Introduction to Landfill Gas Use and the U.S. Landfill Gas Industry

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Landfill Methane Outreach Program (LMOP)

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Training Workshop

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Presentation Outline

- Global Waste Management Trends
- Overview of Landfill Gas
- Benefits of Utilizing Landfill Gas
- US Policies and Programs Affecting the Landfill Gas Industry
- Future of the LFG industry
- The US EPA's Landfill Methane Outreach Program

Global Waste Management Trends…

- Global Trends
  - Increase in per capita waste generation rates
  - Increase in total waste quantities

… and problems

- Lack of waste collection and management infrastructure
- Lack of available and suitable disposal facilities
- Lack of basic information on solid waste

Impacts of Increasing Waste

- Human Health
  - Disease
  - Fumes
- Environment
  - Air Quality
  - Water Quality
  - Land Use
  - Vegetative Distress

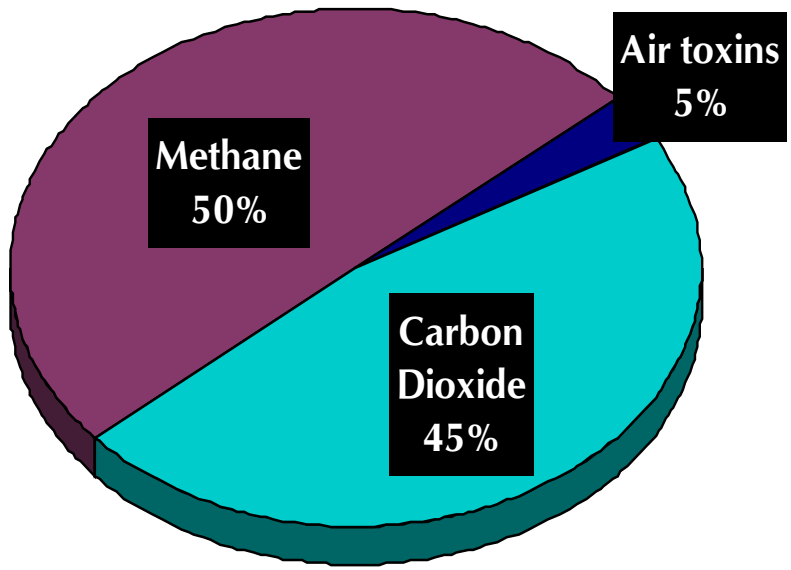
Solutions for Dealing with Waste

- Integrated Solid Waste Management
  - Reduce waste produced
  - Reuse/Recycle
  - Determine Disposal Methods
    - Landfilling
    - Composting
    - Other

  - Be aware: creating managed landfill sites will increase landfill gas emissions

What is Landfill Gas?

- **Landfill Gas (LFG) is created when waste in a landfill decomposes under anaerobic -- or oxygen free -- conditions**
- **LFG is approximately:**
  - **50% methane**
  - **45% carbon dioxide**
  - **5% Non-methane Organic Compounds (NMOCs)**

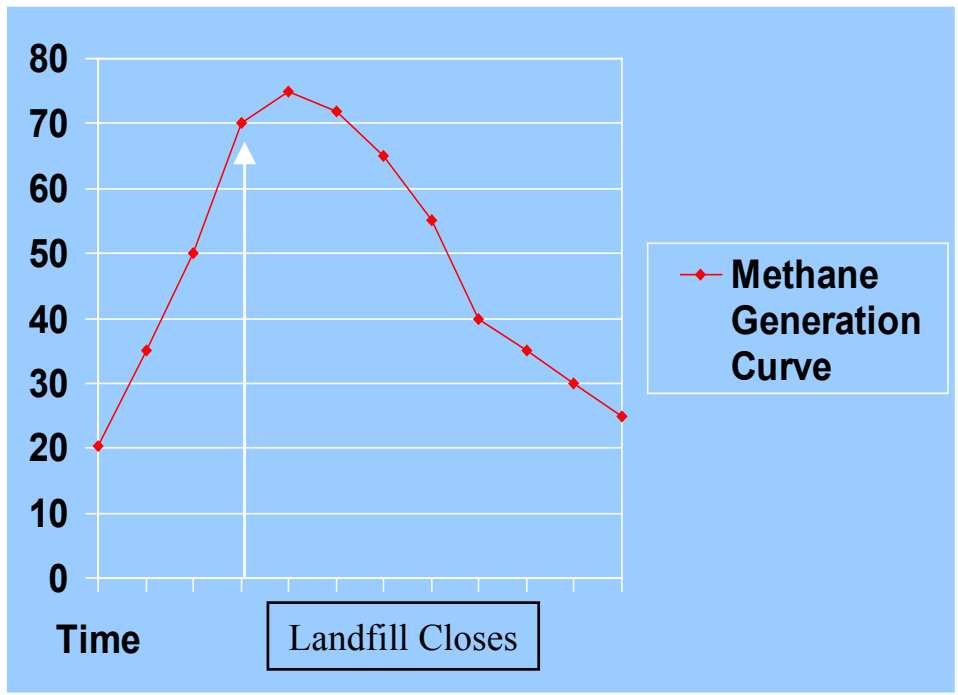


Uncontrolled Landfill Gas Concerns

- Safety
  - Fire
  - Explosion
  - Asphyxiation
- Air Quality
  - NMOC emissions contribute to smog
  - Odor
  - Greenhouse gas emissions

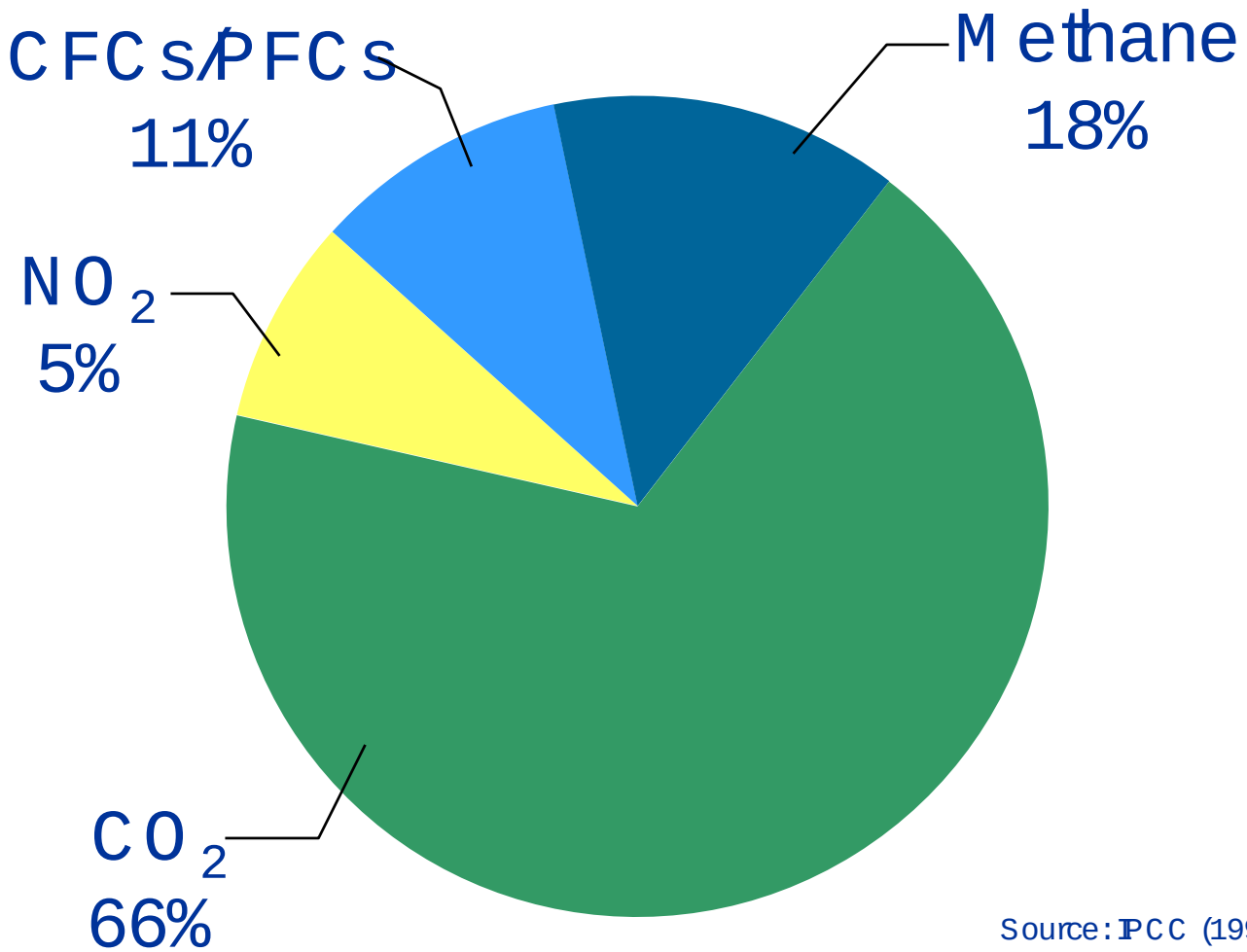
Landfill Gas Generation

- Generated for years, depending on certain factors:
  - waste composition
  - waste quantity
  - moisture content
  - pH
  - management of waste
  - others



- After a landfill stops receiving waste, methane generation will decline

Climate Change: Contributing Gases



Source: IPCC (1990)

Why Reduce LFG Emissions

- Using landfill gas reduces emissions of methane, a potent green house gas, and benefits the environment
- Methane is 21 times more potent than carbon dioxide (CO_2)
- Global emissions will increase as developing countries improve landfilling practices

Ways to Reduce Landfill Gas Emissions

- Flaring
- Using Landfill Gas for Energy
- Landfill Gas, when used for energy, actually removes pollution from the air

What can you do with Landfill LG as?

- **Landfill Gas Uses**
  - Electric generation
  - Direct use
  - Emerging technologies
    - Greenhouses
    - Vehicle Fuel
    - Microturbines
    - High Btu Upgrades
    - Leachate Treatment
    - On-site uses

Environmental and Economic Benefits of Using Landfill Gas

- Reduce air toxins which contribute to local air pollution
- Improve overall management of the landfill site
  - Reduce Odor
  - Reduce explosions and fires at the landfill
  - Improve safety in the surrounding areas
- Lower emissions from displacing coal or oil
- Revenue may be generated from the sale of the gas
- Source of "Renewable" or "Green" Energy
- Projects are able to be replicated internationally

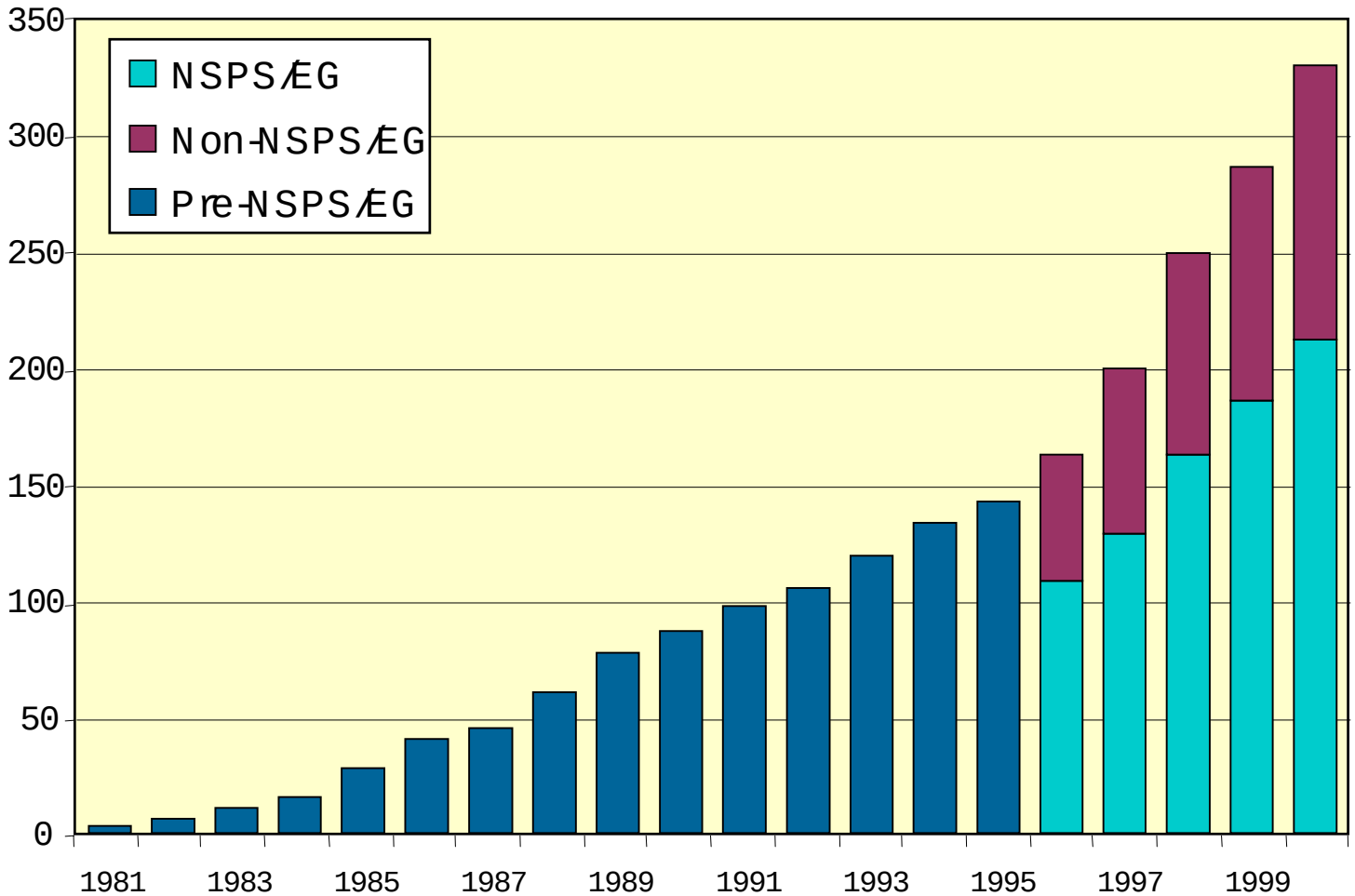
State of the US Landfill Gas Industry

- LFG project development started in the US in the 1970s
  - 86 operational projects in 1990
  - 142 operational in 1995
- The LFG Industry is thriving
  - 330 Operational Projects
  - 57 Projects Under Construction
  - 153 Planned Projects
- Great potential for future project development
  - Approximately 550 landfills could economically develop a landfill gas recovery project

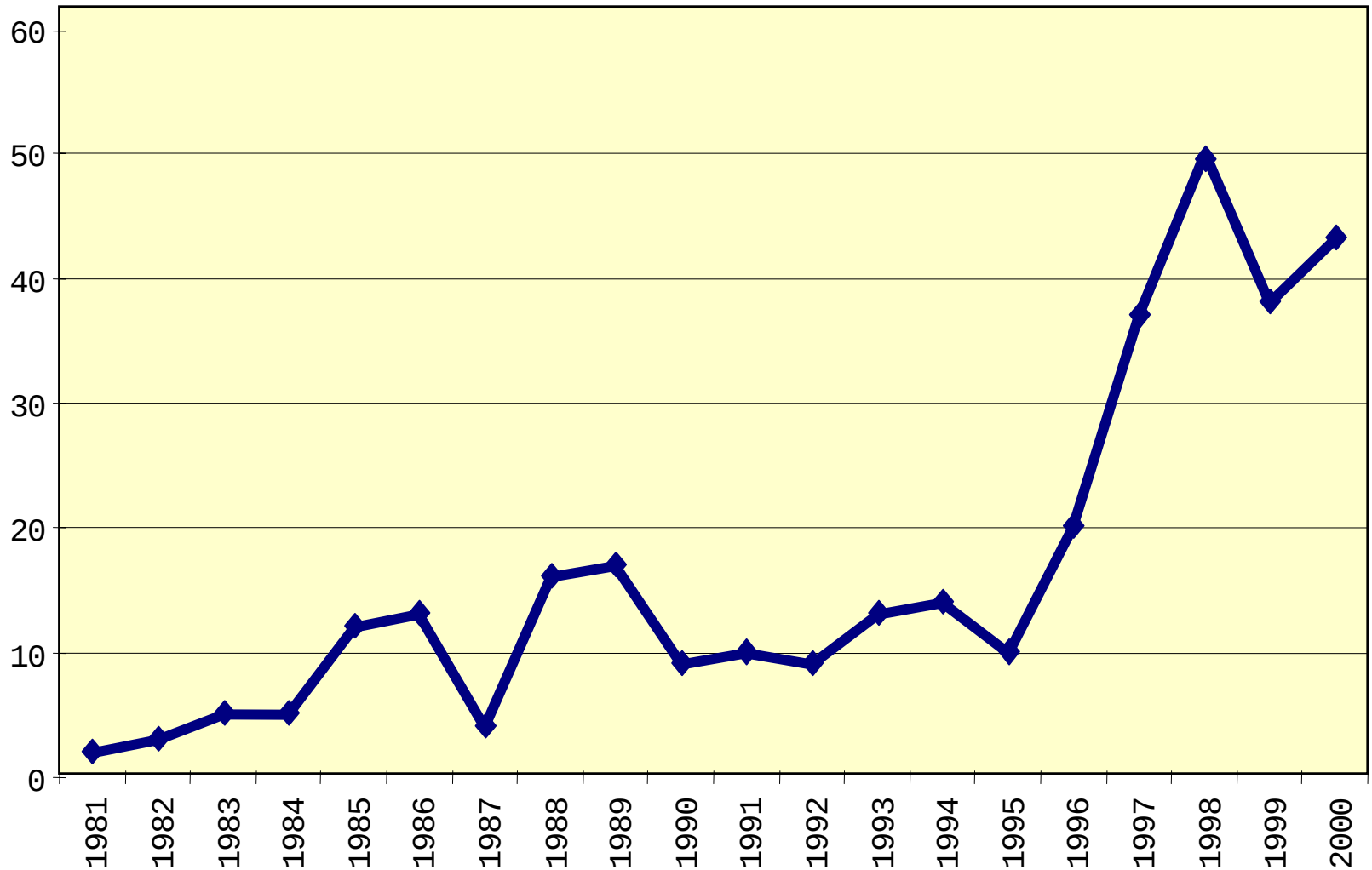
State of the US Landfill Gas Industry

- The industry has thrived since 1990
- If all planned projects move forward, the LMOP expects
  - 410-430 operational projects by 2002
  - 480-500 operational projects by 2005

Growth in LFG Utilization Projects in the US



New LFG Projects Per Year in the US



Technology Trends at US Landfill Gas Projects

Utilization Technology	Operating Projects		Projects Under Construction		Planned Projects	
	Count	Capacity (MW)	Count	Capacity (MW)	Count	Capacity (MW)
Reciprocating Engine	173	536	35	118	58	168
Gas Turbine	27	157	1	15	-	-
Steam Turbine	8	125	-	-	-	-
Combined Cycle	6	67	-	-	-	-
Cogeneration	2	8	-	-	1	1
Fuel Cell	1	<1	-	-	-	-
Microturbine	1	<1	-	-	-	-
TOTALS	218	893	36	133	59	169

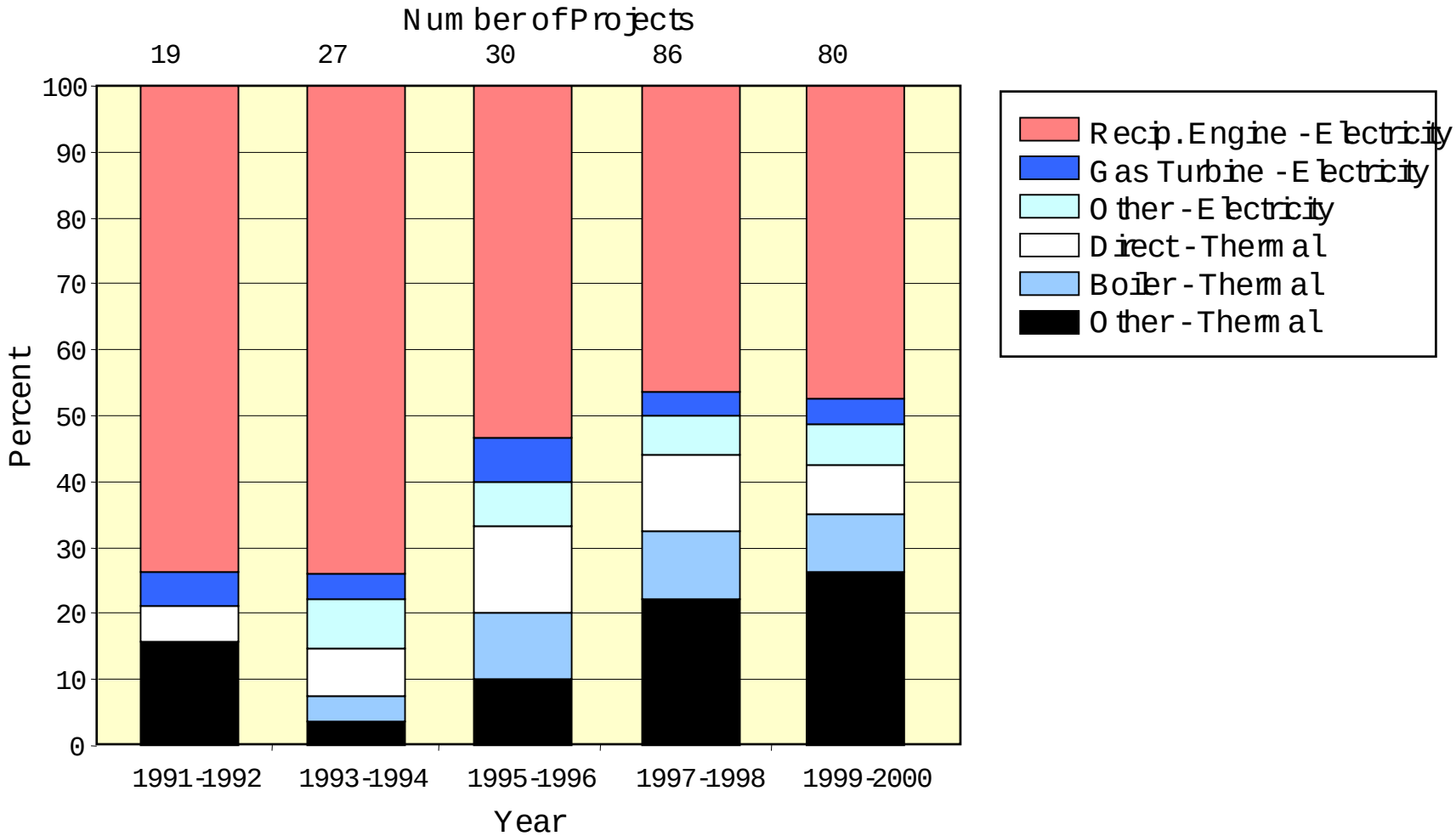
- Currently 2/3 of operational project generate electricity
- Operation projects represent almost 900 MW
- Potential for 95 projects

Technology Trends at U.S. Landfill Gas Projects

- Trend toward more direct-use projects
  - 21 operational in 1990
  - 112 operational in 2001
  - Projects slated to double to 225

Utilization Technology	Operating Projects	Projects Under Construction	Planned Projects
Direct Thermal	31	7	26
Boiler	26	1	5
Leachate Evaporation	19	3	4
High Btu	15	6	7
Medium Btu	9	3	2
Greenhouse	5	-	4
Liquefied Natural Gas	1	-	-
Vehicle Fuel	1	-	1
Methanol Synthesis	-	-	1
Unknown	5	1	44
TOTALS	112	21	94

Technology Trends: 1991 Through 2000



Summary of Technology Trends

- Growth in Direct Use Projects
- Greater Diversity in Project Types
- LFG utilization is proven, cost effective, and successful
- Selection of technology is site specific
- Technologies exist for low and high volumes of LFG production
- Niche technologies are gaining popularity, but are slow to emerge

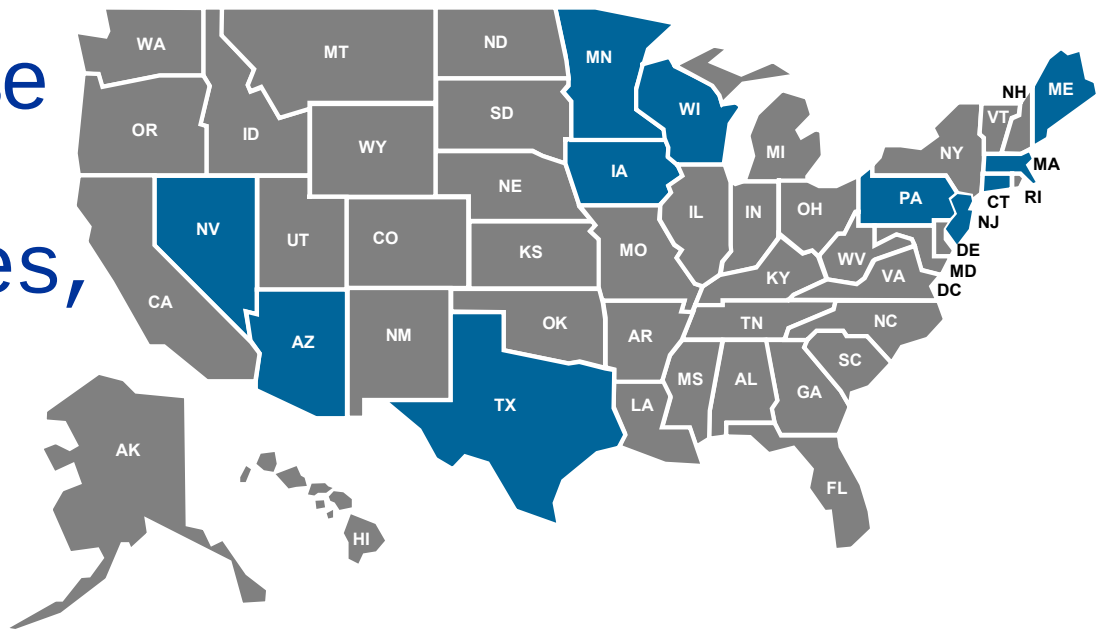
Trends Affecting the US Landfill Gas Industry

Energy Supply

- The current US energy situation is likely to increase the competitiveness of LFG
  - Recent energy shortages
  - Rising natural gas prices
  - Growing awareness that renewable energy could be an economically viable alternative to conventional fuel

Utility Restructuring

- 11 restructured states include renewable portfolio standards (RPS) as part of their power portfolio
- RPS may increase demand for renewable sources, including LFG
- Texas: 2000 MW by 2009
- Reliant: 44 MW



Green Power/Green Pricing

- A recognized renewable resource
- Among the most cost-competitive of renewable resource options
- Green pricing opportunities
  - At least 80 utilities have developed or plan to develop green pricing programs
  - Customers are willing to pay for green power

Alternative Financing Options

- New state/local economic incentives have emerged to help offset project costs
  - Grants
  - Low-interest loans
  - Tax credits
- Project partners have diversified their funding sources and rely less on direct project revenues
- Some federal program are still offering grants/loans

Emissions Credits

- In the US, projects are reporting emissions reductions from their projects
  - create record of reductions
  - prepare for trading possibilities
- International Trades for Emissions Reductions Credits
  - ZAPCO/Ontario Power
  - New Jersey/Netherlands

Innovative Ideas

- Renewable energy parks
  - LFG developers considering the co-locating PV panels, fuelcells, and wind turbines at landfills

Photos courtesy of NREL

Innovative Ideas

- New technologies and applications make landfill gas projects at smaller landfills more feasible
  - Microturbines
  - Greenhouses

Greenhouse
Burlington, NJ

Microturbine
Courtesy of Capstone Microturbines

Innovative Ideas

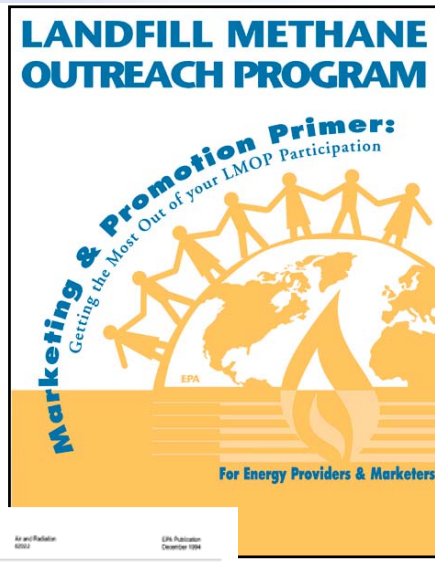
- Project Efficiency
  - Examine ways to extract gas more effectively from the landfill
  - More gas extraction, greater profits
    - Additional wells
    - Replacing wells
    - Well cleaning

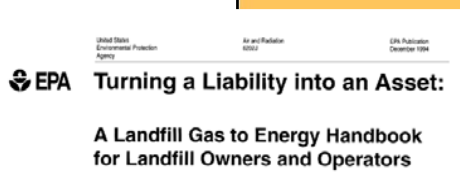
The US EPA's Landfill Methane Outreach Program

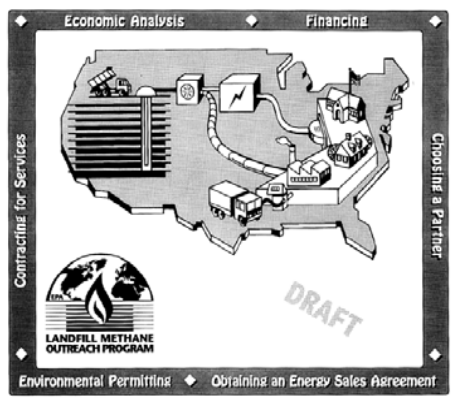
- What is the LMOP?
  - Voluntary Partnership Program
- What do we do?
  - Help overcome barriers to project development
  - Work hand-in-hand with regulations
  - Provide products and services
  - Create partnership and networking opportunities

Let the LMOP Help

- **Technical information**
  - **Project Development Handbook**
  - **Technical Fact Sheets**
- **Technical Assistance**
  - **Assistance tailored to individual landfill needs**
- **Networking Opportunities**
  - **Workshops**
  - **Newsletters**
- **Marketing Assistance**







Domestic Activities

- LMOP assisted in development of over 170 LFGTE projects
- Currently LFGTE projects have prevented methane emission equivalent to:
  - Planting 3 million acres of forest
  - Removing 2 million cars from the road

International Activities

- Bangkok, Thailand
- Manila, the Philippines
- Anshan, China
- Other Countries
  - Mexico
  - Russia
  - Brazil

International Assistance

- **Three types of Support:**
  - **Training and on-site technical support:**
    - **Assist with project identification, assessment, design, end-user identification, and development**
  - **Financing:**
    - **Work with international agencies and the private sector to locate appropriate financing**
  - **Outreach:**
    - **Work with project partners to communicate project benefits on local and national levels**

Contact Information

- **Shelley Cohen**
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- **5th Annual LMOP Conference & Project Expo**

  -- December 12-14, 2001

  -- Washington, DC

  Watch the web site for more information
  www.epa.gov/lmop