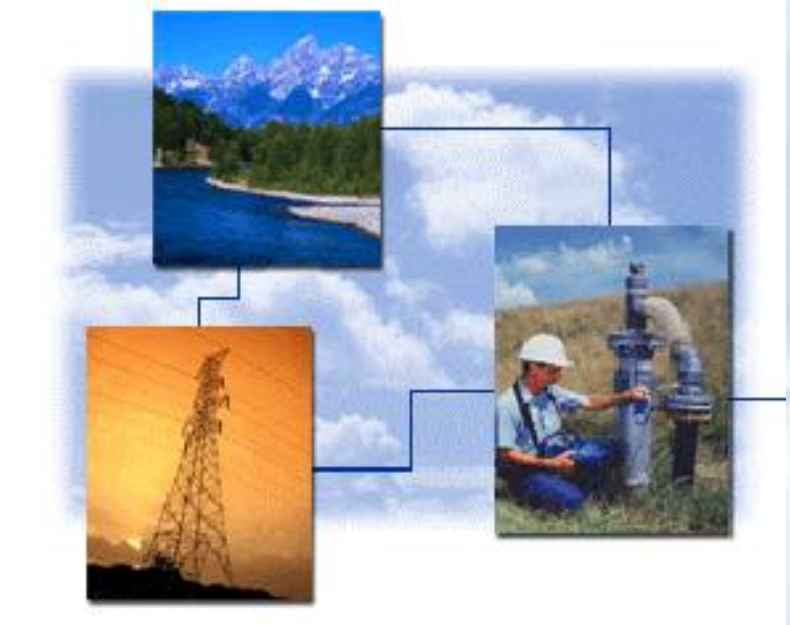
Landfill Gas Energy Potential in the Northwest



Presentation to SWANA 2008 Northwest Regional Solid Waste Symposium

Tom Frankiewicz, Program Manager
U.S. Environmental Protection Agency
Landfill Methane Outreach Program (LMOP)

LANDFILL METHANE OUTREACH PROGRAM

Talking Points

- Methane 101
- LFG Project Cost
- Project Benefits
- Case Studies
- Pacific Northwest Market Assessment
- Partnering with LMOP

EPA's Landfill Methane Outreach Program

- Established in 1994
- Voluntary program that creates alliances among states, energy users/providers, the landfill gas industry, and communities

Mission: To reduce methane emissions by lowering barriers and promoting the development of cost-effective and environmentally beneficial landfill gas energy (LFGE) projects.

Why EPA is Concerned about Landfill Gas

- Why is methane a greenhouse gas?
  - Methane absorbs terrestrial infrared radiation (heat) that would otherwise escape to space (GHG characteristic)
- Methane as GHG is over 20x more potent by weight than CO_2
- Methane is more abundant in the atmosphere now than anytime in the past 400,000 years and 150% higher than in the year 1750
- Landfills were the largest human-made source of methane in the United States in 2005, accounting for 24% generated

Landfill Gas 101

- Landfill gas (LFG) is a by-product of the decomposition of municipal solid waste (MSW):
  - ~50% methane (CH_4)
  - ~50% carbon dioxide (CO_2)
  - <1% non-methane organic compounds (NMOCs)
- For every 1 million tons of MSW:
  - ~0.8 megawatts (MW) of electricity
  - ~432,000 cubic feet per day of LFG
- If uncontrolled, LFG contributes to smog and global warming, and may cause health and safety concerns

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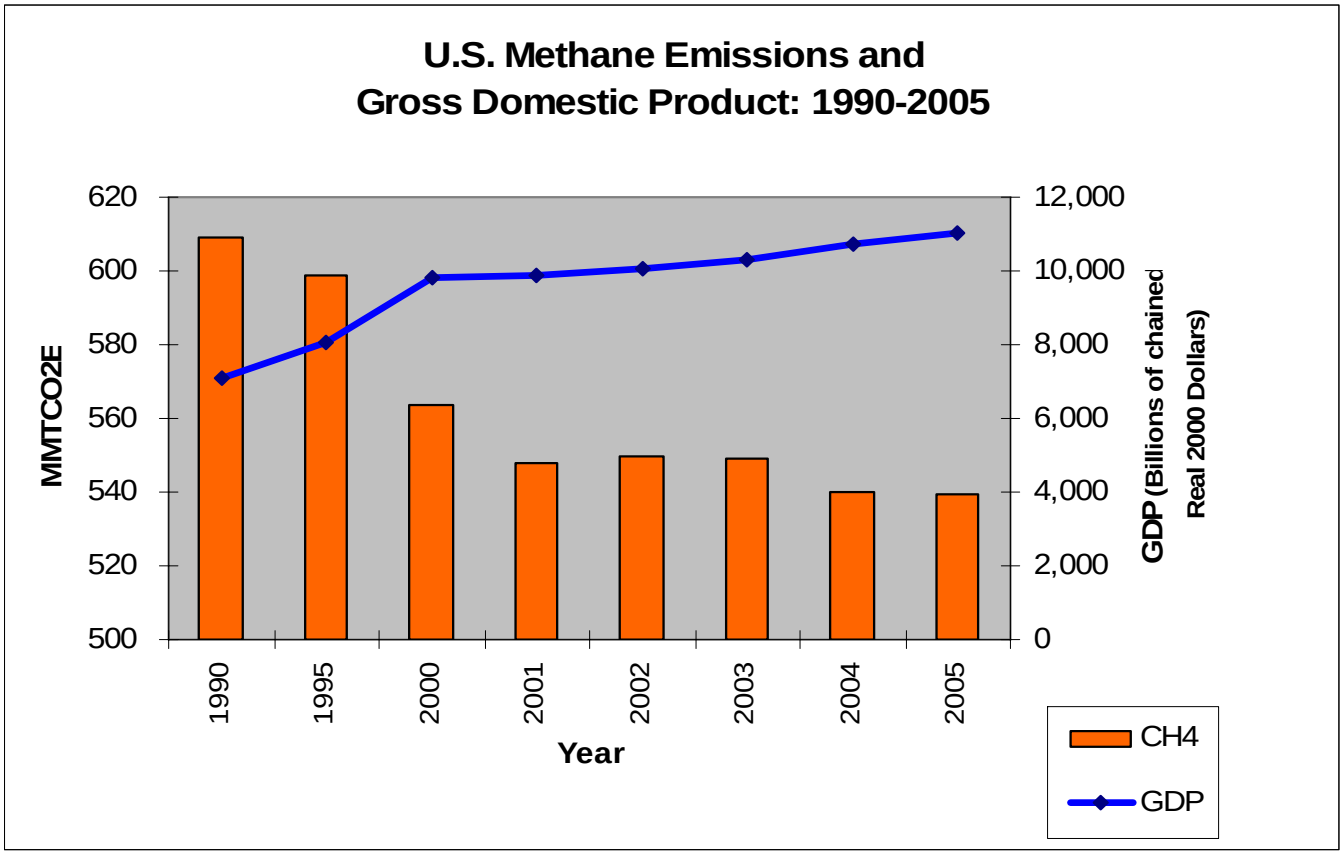
Targeting Methane… Producing Measurable Results

Since 1990, U.S. methane emissions have decreased by over 10% while GDP increased by over 50%



Sources: Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2005, U.S. EPA, April 2007; DOC/Bureau of Economic Analysis. Interactive National Income and Product Accounts Table. Last updated July 2006 (August 17, 2006).

Landfill Gas and Green Power A Winning Combination

- Dual benefit ➔ destroys methane and other organic compounds in LFG
- Offsets use of nonrenewable resources (coal, oil, gas) reducing emissions of
  - SO_2, NO_X, PM, CO_2
- LFG is a recognized renewable energy resource
  - Green-e, EPA Green Power Partnership, 28 states, Sierra Club, NRDC
- LFG is generated 24/7 and projects have online reliability over 90%
- LFG can act as a long-term price and volatility hedge against fossil fuels

LFG Electricity Emission Reduction Benefits
(lb/MWh)

Emission Type	NO_X	SO_2	Mercury
Weighted Average for All LFG Electricity Generating Technologies	2.13	0.17	3.40×10^{-6}
National Grid Average for Emitting Sources	2.83	7.47	35.5×10^{-6}
National Grid Average for All Sources	2.10	5.44	26.9×10^{-6}

Sources: LFG from AP-42; Grid averages from eGRID

Typical Electric Project Components & Costs

- 3 MW engine project for 15 years:
  - Gas compression & treatment, engine, & generator
    - Installed capital cost = ~$3.5 million
  - Annual operation & maintenance
    - Cost = ~$570,000/year
  - Interconnect equipment = ~$260,000
- Total capital cost = ~$3.76 million
- Total annual cost = ~$570,000

Typical Direct-Use Project Components & Costs

- 800 scfm project for 15 years:
  - Gas compression & treatment
    - Installed capital cost = ~$230,000
  - Pipeline
    - Installed capital cost = ~$280,000/mile
  - Annual operation & maintenance
    - Cost = ~$140,000/year
  - End-of-pipe combustion equipment retrofits, if needed
- Total capital cost (5-mile) = ~$1.63 million
- Total annual cost = ~$140,000

Potential LFG Revenue

- Electric projects
  - Sale of electricity (4 - 6 cents/kWh)
  - Sale of Renewable Energy Certificates (RECs)
  - Premium pricing for renewables through RPS/RPG or voluntary green power markets
  - Tax credits & incentives
  - Clean Renewable Energy Bonds (CREBs)
- Direct-use projects
  - Sale of LFG (~$4.50 per MMBtu)
- Both
  - Greenhouse gas emissions trading
  - Energy cost savings

State of the National LFG Industry (Dec '07)

- At least 435 operational projects in 42 states supplying:
  - 10.5 billion kilowatt hours of electricity and 79 billion cubic feet of LFG to direct-use applications in 2007

- *Estimated **Annual** Environmental Benefits*
  - *Planting ~**20,500,000 acres of forest**, or*
  - *Preventing the use of ~**177,000,000 barrels of oil**, or*
  - *Removing emissions equivalent to ~**14,500,000 vehicles***
- *Estimated **Annual** Energy Benefit*
  - *Powering over 810**,000 homes** and heating nearly **547,000 homes***

Diversity of Project Types
Direct Use of LFG

- Direct-use projects are growing!
  - Boiler applications – replace natural gas, coal, fuel oil
  - Combined heat & power (CHP)
  - Direct thermal (dryers, kilns)
  - Natural gas pipeline injection
    - Medium & high Btu
  - Greenhouse
  - Leachate evaporation
  - Vehicle fuel (LNG, CNG)
  - Artist studio
  - Hydroponics
  - Aquaculture (fish farming)

Greenhouse Burlington, NJ

Pottery Studio Sugar Grove, NC

LFG-fired Boiler Ft. Wayne, IN

Emerging Technologies: LFG for Vehicle Fuel

- City of Denton, TX uses LFG to fuel a 3 million gal/yr biodiesel production facility
- Los Angeles, CA converts LFG into CNG to fuel landfill equipment (Puente Hills LF)
- Orange Co, CA – 1st commercial LFG-to-LNG facility online Jan. '07 – used in county waste trucks (Frank R. Bowerman LF)
- Central LF, CA plans to convert LFG to CNG to fuel Sonoma County school buses
- Franklin Co, OH is in the process of using LFG to produce methanol as a feedstock for biodiesel
- Waste Management in CA plans to produce 10-20K gal LNG per day for garbage trucks

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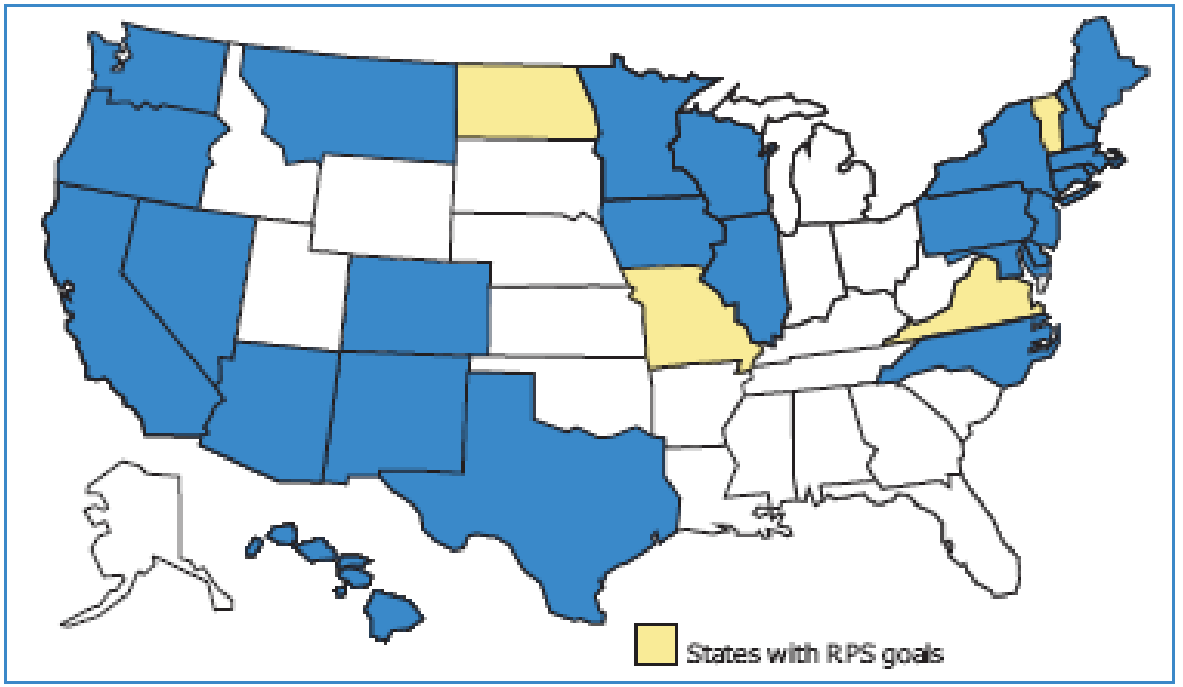
LFG and State Renewable Portfolio Standards



Source: Database of State Incentives for Renewable Energy (DSIRE) last accessed January 2008, www.dsireusa.org.

Public and Private Entities Moving to Reduce GHG Emissions

- Voluntary Markets
  - Currently where most GHG activity occurs
  - Examples - Chicago Climate Exchange, Blue Source, Bilateral Agreements

- Compliance Markets
  - Rapidly evolving, will become the dominant market
  - Led by state and regional efforts

Federal Financial Incentives

- Section 45 Tax Credit
  - Electricity generation – 1.0 cent/kWh
  - Placed in service by 12/31/08
  - 5- or 10-year window for credits depending on placed-in-service date
- Clean Renewable Energy Bonds (CREBs)
  - National allocation of $1.2 billion
  - Current issuance period of 1/1/07 to 12/31/08
  - In 2006, IRS granted issuance of 36 bonds for LFGE projects
- Renewable Energy Production Incentive (REPI)
  - Local/state government or non-profit electric co-op facilities
  - Online by 10/1/16
  - Payment for first 10 years of operation


Honeywell
NUCOR
HILL AIR FORCE BASE, Utah
OGDEN AIR LOGISTICS CENTER
DART
CYTEC
Rolls-Royce
SENECA Foods.com
"A World Leader In Agribusiness"
Owens Corning
Cargill
Ford
The Ultimate Driving Machine
The Solae Company
Frito Lay
GM
LAFARGE
Look Who's Using Landfill Gas!
Jenkins Brick Company
AJINOMOTO
CONE
corporatedenimfinishingjacquards
Nestlé
Makes the Very Best
INTERNATIONAL PAPER
From innovation to results.
INTERFACE
NASA
MALLINCKRODT
DUPONT
The miracles of science
Lucent Technologies
Bell Labs Innovations
SUNOCO
SC Johnson
CHRYSLER
TURKEY HILL

Electricity Case Study

Coffin Butte Landfill Corvallis, Oregon

- The Coffin Butte Landfill LFGE facility
  - 2007 expansion project from 2.4 MWs to 5.66 MWs
  - Expansion project removes emissions equivalent of:
    - 3,200 vehicles,
    - 38,000 barrels of oil, or
    - Planting 4,500 acres of forest

LANDFILL METHANE OUTREACH PROGRAM

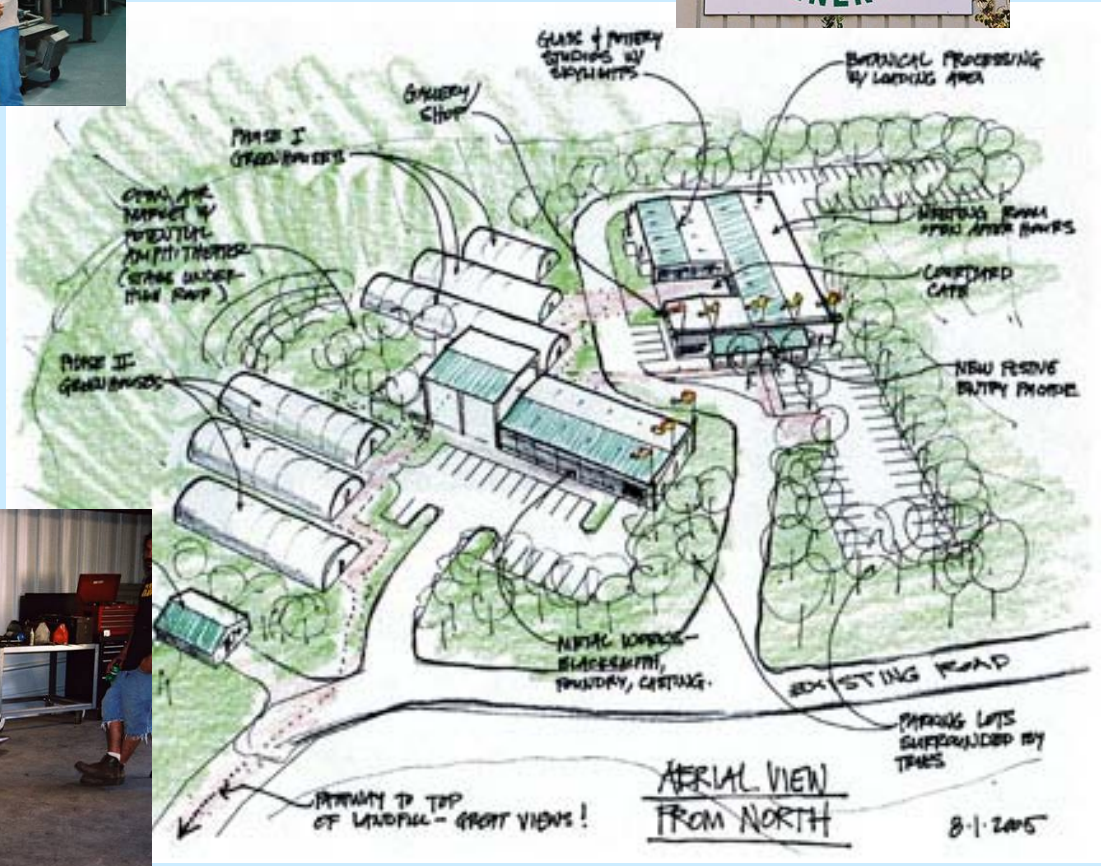
Direct-Use Case Study

Jackson County Green Energy Park

Sylva, NC

JACKSON COUNTY GREEN ENERGY PARK
Biofuels

LMOP
2006
Project of the Year



Many Untapped LFG Resources

- Currently ~550 candidate landfills with a total gas generation potential of 245 billion cubic feet per year (~14,000 MMBtu/hr) OR electric potential of 1,300 MW (~10 million MWh/yr)
- If projects were developed at all these landfills, estimated
  - **Annual** Environmental Benefit =

    Planting ~15.2 million acres of forest OR removing the emissions from ~10.7 million vehicles on the road, AND
  - **Annual** Energy Benefit =

    Powering 825,000 homes OR heating 1.5 million homes per year

Development Potential in the Pacific Northwest

At least 13 candidate sites can generate approximately 37 MW, equivalent to:

- removing 325,202 cars from Oregon's and Washington's roads
- planting 463,000 acres of trees

State of LFGE in Washington

- 54 Landfills in the state
- 7 Operational Projects at 6 Landfills
  - 2 direct use projects, generating 0.24 mmBtus/hr
  - 5 electricity projects, generating 32.2 MWs
- 2 Under Construction Projects
  - 1 electricity, 17 MW potential
  - 1 direct use, 630 scfm (19 mmBtu/hr) potential
- 8 Candidate Landfills
  - 15 MW potential
  - 82,092 tons of potential CO_2 emission reductions

State of LFGE in Oregon

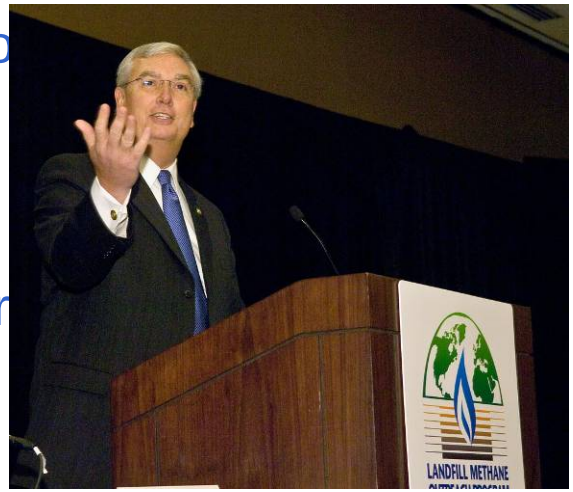
- 15 Landfills in the state
- 7 Operational Projects at 5 Landfills
  - 2 direct use projects, generating 31.6 mmBtu/hr
  - 5 electricity projects, generating 12 MWs
- 5 Candidate Landfills
  - 22 MW potential
  - 124,402 tons of potential CO_2 emission reductions

How Can We Work Together? Direct Project Assistance

- Analyze landfill resource – gas modeling
- Identify potential matches – *LMOP Locator*
- Assess landfill and end user facilities
- Look at project possibilities
  - Direct-use (boiler, heating, cooling, direct thermal)
  - Combined Heat & Power (engine, turbine, microturbine)
  - Electric (engine, turbine, microturbine)
  - Alternative Fuels (medium or high Btu, LNG, CNG)
- Initial feasibility analyses – *LFGcost*

LMOP Tools and Services

- Network of 700+ Partners (and growing)
- Newsletter and listserv
- Direct project assistance
- Technical and outreach publicatio
- Project and candidate landfill database
- Web site (epa.gov/lmop)
- Support for ribbon cuttings/ other PR
- Presentations at conferences
- State training workshops
- ***LMOP 12th Annual Conference, Project Expo & Partner Awards – January 13th & 14th in Baltimore***



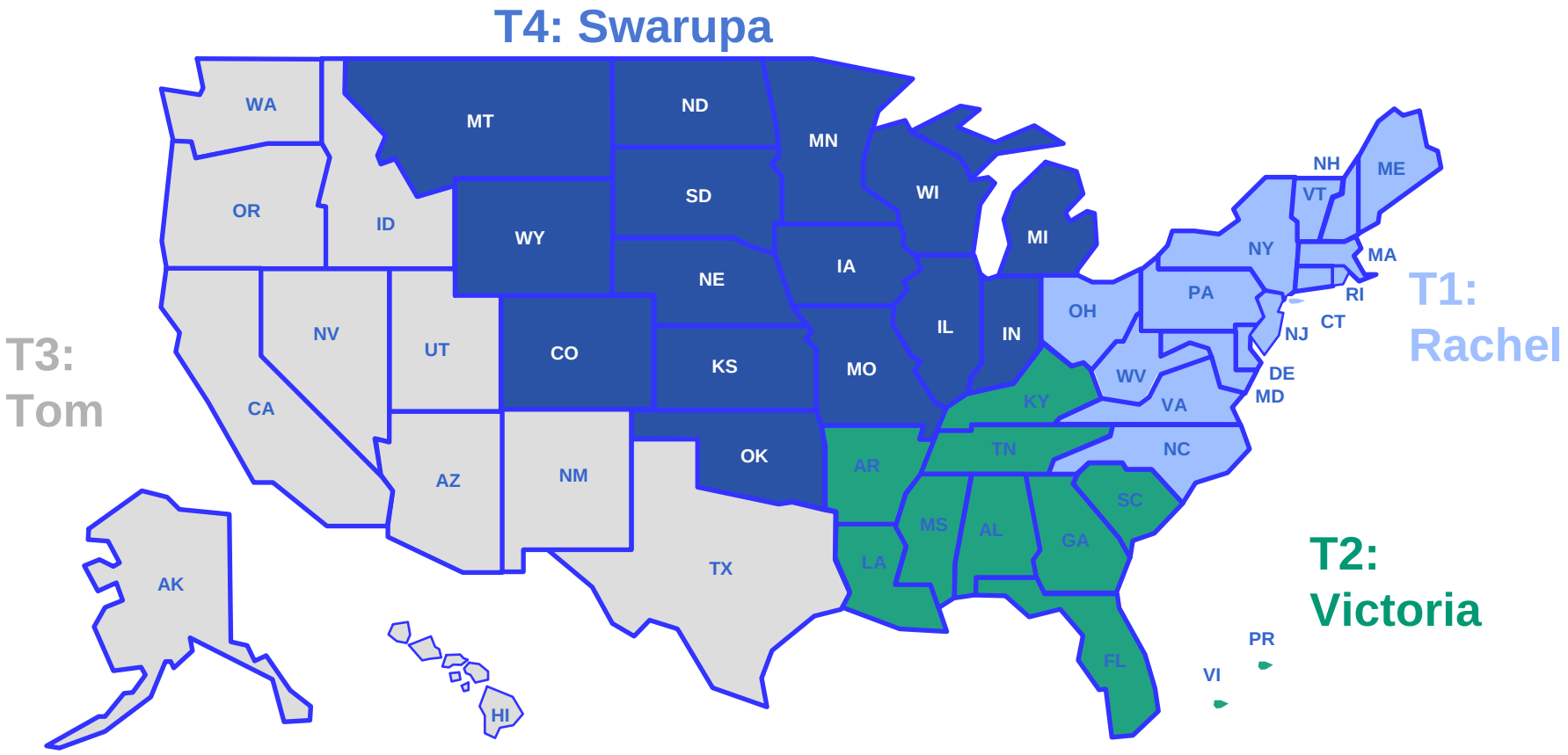
EPA Administrator
Stephen L. Johnson

Keynote Speaker
11th Annual LMOP Conference
Washington, DC

January 9, 2008

For More Information

www.epa.gov/lmop



Tom Frankiewicz
frankiewicz.thomas@epa.gov, (202) 343-9232

Rachel Goldstein
goldstein.rachel@epa.gov, (202) 343-9391

Victoria Ludwig
ludwig.victoria@epa.gov, (202) 343-9291

Swarupa Ganguli
ganguli.swarupa@epa.gov, (202) 343-9732