DOE Natural Gas Infrastructure Reliability

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Strategic Center for Natural Gas

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National Energy Technology Laboratory

- One of DOE’s 17 national labs
- Government owned/operated
- Sites in Pennsylvania, West Virginia, Oklahoma, Alaska
- More than 1,100 federal and support contractor employees
- FY 03 budget of $750 million
Fossil Fuels Today

- Provide 85% of U.S. energy
- Will provide 87% of U.S. energy in 2020
- Supply should last throughout this century
- Infrastructure to deliver at low cost

![Graph showing energy consumption from 1950 to 2000, indicating 85% of energy supply is fossil fuels.](EIA, AER Interactive Data Query System)
Energy Sector R&D Investments Low

- Drugs / Medicine
- Professional / Scientific Instruments
- Communication Equipment
- Services
- Transportation Equipment
- Industrial Chemicals
- Stone / Clay / Glass Products
- Primary Metals
- Energy

Energy Industry Invests < 0.5% of Sales


Strategic Center for Natural Gas
Gas Infrastructure Reliability

- Transmission, distribution, storage & LNG
- Program goals:
  - Maintain/enhance system reliability and integrity
  - Increase gas deliverability
  - Reduce environmental impact
  - Address gas & electric interdependencies
  - Develop technology for future gas delivery system
  - Support infrastructure security
- Budget: FY04
  - $2 million storage technology
  - $7 million infrastructure reliability
Program Summary

- 63 current active projects
- 26 completed projects
- Total program value > $47 million
- Several projects near hand-off phase
- Industry supported field tests necessary
- Commercialization path still difficult
- Industry involvement required
Infrastructure Activities

Interagency Workshop
March 22 & 23, 2000 Washington, DC
DOE, DOT, FERC, EPA, DOI

Visioning Workshop
May 3, 2000 Pittsburgh, PA
15 industry executives

Roadmapping Workshop
June 6 & 7, 2000 St. Louis, MO
40 industry experts

Roadmap Update Workshop
January 29 & 30, 2002 Pittsburgh, PA
40 industry experts

Industry Forum
September 16 & 17, 2002
Morgantown, WV
100 attendees

Workshop Goals
Elicit stakeholder input
- Vision
- Technology needs & opportunities
Determine government role

Gas Storage Workshop
November 29, 2001
Pittsburgh, PA
50 industry experts

GTI/PRCI Storage Committee
Bi-annual meetings
20 industry experts

Strategic Center for Natural Gas
Natural Gas Industry Background

- 410 storage fields
- 500 bcf of LNG imports for 2003
- 270,000 miles of transmission pipelines*
- 952,000 miles of distribution pipelines*
- $8 billion/yr investment in infrastructure*
- Energy companies dominating the industry
- R&D viewed as expense, not investment
- FERC-funded R&D loss
- Security difficult with dispersed assets

*NPC Report, December 1999
Core R&D Areas & Issues

- **Inspection Technologies**
  - Robotic platforms
  - Sensors
  - Pigs
  - Automation

- **Remote Sensing**
  - 3rd party damage
  - Underground imaging
  - Leak detection

- **Materials**
  - Repair
  - Smart Pipe
  - Liners

- **Operational Technologies**
  - Compressors
  - Modeling
  - Corrosion

- **Deliverability enhancement and reservoir management**
  - Storage well deliverability
  - Storage resource efficiency

- **Metering and Measurement**
  - Accuracy and real-time measurement of both gas volume and energy content

- **Advanced Storage Concepts**
  - Storage alternatives

- **LNG**
  - Education
  - Safety
  - Transportation/storage

*Strategic Center for Natural Gas*
Implementation Strategy

- Focus on high risk, innovation, and leap frog technologies
- Strong industry participation
  - Input to R&D priorities
  - Feedback on program & project status
  - Collaborations & cost sharing
- Balanced R&D program
  - Distribution, transmission, & storage
- Most funding dedicated to private sector projects
- National laboratory efforts focused on innovation
- Some quick wins to demonstrate progress
Conformable Array for Mapping Corrosion Profiles
Southwest Research Institute

**Description:** A simple, rugged, low cost device that can be used to quickly map the corroded surface of a pipe, without cleaning of the pipe surface. The device will use eddy current sensing coils in a conformable array that can be wrapped around the pipe surface.

**Schedule/Status:**
- Start Date: 8/1/01
- End Date: 9/30/03
(2 Projects)

**Partners:** Clock Spring Inc.
Innovative Sensors for Pipeline Crawlers to Assess Pipeline Defects and Conditions
Battelle

Description: The project will design and develop Remote Field Eddy Current Sensors to detect internal and external pipeline corrosion. The last phase of the work will attempt to integrate these sensors with autonomous robotic platforms.

Schedule/Status:
– Start Date: 9/30/03
– End Date: 9/29/06

Partners: Platform developer - TBD
New Acoustic Wave Pipe Inspection System
Oak Ridge National Laboratory

Description: This project will develop and demonstrate a new waveguide pipe flaw detection technique that has the potential to detect pipeline flaws in a single pass at speeds of approximately 2 miles per hour.

Schedule/Status:
- Start Date: 8/13/01
- End Date: 12/31/04
Ultrasonic Measurements of Plastic Strain in Pipelines
Pacific Northwest National Laboratory

**Description:** PNNL will develop and demonstrate a novel ultrasonic nondestructive test method to detect and evaluate the severity of third party damage in pipelines.

**Schedule/Status:**
- Start Date: 8/13/01
- End Date: 12/31/04

**Partners:** Battelle Memorial Institute Pipeline Inspection Facility, National Institute of Standards, Pacific Gas and Electric
**EXPLORER: A Long Range Untethered Live Gasline Inspection Robot System**

**Northeast Gas Association (New York Gas Group)**

**Description:** A long-range untethered visual inspection robot prototype for use in distribution pipelines 6 to 8 inches in diameter, capable of independent movement and communication of 5,000 - 10,000 ft.

**Schedule/Status:**
- Start Date: 9/26/01
- End Date: 6/30/04

**Partners:** Carnegie Mellon University, Keyspan, Central Hudson Gas and Electric, Consolidated Edison of New York, Niagara Mohawk Power Corporation, New York State Electric and Gas, Orange and Rockland Utilities, Rochester Gas and Electric, NASA
Roboscan – A Robotic Inspection Platform and Sensors for Assessing Corrosion and Mechanical Damage in Un-Piggable Transmission Mains
Northeast Gas Association (New York Gas Group)

Description: A Pipeline Inspection Robot to overcome the shortcomings of transmission pigs. Self-powered and self-propelled. Capable of carrying NDE sensors, navigating both in both directions. Negotiate mitered elbows, tees and back to back bends. Passable through partially ported plug valves. Automatically adaptable, by a factor of two, to changes in pipe diameter.

Schedule/Status:
- Start Date: 9/30/02
- End Date: 2/29/04

Partners: Foster-Miller, PII North America, Public Service Electric & Gas Company, and Southern California Gas Company

Strategic Center for Natural Gas
Remote Sensing

3rd Party Damage
- Det RoW Intrusion
  - GTI '01
  - DOE $291K, CS $157K
- Acoustic Detection
  - WVU '02
  - DOE $406K, CS $109K
- Real-Time Monitoring
  - SwRI '03
  - DOE $320 CS $80
- Distributed Sensing
  - Itpek '03
  - SBIR

Leak Detection
- Mobile LD
  - PSI '02
  - DOE $160K CS $40K
- Act/Pass Imagers
  - SNL '02
  - DOE $586K, CS $0K
- Hyperspectral/radar
  - LLNL '02
  - DOE $490K, CS $0K
- Airborne LD
  - Ophir '02
  - DOE $600K, CS $150K
- Airborne Detection
  - Eastman Kodak '03
  - DOE $500 CS $1680
- Multi-Spectral Scanner
  - En-Urga Inc '03
  - DOE $281 CS $352
- Optical Leak Detection
  - Southwest Science, Inc '03
  - SBIR

Underground Imaging
- Low-cost GPR
  - GSSI '01
  - DOE $646K, CS $277K
- Soil Impedance Boring
  - GTI '01
  - DOE $192K CS $192K

Note: 01, 02 & 03 refer to fiscal year of award
Detection of Unauthorized Construction Equipment in Pipeline Right-of-Ways
Gas Technology Institute

**Description:** Develop and demonstrate an optical fiber intrusion detection device that will prevent outside force damage by detecting and alarming when construction equipment is near a natural gas pipeline.

**Schedule/Status:**
- Start Date: 9/13/01
- End Date: 9/30/04

**Partners:** ANR Pipeline, Gas Research Institute (IL)
Acoustic Detecting and Locating Gas Pipeline Infringement
West Virginia University

Description: This project will develop a system to detect the unique sound wave generated when a pipeline break releases a large discharge of gas after being damaged by landslides, excavations, or other disturbances. The system will be designed to monitor the background noise inside the pipe and pick up any sudden new frequencies that might signal a sudden pipeline rupture.

Schedule/Status:
- Start Date: 7/5/02
- End Date: 7/4/04

Partners: Dominion Transmission
A Low-Cost GPR Gas Pipe and Leak Detector
Geophysical Survey Systems Inc.

**Description:** A low-cost, easy-to-use, Ground Penetrating Radar (GPR) for locating metallic and non-metallic gas pipelines, as well as the remote detection of pipeline leaks.

**Schedule/Status:**
- Start Date: 10/1/01
- End Date: 9/30/04
Description: A unique down-hole obstacle detection sensor for Horizontal Directional Drilling (HDD) equipment. This sensor utilizes a differential soil impedance measurement technique that will be sensitive to the presence of plastic, ceramic, and metallic obstacles in the proximity of the HDD head.

Schedule/Status:
- Start Date: 3/25/02
- End Date: 9/30/04
Mobile Sensor for Remote Detection of Natural Gas Leaks
Physical Science Inc.

Description: Development of mobile gas leak detector technology capable of quantifying and distinguishing natural pipeline gas leaks from other hydrocarbon leaks or ambient methane sources. R&D will focus on extending the performance and applicability of the Remote Methane Leak Detector (RMLD) developed by PSI.

Schedule/Status:
- Start Date: 9/30/02
- End Date: 3/31/04

Partners: Heath Consultants
Testing of an Advanced Airborne Natural Gas Leak Detection System

Eastman Kodak

Description: The project objective is to flight test a high-sensitivity, broad-coverage, natural gas leak detection system in an operational environment. The system will accurately detect and locate small concentrations of natural gas leaks from transmission pipelines with very high confidence.

Schedule/Status:
- Start Date: 9/30/03
- End Date: 12/31/04

Partners: Coherent Technologies
Internal Repair of Pipelines
Edison Welding Institute

**Description:** The work will evaluate, develop and validate internal repair methods for pipelines, perform laboratory demonstrations of potential internal pipeline repair techniques and develop a functional specification for a combined prototype system to perform internal inspection and repair of pipelines.

**Schedule/Status:**
– Start Date: 9/30/02
– End Date: 3/31/05
“Smart Pipe”
Integral Communication, Damage Detection and Multiple Sensor Application in Pipelines
Idaho National Engineering and Environmental Laboratory

Description: Thermally sprayed conductive traces applied in natural gas transmission and distribution pipelines that can be used for pipeline communications, detection and location of damage and as a conductive pathway for attaching or embedding sensors for performance monitoring.

Schedule/Status:
– Start Date:
– End Date:
Operational Technologies

Compressors
- Retrofit Micro-Pilot
  CSU '01
  DOE $572K, CS $959K
- Flexibility of Turbos
  SwRI '01
  DOE $368K, CS $220K
- Laser Ignition
  NETL '01
  In-House Research
- In-Line Compressor
  Dresser-Rand '02
  DOE $600K, CS $516K
- Op. Enhancements
  SwRI '02
  DOE $450K, CS $150K
- Engine Controls
  SwRI '03
  DOE $96 CS $120

Modeling
- Virtual Testbed
  KSU '01
  DOE $808K, CS $291K
- LNG Dispersion
  University of Arkansas
  DOE $438K CS $110K

Corrosion
- Microbial Inhibitor
  GTI '01
  DOE $509K, CS $274K
- LNG Education
  NARUC
  DOE $100K CS $0K

Note: 01, 02 & 03 refer to fiscal year of award
IEMDC - Totally Enclosed In-Line Electric Motor Driven Gas Compressor
Dresser-Rand Company

Description: Development of the world’s first gas compressor that can be installed directly into the pipeline (possibly underground.) The unit will utilize a direct coupled, variable speed induction motor with magnetic bearings mounted inside the casing of a 10 MW centrifugal compressor.

Schedule/Status:
- Start Date: 01/01/03
- End Date: 06/30/04

Partners: Curtiss-Wright / Westinghouse Electro-Mechanical Division (EMD)
Technologies to Enhance Operation of the Existing Natural Gas Compression Infrastructure

Southwest Research Institute

**Description:** Develop and substantiate methods for operating integral reciprocating engine / compressors to reduce fuel consumption, increase capacity, and enhance mechanical integrity. The approach to optimization is by balancing engine power cylinders, and distributing the load in the compressor cylinders so as to minimize fuel consumption, minimize damage rate, and maximize capacity.

**Schedule/Status:**
- Start Date: 9/29/02
- End Date: 9/30/05

**Partners:** Gas Machinery Research Council, Pipeline Research Council International

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**PEAK PRESSURE**

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**STANDARD DEVIATION**

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**EXHAUST / HEAD TEMPS.**

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<td>2</td>
<td>68</td>
</tr>
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*OEM max pk-pr = 650*

*OEM max temps = 750*
Current LNG Projects

**Education**
- LNG Education
  - NARUC
  - DOE $100K CS $0K
- LNG Technical Primer
  - NETL
  - DOE $30K CS $0K
- LNG Technology Roadmap
  - NETL
  - DOE $35K CS $0K

**LNG R&D**
- Novel LNG Receiving
  - CGI, Inc. ’01
  - DOE $1,806K, CS $802K
- Satellite LNG Storage
  - NYSEG ’03
  - DOE $600K, CS $1,530K

**LNG Safety**
- LNG Dispersion Models
  - University of Arkansas
  - DOE $438K CS $110K
- LNG Dispersion Studies
  - NETL
  - DOE $100K CS $0K
- LNG Risk Assessment
  - SNL
  - DOE $150K CS $0K

Note: 01, 02 & 03 refer to fiscal year of award

*Strategic Center for Natural Gas*
FY04 Planned Activities

- Update Natural Gas Infrastructure Roadmap (February 2004)
- Broad-based solicitations (February)
  - Portfolio gaps and innovation
- Develop LNG Technology Roadmap (spring)
- Gas hydrate storage demonstration (winter)
- Robotic platform demonstration (winter/spring)
- Inspection/remote sensing field demos (summer)
- LNG Heat exchanger field tests (spring)
- Continue collaboration with DOT/OPS – joint technical conference

No new targeted solicitations scheduled in FY 2004
Natural Gas Infrastructure
Reliability Industry Forums
The Strategic Center for Natural Gas (SCNG) at the NETL will conduct a series of Natural Gas Infrastructure Reliability Industry Forums in September 2002. Read More!

Natural Gas Technology – Investment in a Healthy U. S. Energy Future
Time is running short to register for the “Natural Gas Technology – Investment in a Healthy U.S. Energy Future” conference. Read More!

DOE Kicks Off “Deep Trek” to Develop Deeper, Smarter Drilling Technology
To develop a new high-tech “smart” drilling system that can tap into deep reservoirs, the DOE is beginning “Deep Trek.” Read More!