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….)

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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)

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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.

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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

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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

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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

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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

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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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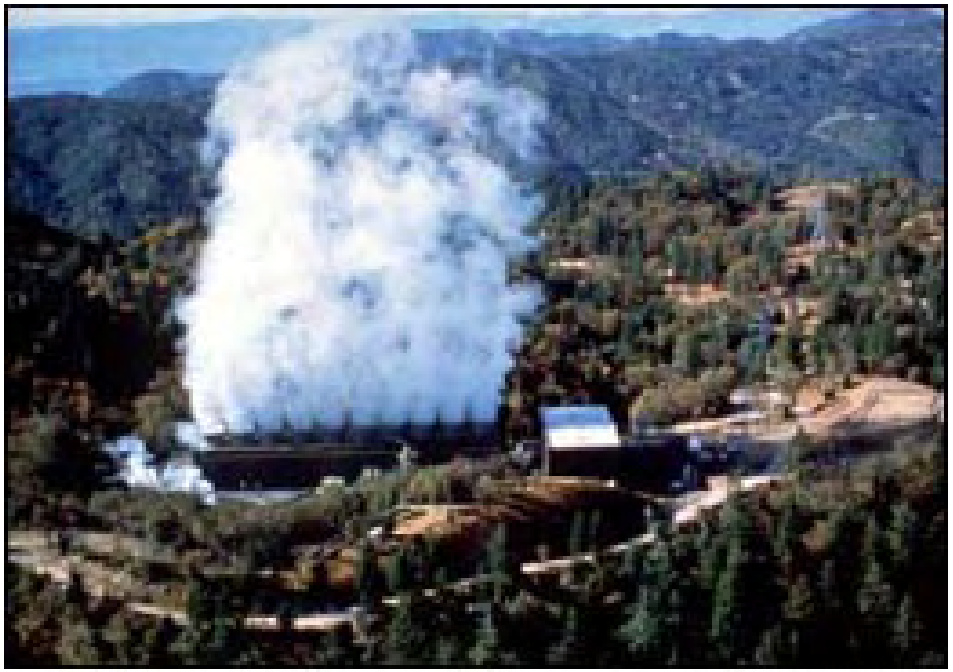
Energy Conservation and Production at Waste Cleanup Sites

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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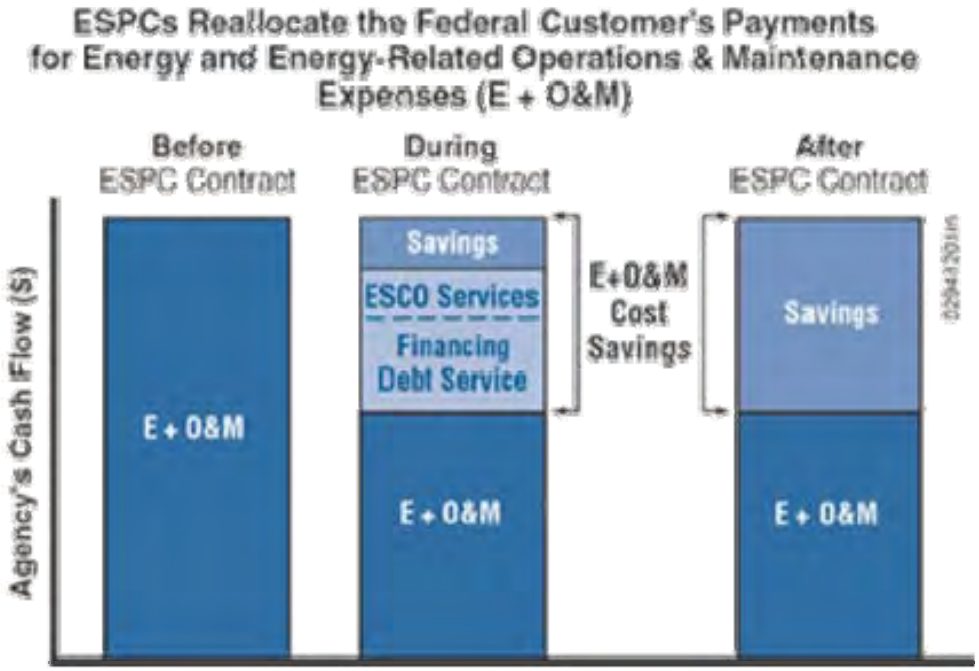
Energy Conservation and Production at Waste Cleanup Sites

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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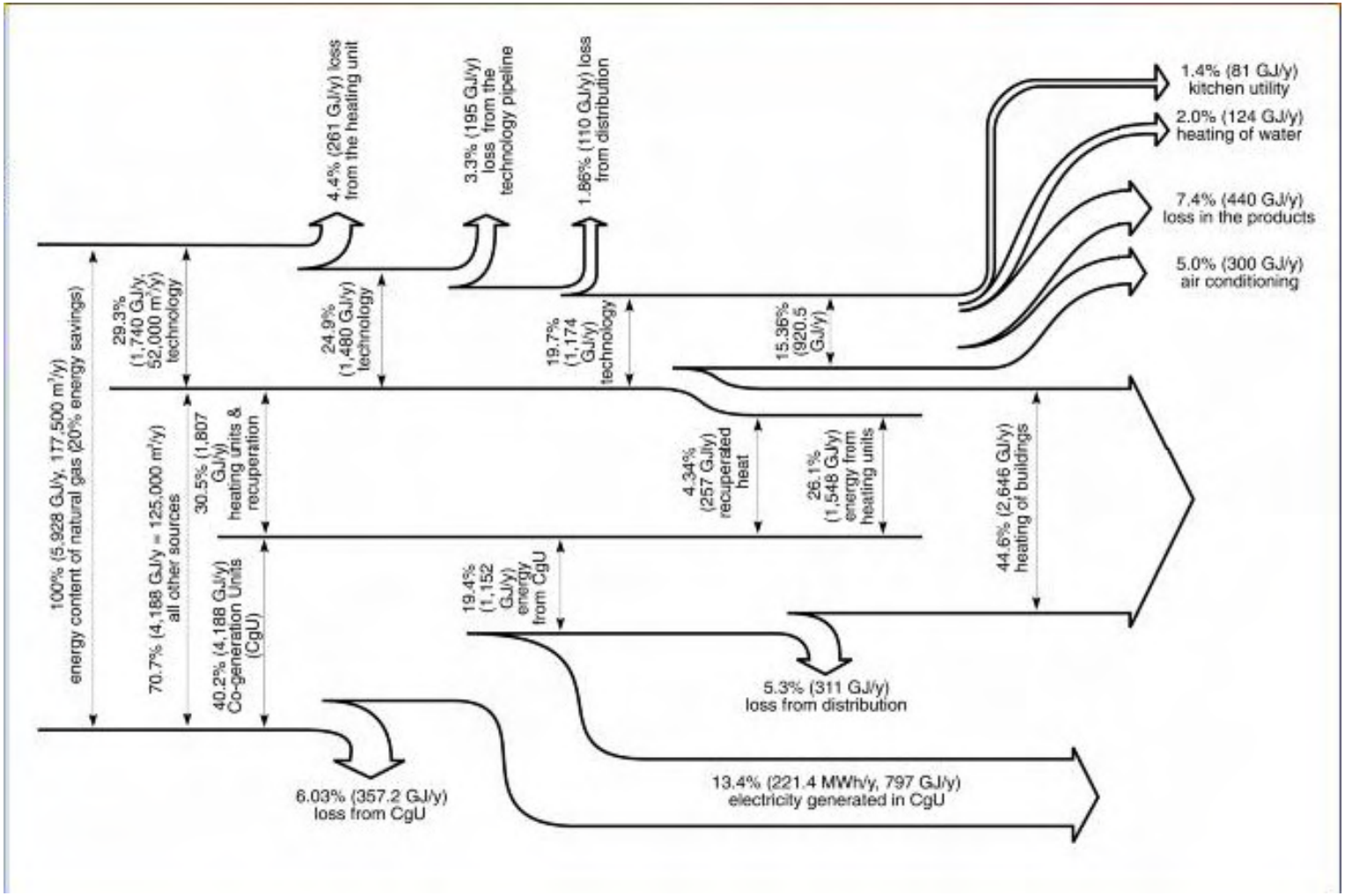
Energy Conservation and Production at Waste Cleanup Sites

Example of Sankey Diagram (De Miclen Levice Slovakia)



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

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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

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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)

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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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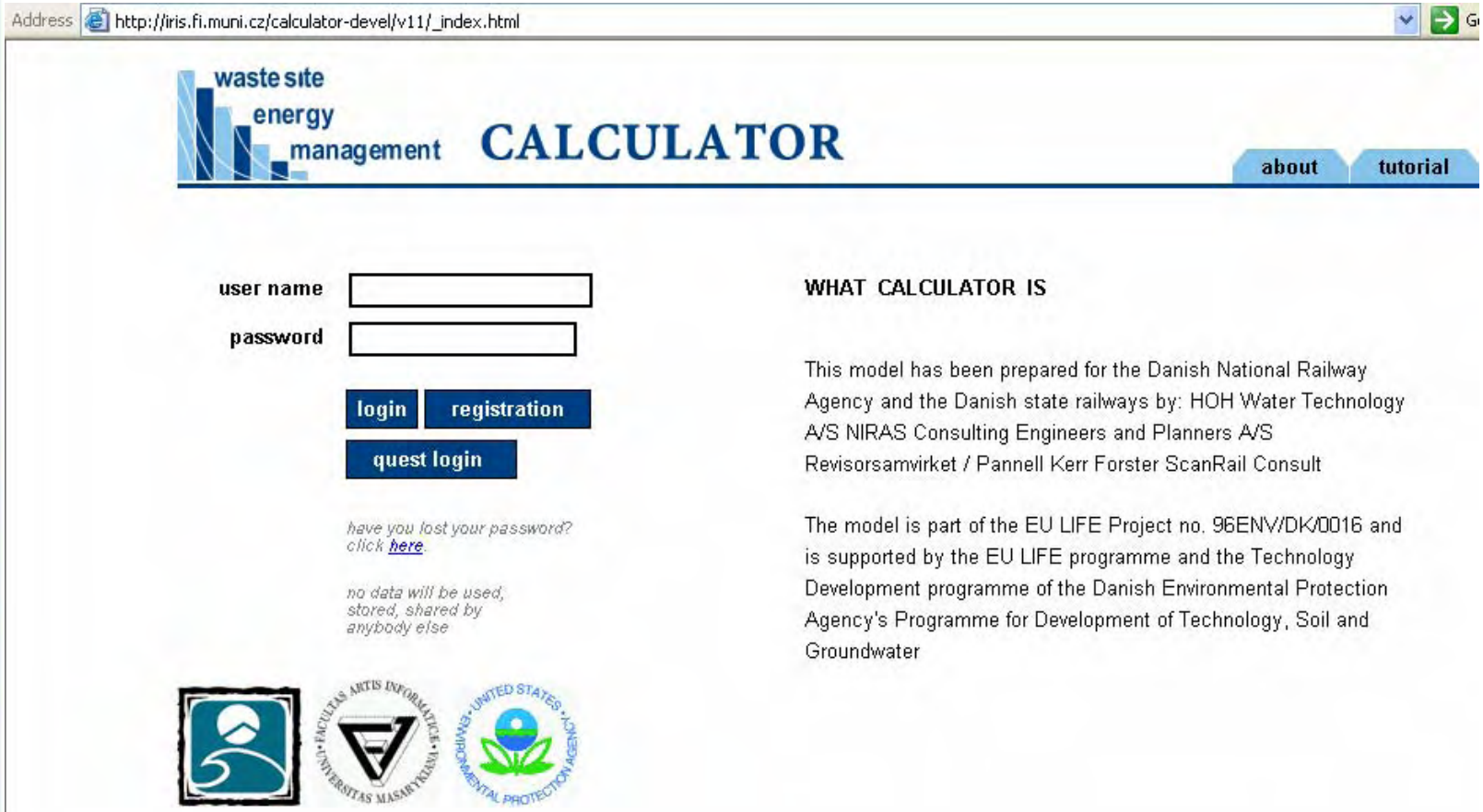
Energy Conservation and Production at Waste Cleanup Sites

Energy Calculator Home Page



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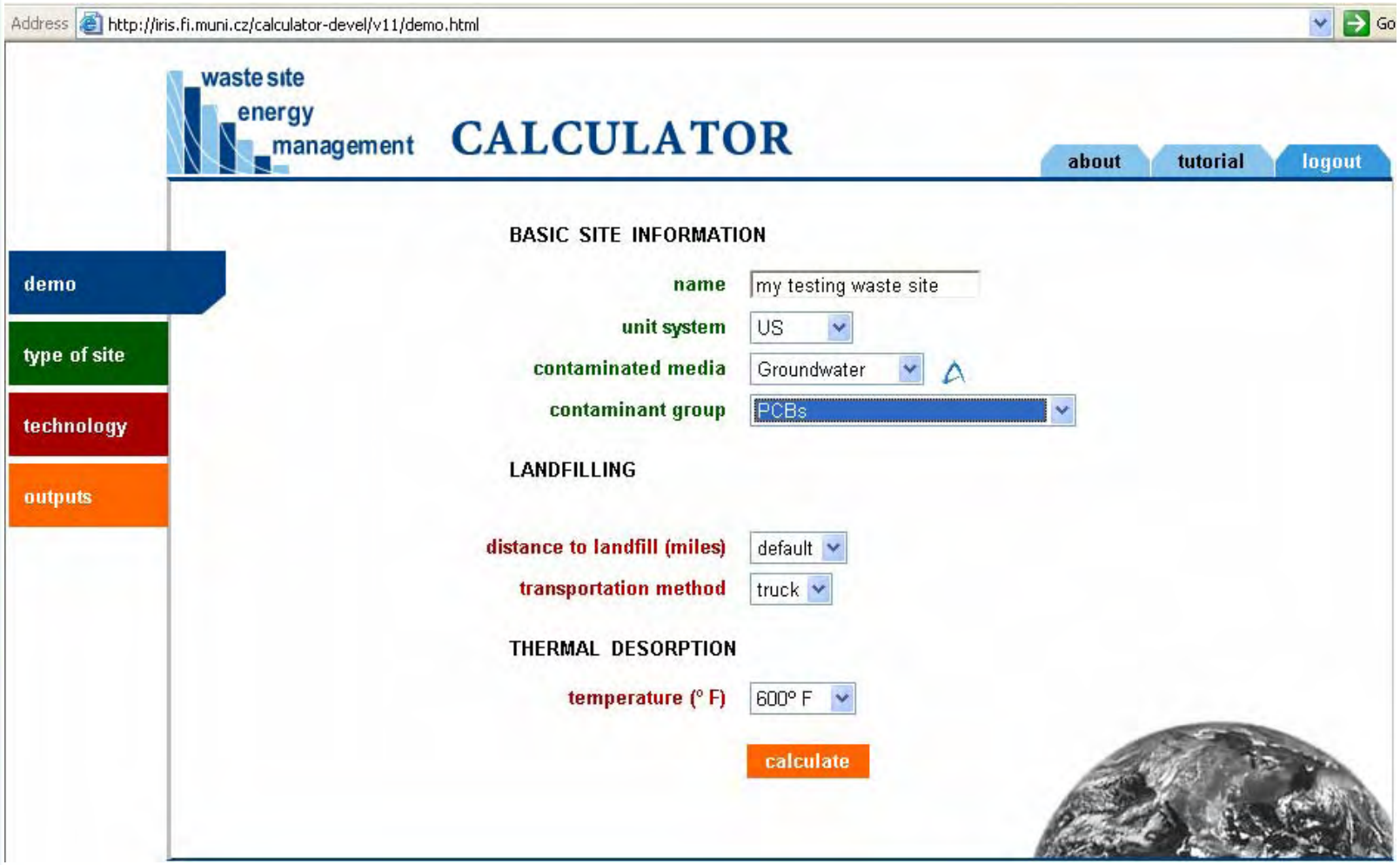
Energy Conservation and Production at Waste Cleanup Sites

Calculator - Demo Entry Screen



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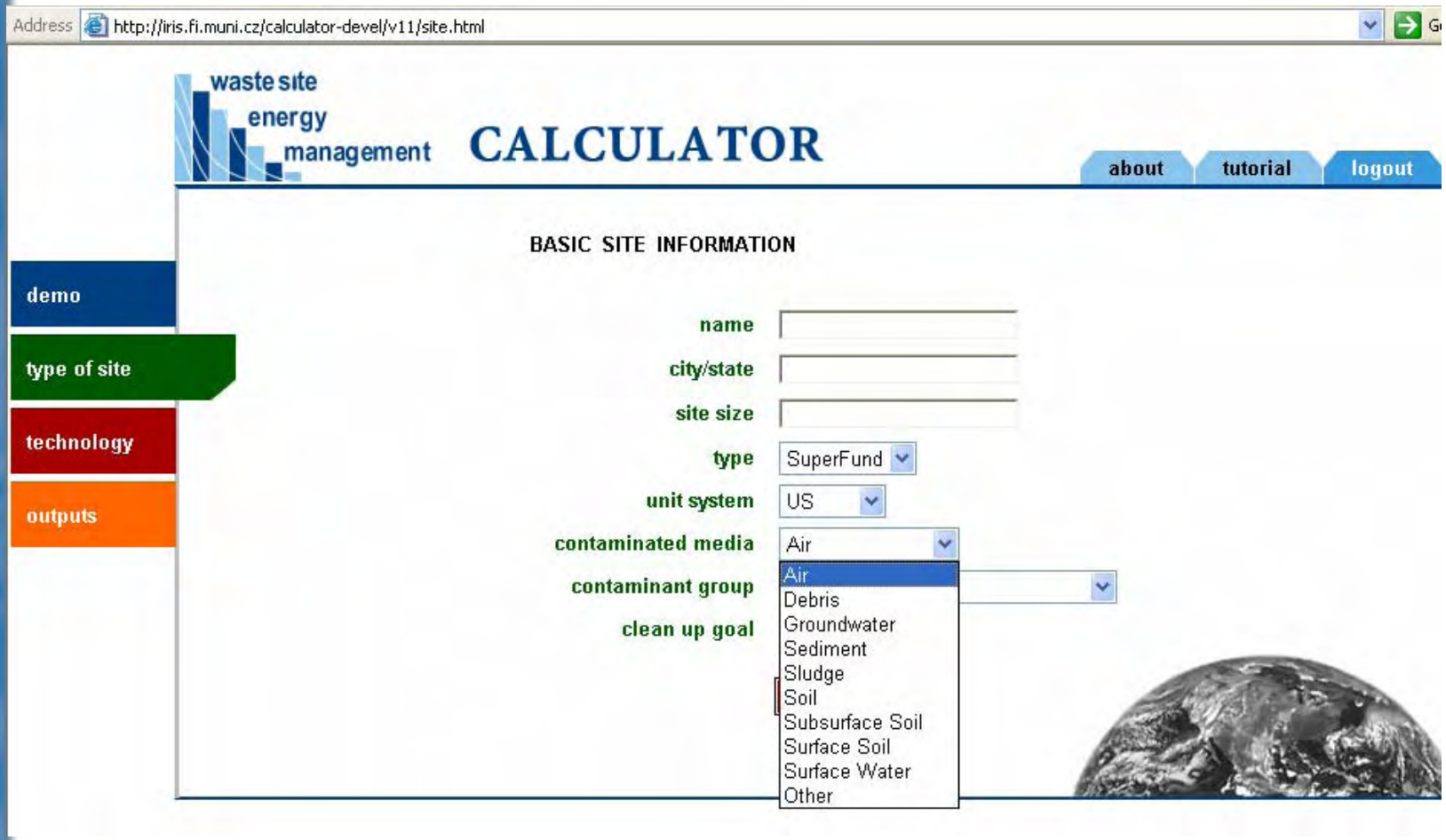
Energy Conservation and Production at Waste Cleanup Sites

Calculator - Selecting Site Parameters



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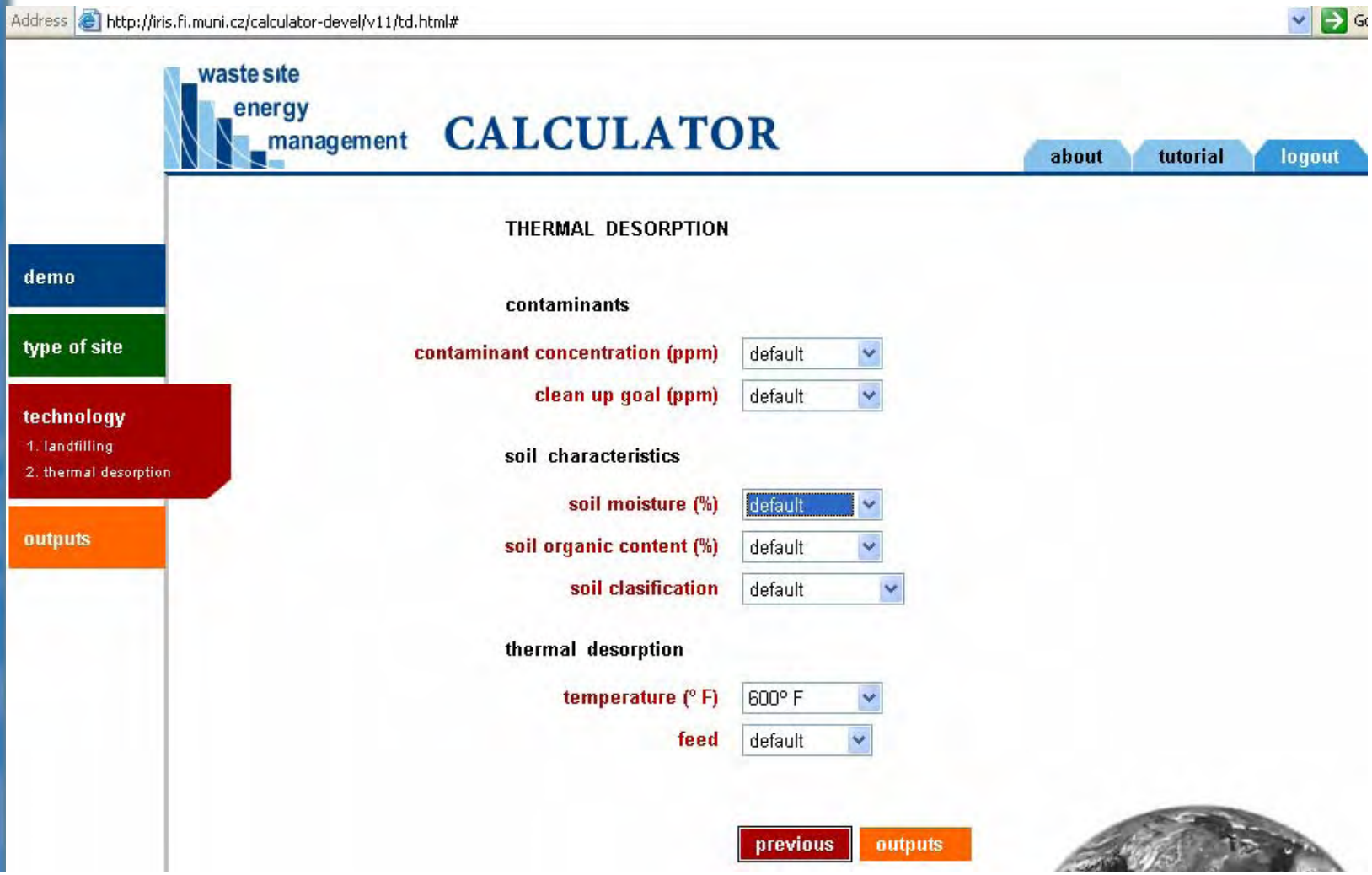
Energy Conservation and Production at Waste Cleanup Sites

Calculator - Thermal Desorption page



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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

  - Idea Conception - Mike Montgomery (Reg 9)
  - Issue Paper Co-author and Calculator Lead - Katarina Mahutova (Reg 10)
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Q&A????