and Production at Waste Cleanup Sites

Photovoltaic Arrays

(Courtesy of Australian National University)

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Energy Conservation and Production at Waste Cleanup Sites

Windpower

(Courtesy of University of Colorado)

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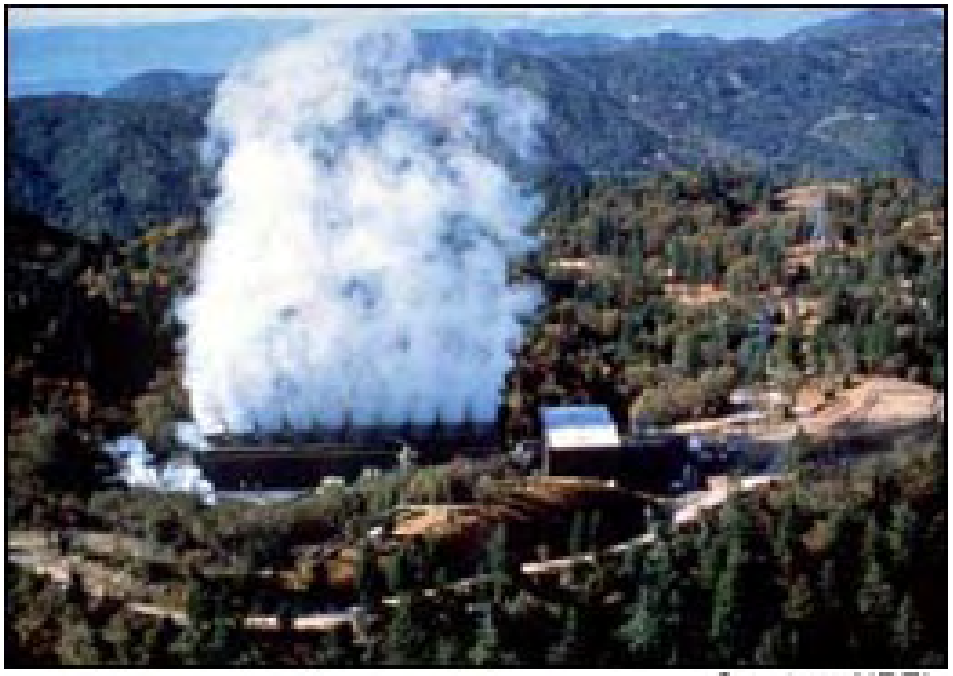
Energy Conservation and Production at Waste Cleanup Sites

Geothermal Plants



Courtesy NREL

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Energy Conservation and Production at Waste Cleanup Sites

CoGeneration Plants

(Courtesy of Stanford University)

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Energy Conservation and Production at Waste Cleanup Sites

- 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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Energy Conservation and Production at Waste Cleanup Sites

EXISTING TOOLS

- Energy Saving Performance Contracts (ESPCs)
- Sankey Energy Flow Diagrams
- Evaluations for Modifying Energy Use

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Energy Conservation and Production at Waste Cleanup Sites

- 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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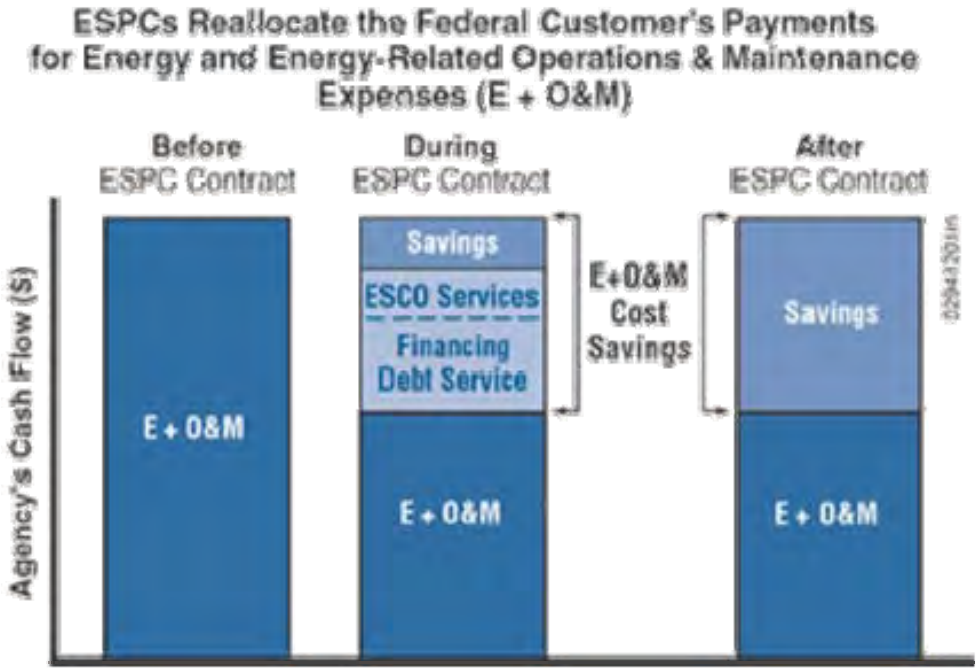
Energy Conservation and Production at Waste Cleanup Sites

Energy Saving Performance Contracts (ESPCs)



(Courtesy US DOE FEMP)

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Energy Conservation and Production at Waste Cleanup Sites

- 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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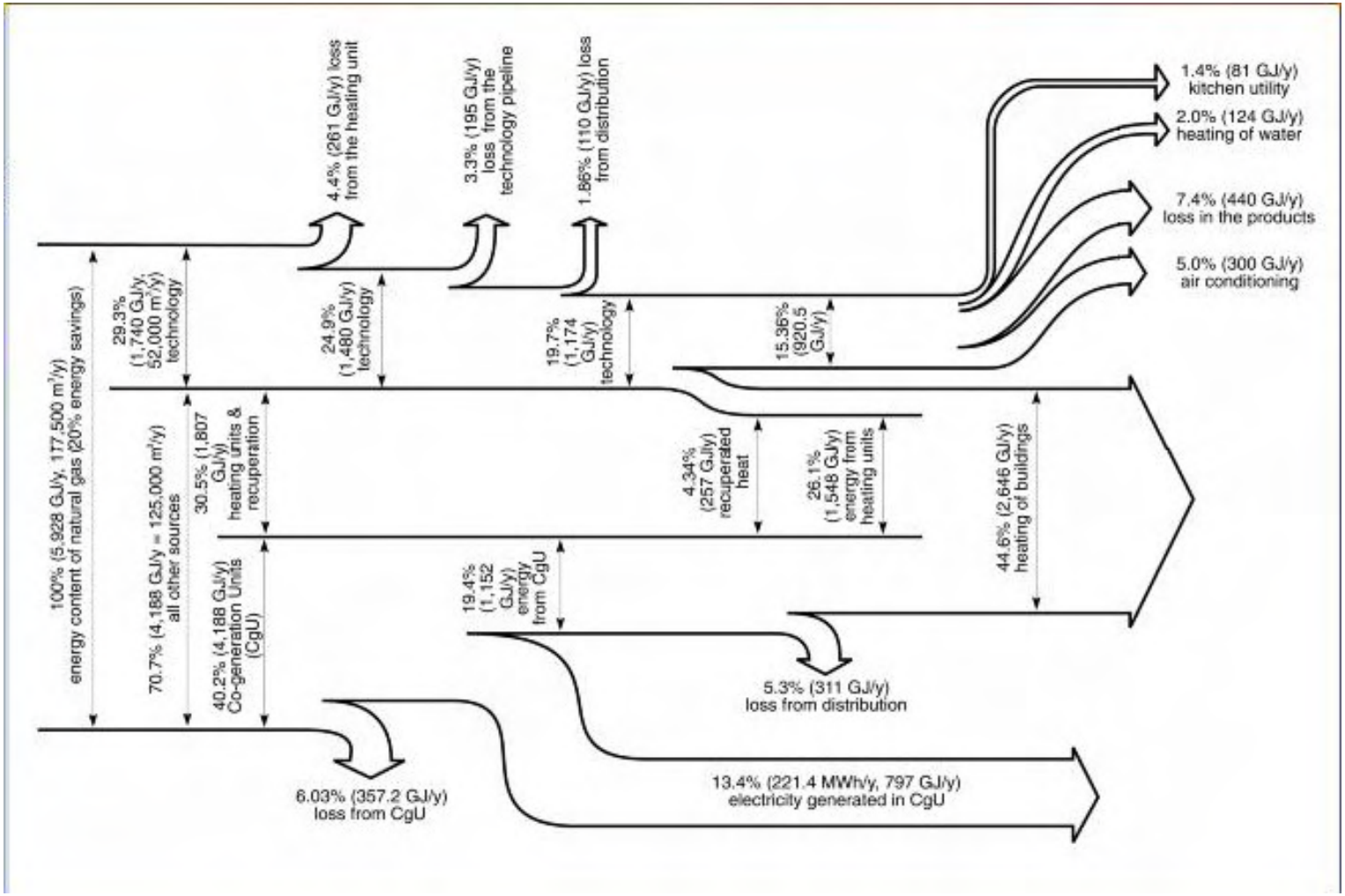
Energy Conservation and Production at Waste Cleanup Sites

Example of Sankey Diagram (De Miclen Levice Slovakia)



(Courtesy Atom Prague, 2000, translated and modified by Katarina Mahutova, EPA Region 10)

Energy Conservation and Production at Waste Cleanup Sites

- 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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Energy Conservation and Production at Waste Cleanup Sites

Evaluations for Modifying Energy Use: Checklist

Pumps, Motors & Other Equipment Used

Major Component Type	Wells Served	Make/ Model	Capacity/ Size	No. Units	Power Requirement/ Output	Hrs. Used/ day

Energy Conservation and Production at Waste Cleanup Sites

- 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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Energy Conservation and Production at Waste Cleanup Sites

- Specific Ways to Reduce Energy
  - Air Stripping
  - Advanced Oxidation
  - Groundwater Extraction Systems
  - Activated Carbon Adsorption Units

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Energy Conservation and Production at Waste Cleanup Sites

Air Stripping

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Energy Conservation and Production at Waste Cleanup Sites

- 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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Energy Conservation and Production at Waste Cleanup Sites

Advanced Oxidation

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Energy Conservation and Production at Waste Cleanup Sites

- 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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Energy Conservation and Production at Waste Cleanup Sites

Groundwater Extraction Systems

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Energy Conservation and Production at Waste Cleanup Sites

- 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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Energy Conservation and Production at Waste Cleanup Sites

Activated Carbon Adsorption Units

(Courtesy JB Systems, Inc.)

(Courtesy - County of Maui, HI)

Energy Conservation and Production at Waste Cleanup Sites

- 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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Energy Conservation and Production at Waste Cleanup Sites

- ***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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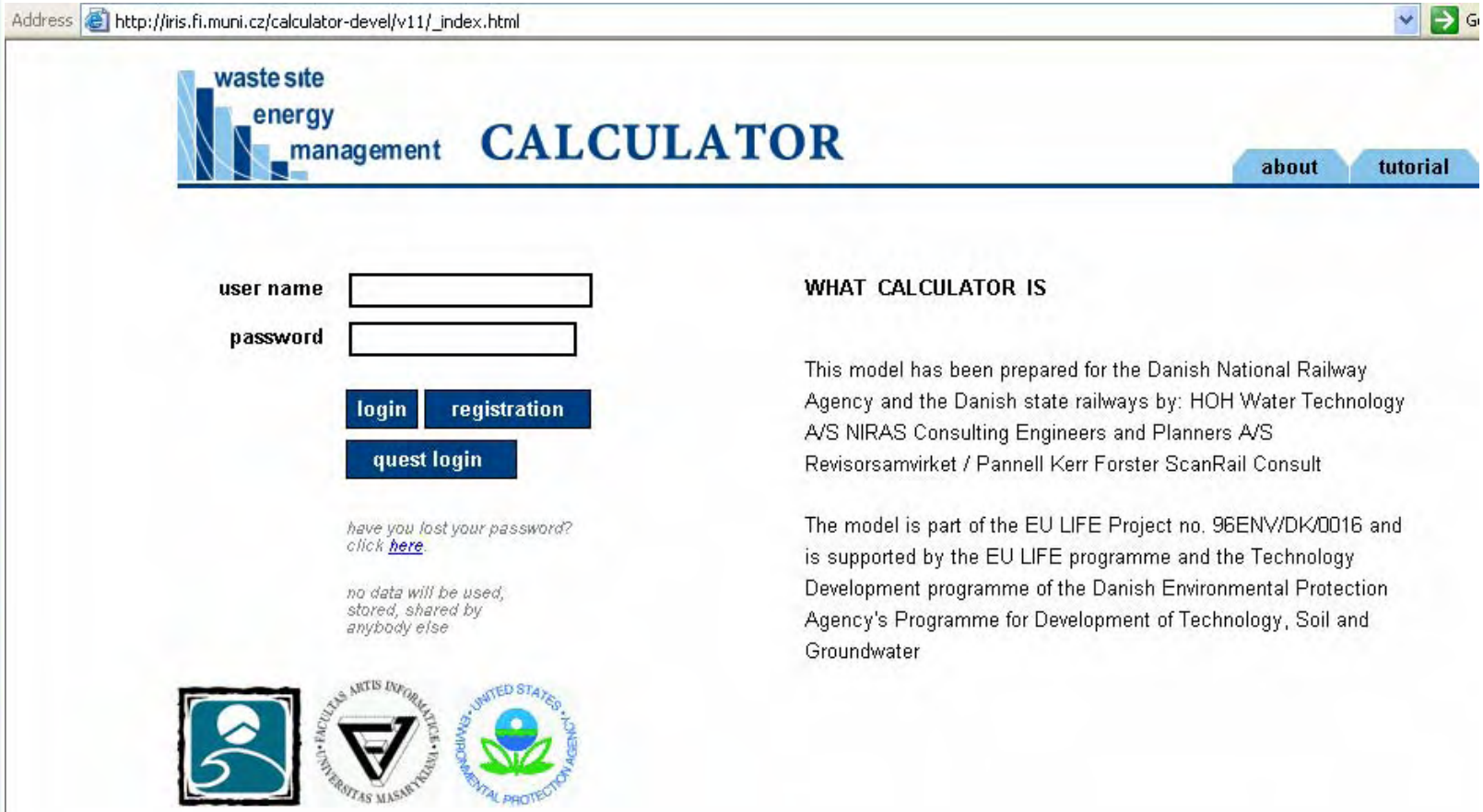
Energy Conservation and Production at Waste Cleanup Sites

Energy Calculator Home Page



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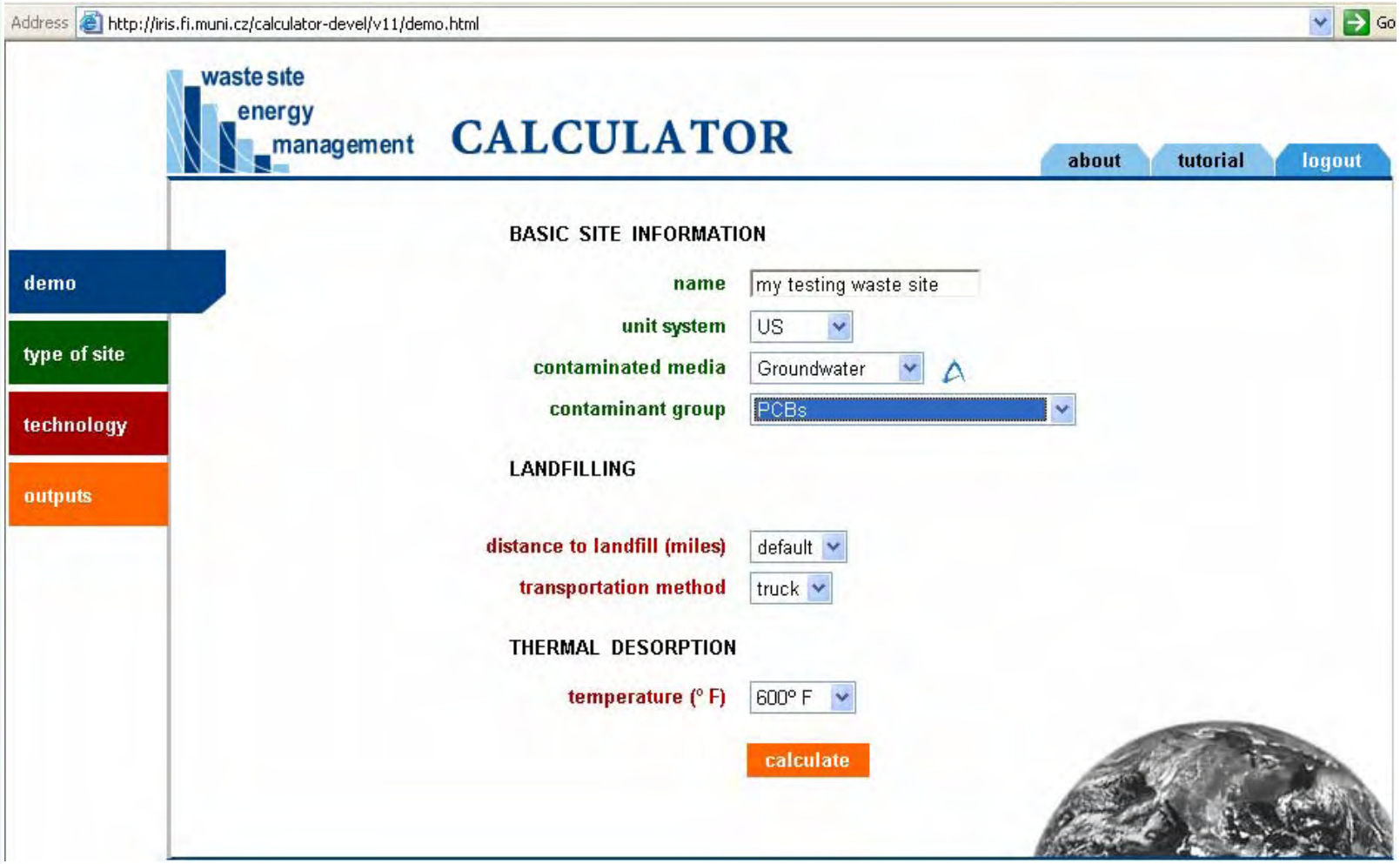
Energy Conservation and Production at Waste Cleanup Sites

Calculator - Demo Entry Screen



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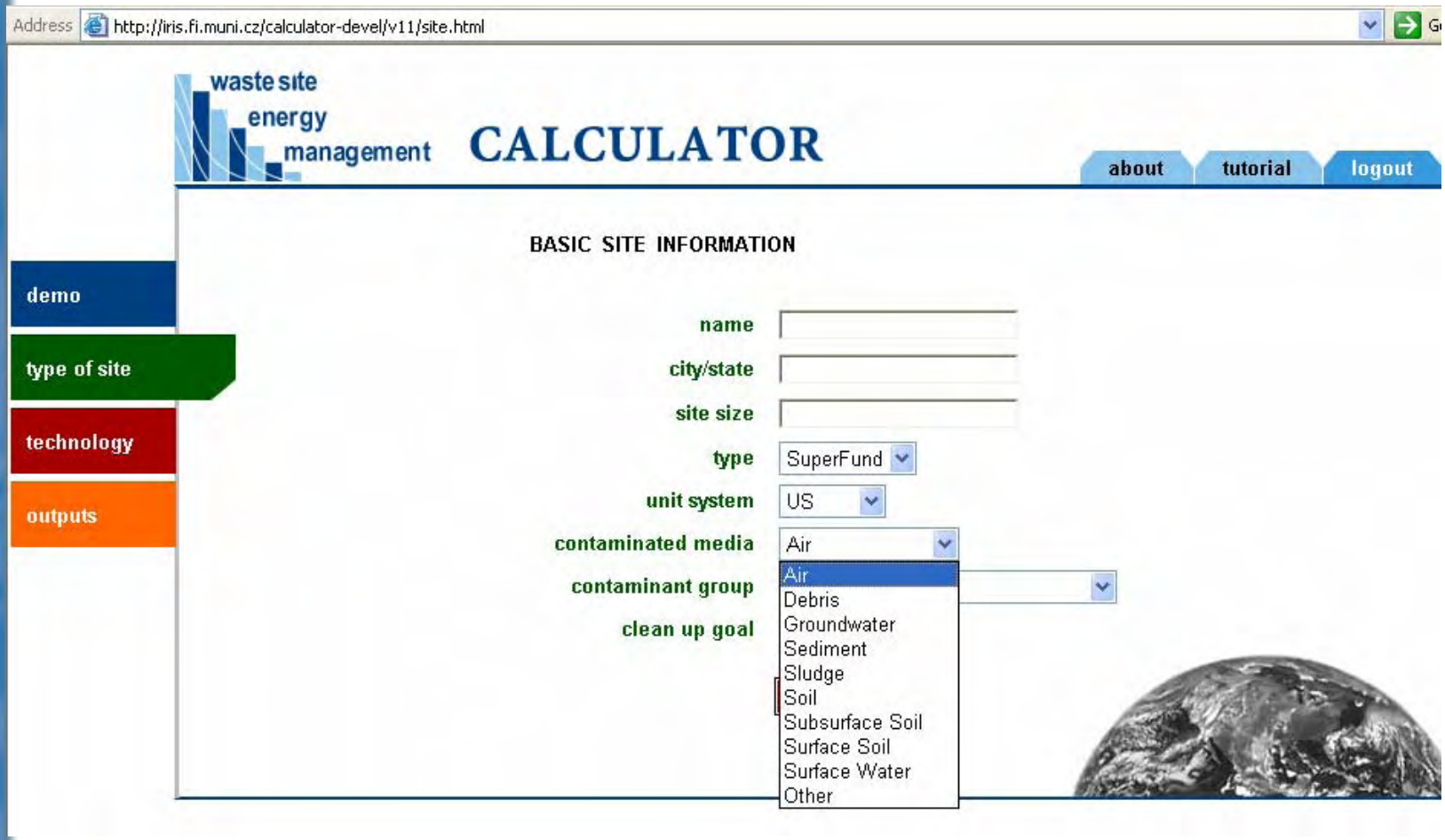
Energy Conservation and Production at Waste Cleanup Sites

Calculator - Selecting Site Parameters



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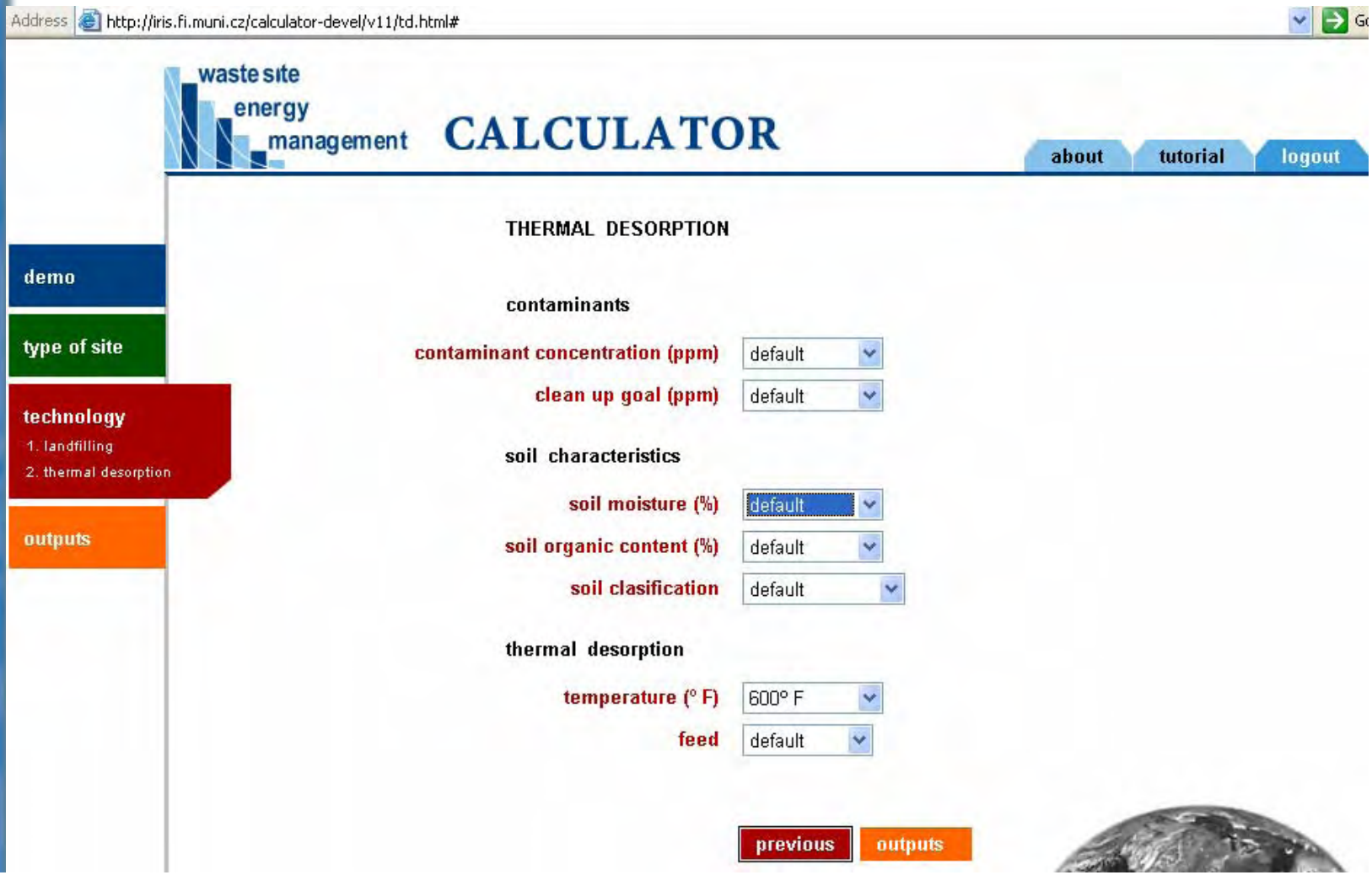
Energy Conservation and Production at Waste Cleanup Sites

Calculator - Thermal Desorption page



Energy Conservation and Production at Waste Cleanup Sites

- 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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Energy Conservation and Production at Waste Cleanup Sites

- …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
  - Issue Paper just published: "Introduction to Energy Conservation and Production at Waste Cleanup Sites" (EPA 542-S-04-001)
    - http://www.epa.gov/tio/tsp/issue.htm
    - http://www.clu-in.org

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Energy Conservation and Production at Waste Cleanup Sites

- Acknowledgements

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  - Issue Paper Co-author and Calculator Lead - Katarina Mahutova (Reg 10)
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Q&A????