# Subsurface Energy in Pennsylvania: Looking Forward, Looking Back

Bureau of Oil and Gas Planning and Program Management
10/21/2025

Pennsylvania
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# Summary Outline

- Carbon Capture and Underground Storage
  - Regulatory Update
- Geothermal Energy
  - Geothermal Potential
  - Current Regulations
  - Future Projects
- Legacy Well Plugging

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# UIC Well Classifications

- Class I – Industrial and Municipal Waste Disposal Wells
- Class II – Injection Wells Related to Oil and Gas Production
- Class III – Injection Wells for Solution Mining
- Class IV – Shallow Hazardous and Radioactive Injection Well (Banned, except for pump-and-treat systems)
- Class V – Wells for Injection of Non-Hazardous Fluids into or Above Underground Sources of Drinking Water
- Class VI – Injection Wells for CO2 Sequestration

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# Class VI UIC Wells

- Used to inject Carbon Dioxide into deep rock formations
- Multiple protective layers of corrosion-resistant casing and cement
- Routine testing before, during, and after operational life

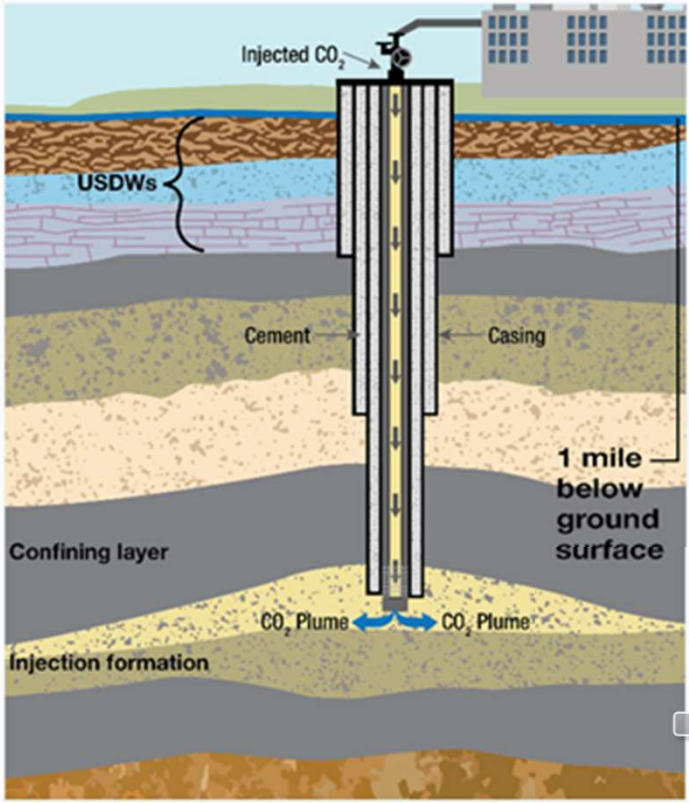


Image from Class VI https://www.epa.gov/uic/class-vi-wells-used-geologic-sequestration-carbon-dioxidefor Geologic Sequestration of Carbon Dioxide | US EPA

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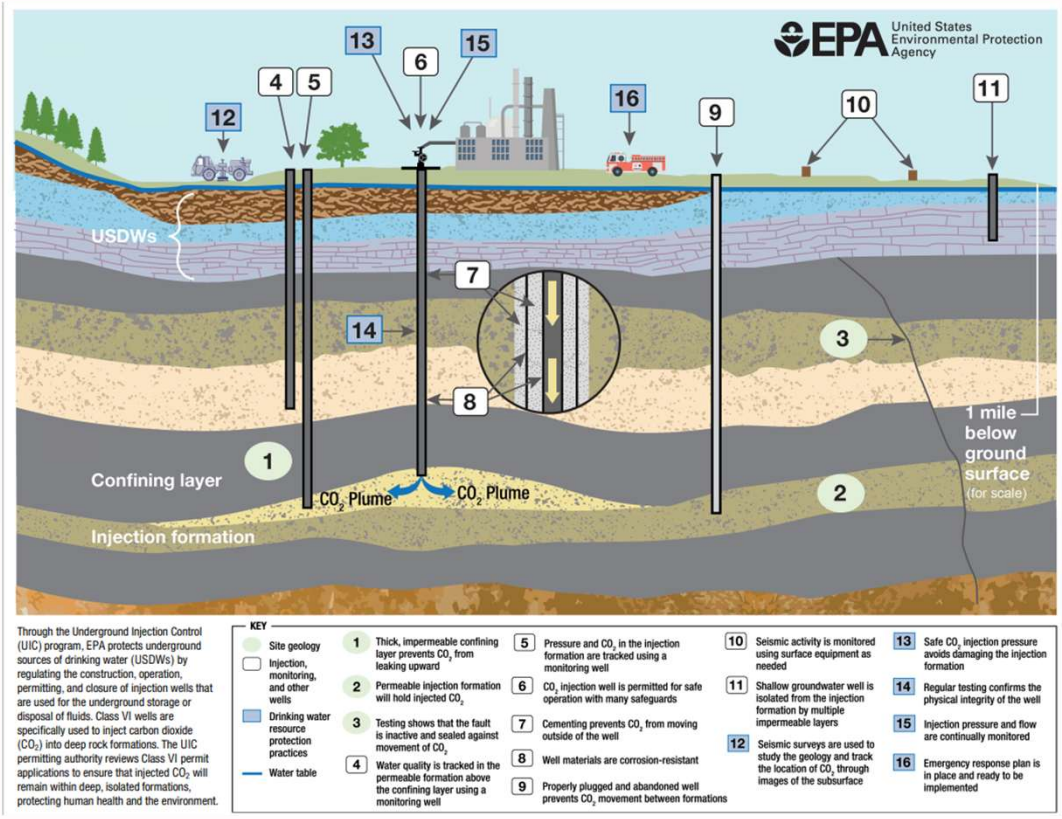
# Class VI UIC Wells




Through the Underground Injection Control (UIC) program, EPA protects underground sources of drinking water (USDWs) by regulating the construction, operation, permitting, and closure of injection wells that are used for the underground storage or disposal of fluids. Class VI wells are specifically used to inject carbon dioxide ($CO_2$) into deep rock formations. The UIC permitting authority reviews Class VI permit applications to ensure that injected $CO_2$ will remain within deep, isolated formations, protecting human health and the environment.

- Wells penetrating storage formation must be plugged
- Safe injection pressures established by testing prior to starting injection
- Deep monitoring wells and seismic surveys used to track plume
- Monitoring of USDWs for stray carbon dioxide

Image from EPA Fact Sheet: “How EPA’s UIC Class VI Regulations Work to Ensure the Protection of Groundwater Resources”

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# UIC Well Permitting

EPA implements the UIC program for Pennsylvania

- Permitting
- Well Monitoring and Reporting
- Abandonment
- Inspections

- Federal regulations for the UIC program are found in Title 40 of the Code of Federal Regulations

- More EPA information can be found at https://www.epa.gov/uic/

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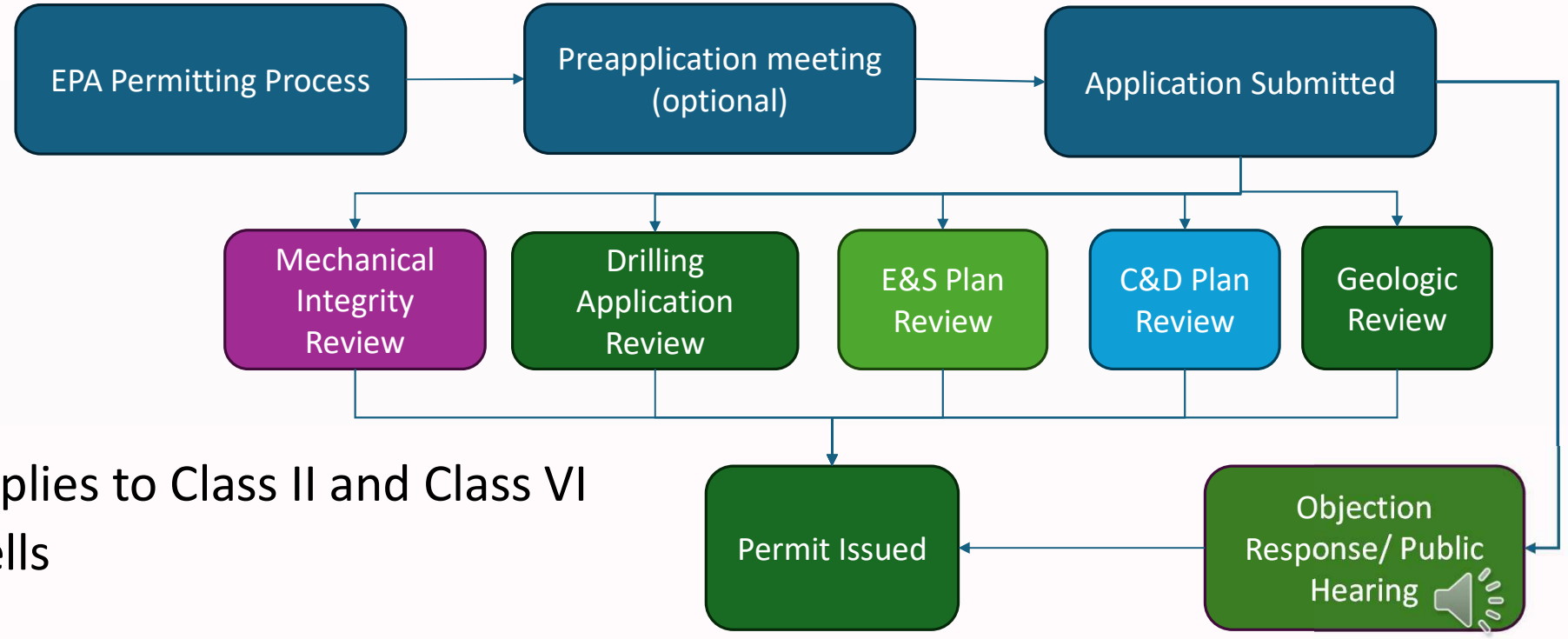
# Current Permitting Process




- Applies to Class II and Class VI wells

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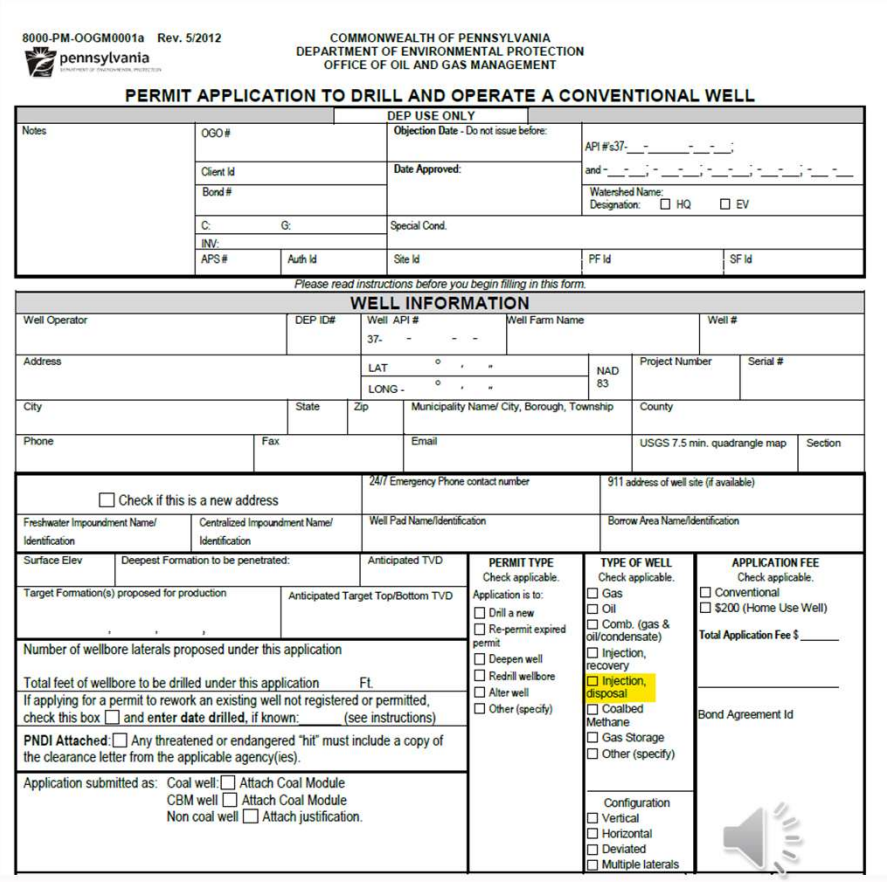
A Pennsylvania disposal well permit is required per 25 Pa. Code §78.18.

Permit application is reviewed by:

- Licensed Professional Geologist
- Oil & Gas Inspector
- Water Quality Specialist
- Environmental Protection Specialist



8000-PM-OOGM0001a Rev. 5/2012

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
OFFICE OF OIL AND GAS MANAGEMENT

**PERMIT APPLICATION TO DRILL AND OPERATE A CONVENTIONAL WELL**

DEP USE ONLY

Notes | OGO # | Objection Date - Do not issue before: | API #s37-__-_____-__-__;
Client Id | Date Approved: | and -__-__; -__-__; -__-__; -__-__; -__-__; -__-__
Bond # | Watershed Name: Designation: ☐ HQ ☐ EV
C: G: | Special Cond.
INV:
APS # | Auth Id | Site Id | PF Id | SF Id

*Please read instructions before you begin filling in this form.*

**WELL INFORMATION**

Well Operator | DEP ID# | Well API # 37- - - - | Well Farm Name | Well #
Address | LAT ° ' " | NAD 83 | Project Number | Serial #
LONG - ° ' "
City | State | Zip | Municipality Name/ City, Borough, Township | County
Phone | Fax | Email | USGS 7.5 min. quadrangle map | Section
☐ Check if this is a new address | 24/7 Emergency Phone contact number | 911 address of well site (if available)
Freshwater Impoundment Name/ Identification | Centralized Impoundment Name/ Identification | Well Pad Name/Identification | Borrow Area Name/Identification
Surface Elev | Deepest Formation to be penetrated: | Anticipated TVD
Target Formation(s) proposed for production | Anticipated Target Top/Bottom TVD

Number of wellbore laterals proposed under this application

Total feet of wellbore to be drilled under this application Ft.

If applying for a permit to rework an existing well not registered or permitted, check this box ☐ and **enter date drilled**, if known: (see instructions)

**PNDI Attached**: ☐ Any threatened or endangered "hit" must include a copy of the clearance letter from the applicable agency(ies).

Application submitted as: Coal well: ☐ Attach Coal Module
CBM well ☐ Attach Coal Module
Non coal well ☐ Attach justification.

**PERMIT TYPE** Check applicable.
Application is to:
☐ Drill a new
☐ Re-permit expired permit
☐ Deepen well
☐ Redrill wellbore
☐ Alter well
☐ Other (specify)

**TYPE OF WELL** Check applicable.
☐ Gas
☐ Oil
☐ Comb. (gas & oil/condensate)
☐ Injection, recovery
☐ Injection, disposal
☐ Coalbed Methane
☐ Gas Storage
☐ Other (specify)

Configuration
☐ Vertical
☐ Horizontal
☐ Deviated
☐ Multiple laterals

**APPLICATION FEE** Check applicable.
☐ Conventional
☐ $200 (Home Use Well)
**Total Application Fee $** _____

Bond Agreement Id

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# Items Submitted to DEP for Review:

- Permit Application to Drill and Operate a Conventional Well - PA Code Chapter 78.15 (Application requirements)
- EPA Underground Injection Control (UIC) Permit and required related documentation - PA Code Chapter 78.18 (Disposal and enhanced recovery well permits)
- Geologic Analysis - PA Code Chapter 91.51 (General Provisions Underground Disposal)
- Casing and Cementing Plan - (PA Code Chapter 78.83 Casing and cementing plan)

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# Items Submitted to DEP for Review:

- Identification and assessment of the effects on deep mines, gas storage fields, other wells penetrating the injection formation, water supplies, water bodies, streams, rivers and wetlands - PA Code Chapter 91.51 (General Provisions Underground Disposal)
- Control and Disposal Plan - PA Code Chapter 78.18 (Disposal and enhanced recovery well permits)
- E&S Plan - PA Code Chapter 78.18 (Disposal and enhanced recovery well permits)

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# Act 87: Carbon Capture and Sequestration Act

"An Act providing for the injection of carbon dioxide into an underground reservoir for the purpose of carbon sequestration, for the ownership of pore space in strata below surface lands and waters of the Commonwealth, for conveyance of the surface ownership of real property; imposing duties on the Department of Environmental Protection and the Environmental Hearing Board; and establishing the Carbon Dioxide Storage Facility Fund."

- Introduced as SB 831 by Senator Gene Yaw in June 2023
- Signed on July 17, 2024

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# Next Steps

## Developing Regulations

- Currently working to develop regulatory framework

## UIC Class VI Primacy Grant (Bipartisan Infrastructure Law)

- $1.9 M
- Funding source for Class VI Program Development
- Submitted and Under Review

## Program Structure and Development

- Identify inter-state opportunities
- Develop regional agreements, MOUs and other structures
- Define potential role for DCNR
- Discussions at policy level are ongoing

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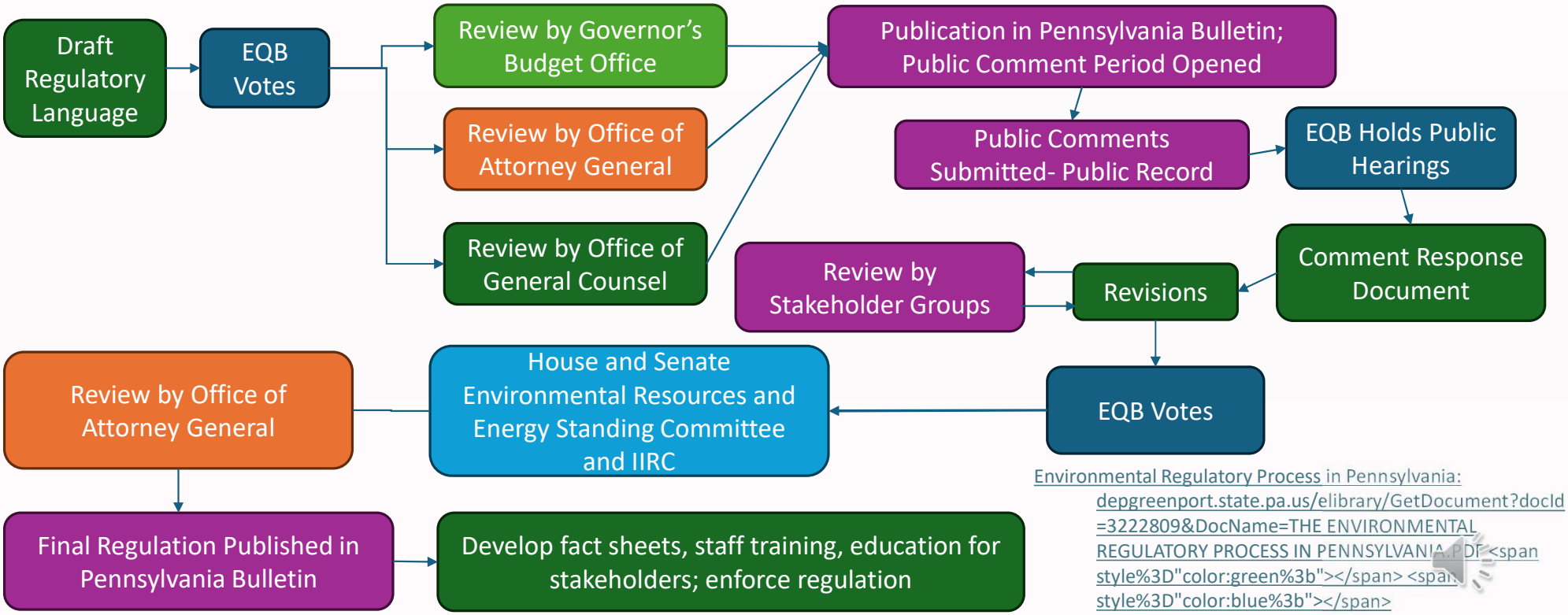
# Regulatory Development




Environmental Regulatory Process in Pennsylvania: depgreenport.state.pa.us/elibrary/GetDocument?docId=3222809&DocName=THE ENVIRONMENTAL REGULATORY PROCESS IN PENNSYLVANIA.PDF<span style%3D"color:green%3b"> <span style%3D"color:blue%3b">

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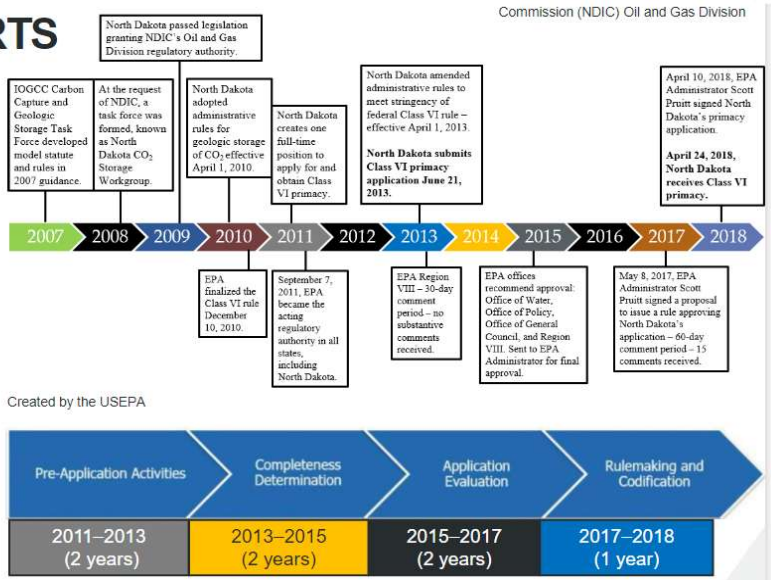
# Next Steps

## CLASS VI PRIMACY EFFORTS

### Establishment of State Authority

- **Geologic Storage of Carbon Dioxide**
  Multiyear effort to pass all-encompassing state legislation
- **Preapplication Activities**
  Approximately 2 years (690 days)
  - Crosswalk stringency demonstration
  - State rulemaking 10–12 months
  - Primacy application package
- **Completeness Determination**
  Approximately 2 years
- **Application Evaluation**
  Approximately 2 years
- **Rulemaking and Codification**
  351 days
- **State Primacy Approval**
  Approximately 5 years (1768 days)




**Wyoming** 2 years and 7 months (943 days)

Critical Challenges. Practical Solutions.

FERC and UND – Regulatory Framework for Geologic Storage of Carbon Dioxide, 2022

# Geothermal Energy

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# Geothermal Energy Types

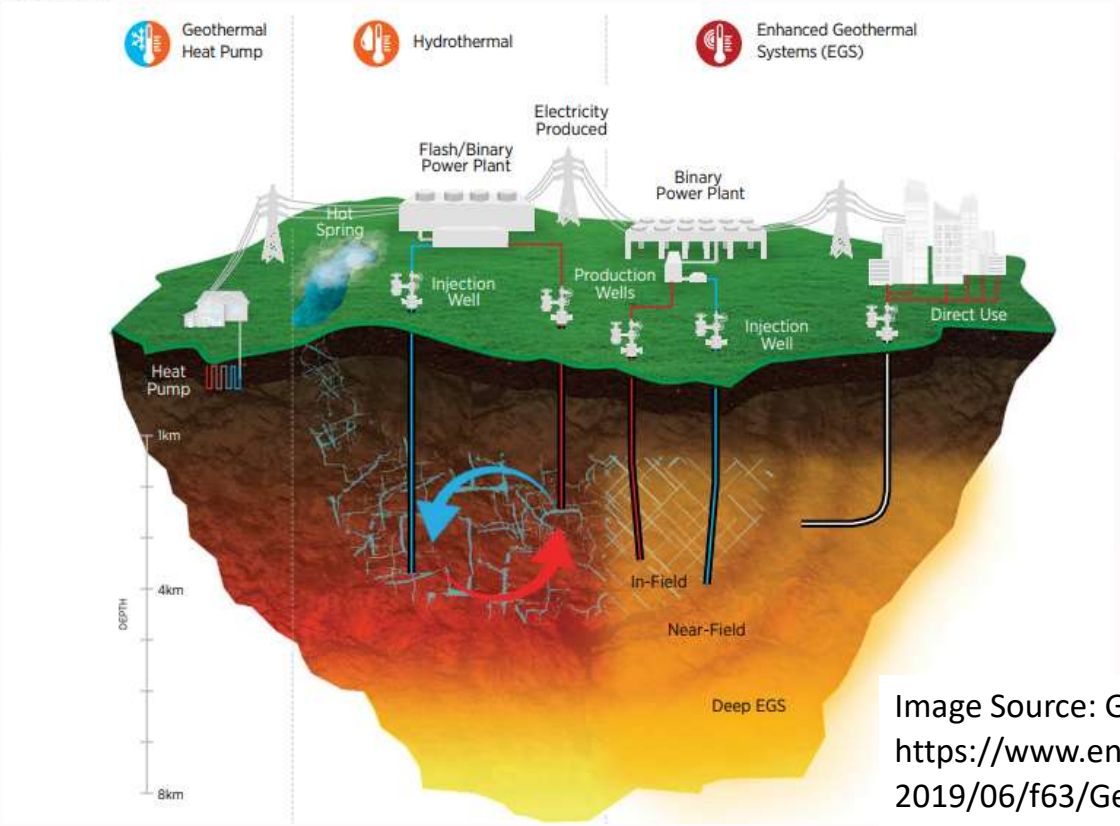


Image Source: GeoVision (2019)
https://www.energy.gov/sites/default/files/2019/06/f63/GeoVision-full-report-opt.pdf

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# Engineered Geothermal System

- Reservoir created through hydrofracture stimulation, similar to unconventional wells

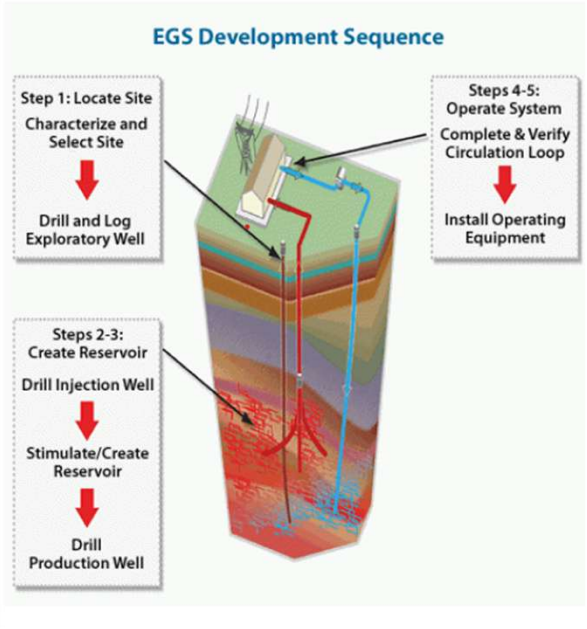


Image Source: U.S. Department of Energy (2019) Enhanced Geothermal Systems Technologies, https://www.energy.gov/eere/geothermal/enhanced-geothermal-systems-technologies

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# Geothermal in Pennsylvania

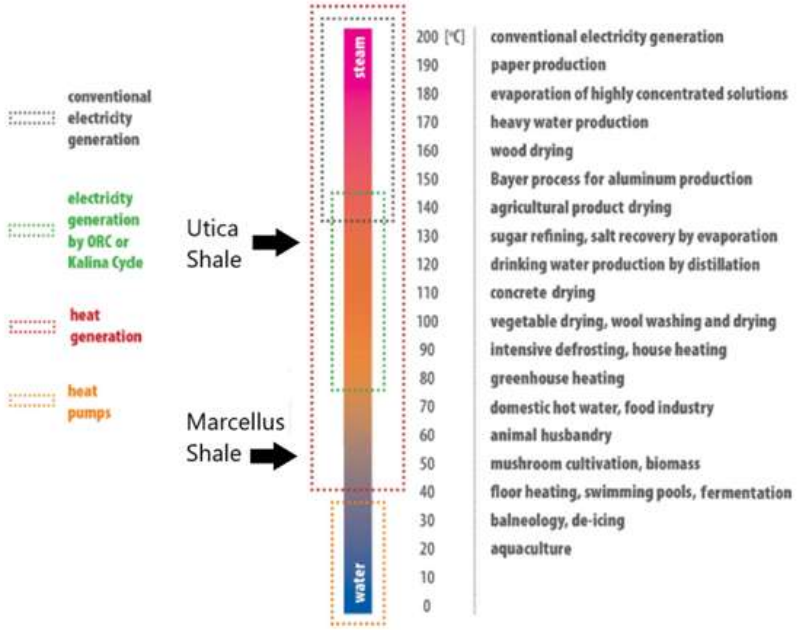


Fig. 1. Modified Lindall Diagram showing a range of well-established applications for geothermal energy at different temperatures [16] [16] T. Vrålstad, A. Saasen, E. Fjær, T. Øia, J.D. Ytrehus, M. Khalifeh, Plug & abandonment of offshore wells: ensuring long-term well integrity and costefficiency, J. Petrol. Sci. Eng. 173 (2019) 478e491, https://doi.org/10.1016/j.petrol.2018.10.049..

L. Santos, A. Dahi Taleghani, D. Elsworth, Repurposing abandoned wells for geothermal energy: Current status and future prospects, Renewable Energy, Volume 194, 2022, Pages 1288-1302, ISSN 0960-1481, https://doi.org/10.1016/j.renene.2022.05.138.

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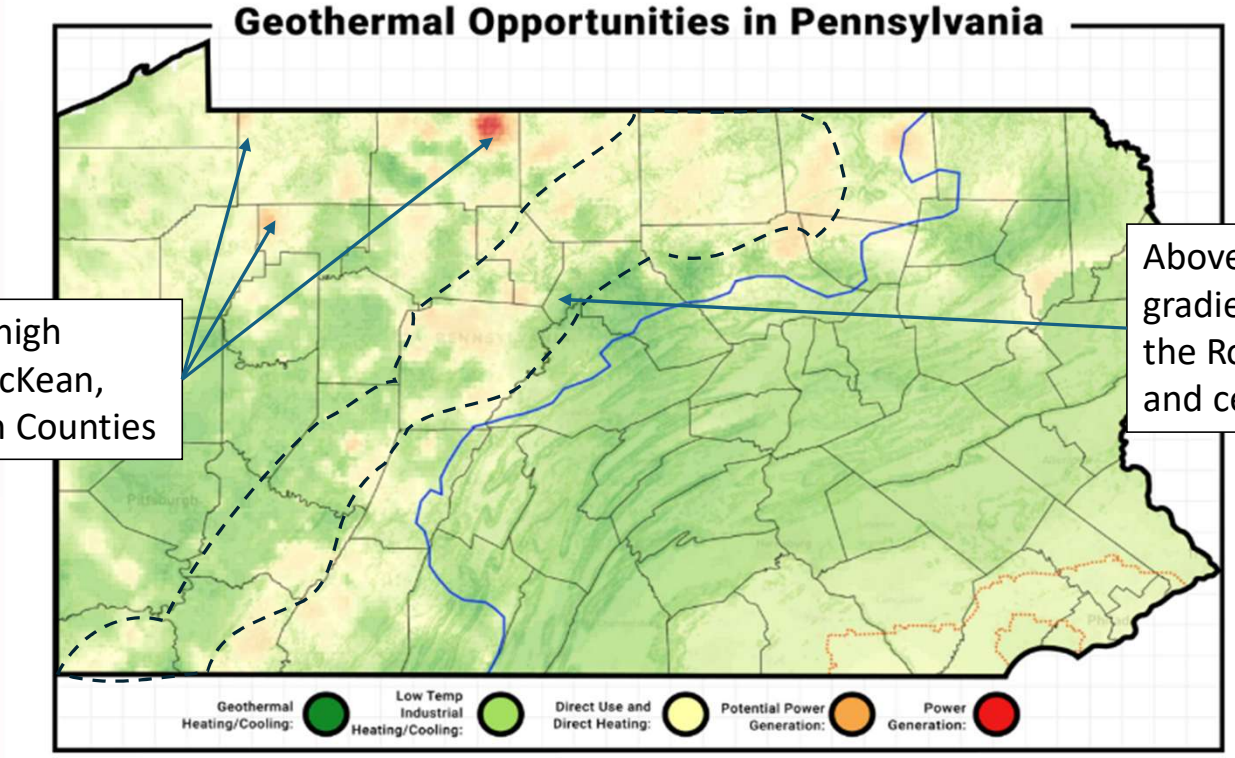


Relatively shallow high temperatures in McKean, Forest, and Warren Counties

Above-average geothermal gradient (30°C/km) is aligned with the Rome Trough in southwestern and central PA

Image modified from “The Future of Geothermal in Pennsylvania”, Project Innerspace, https://projectinnerspace.org

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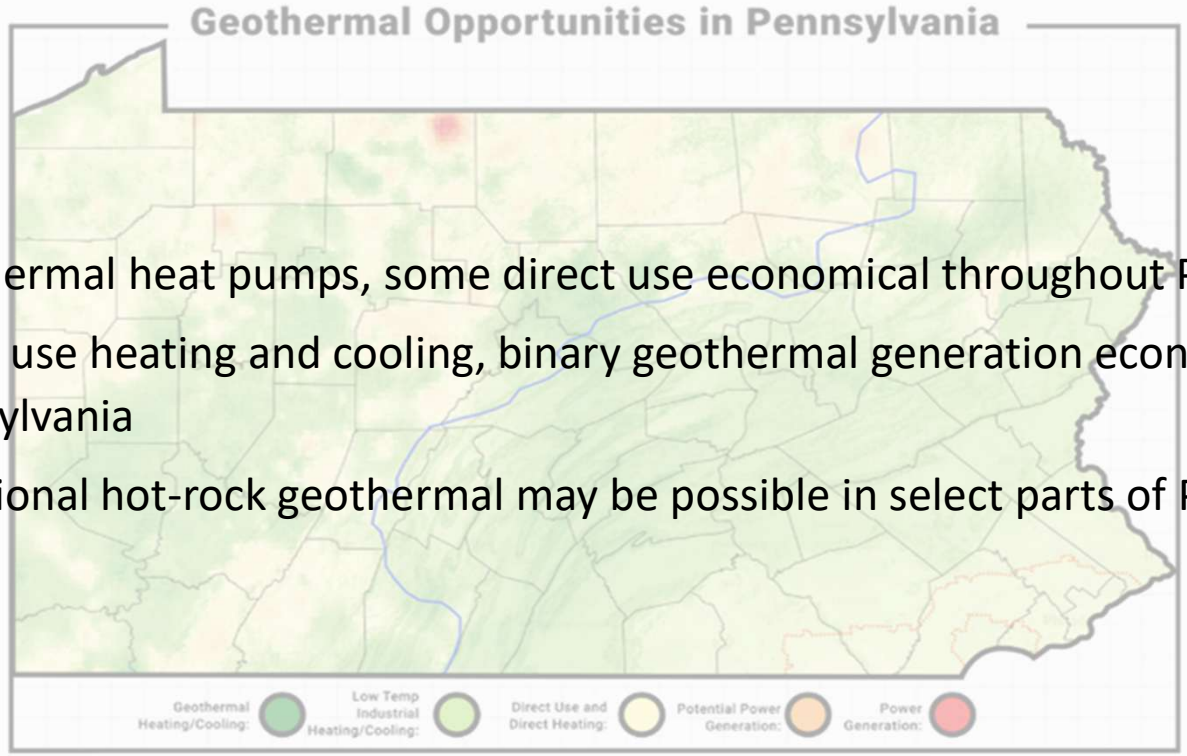
# Geothermal in Pennsylvania




- Geothermal heat pumps, some direct use economical throughout Pennsylvania
- Direct use heating and cooling, binary geothermal generation economical in parts of Pennsylvania
- Traditional hot-rock geothermal may be possible in select parts of Pennsylvania

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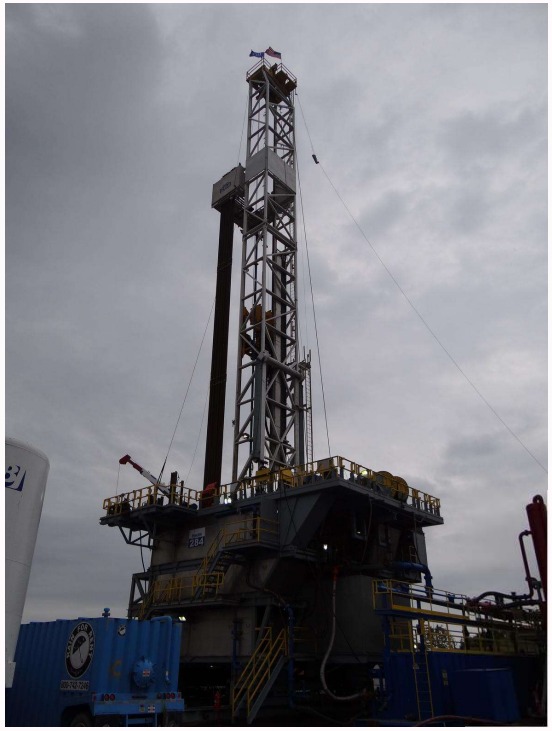
# Geothermal in O&G Fields

- Existing connections to proven permeable and transmissive aquifers.
- Reservoir geology is very well defined, lower exploration costs.
- Cost savings in drilling, development, and reuse of infrastructure.
- Pennsylvania has the population density and grid availability.
- Workforce maintenance and development.



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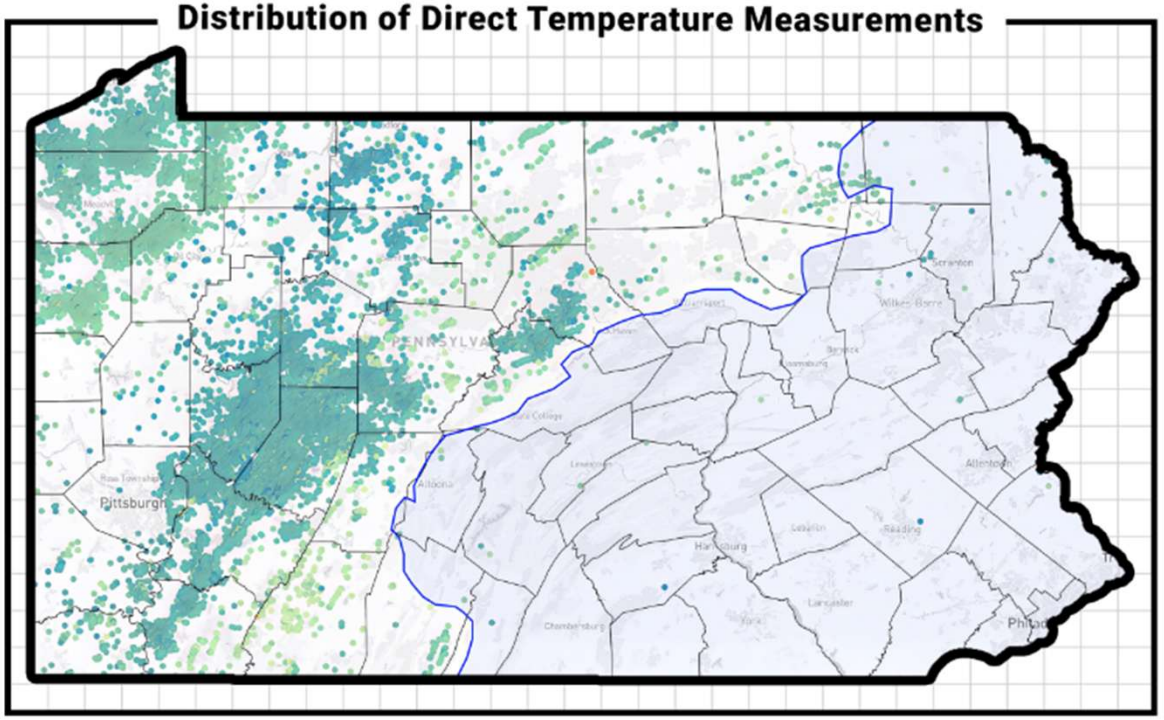
# Geothermal in O&G Fields

Direct measurements from oil and gas drilling in Western Pennsylvania




High uncertainties in Eastern Pennsylvania due to sparse direct temperature measurements

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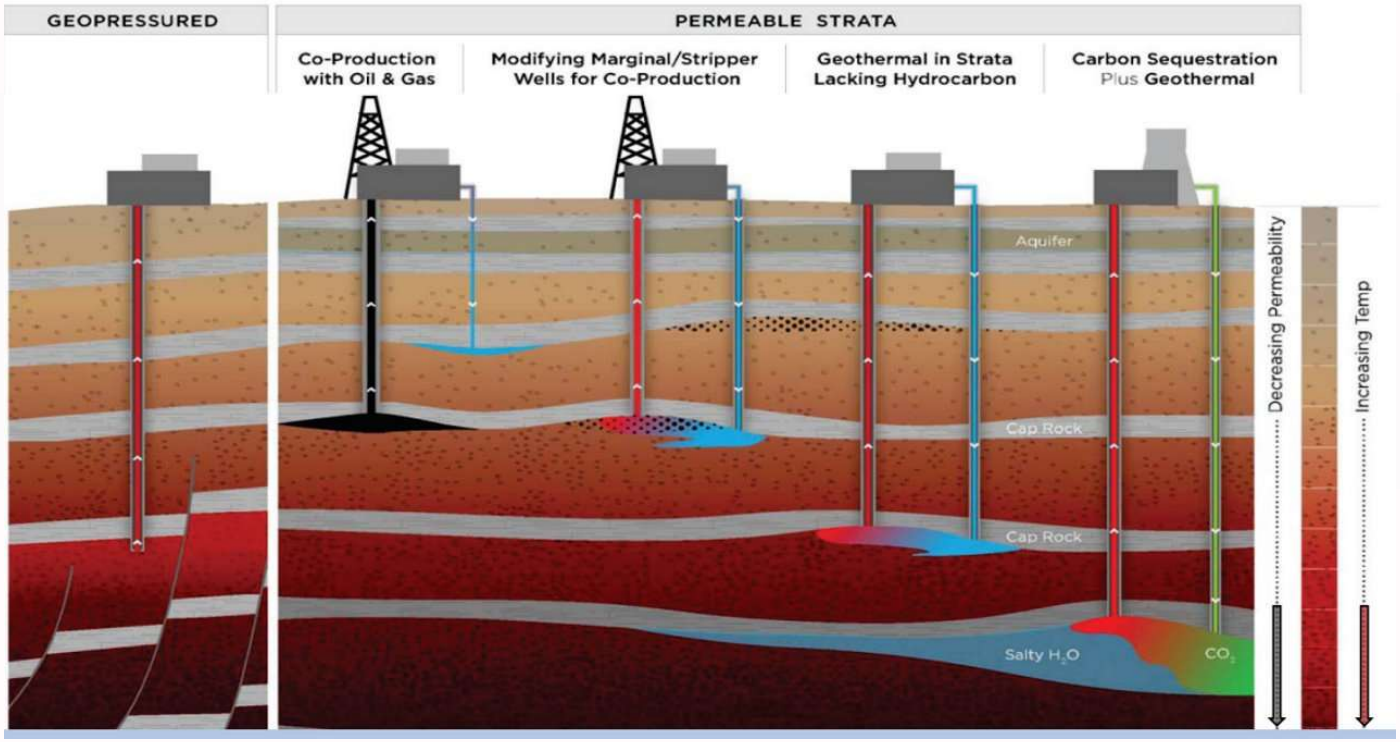
# Geothermal in O&G Fields



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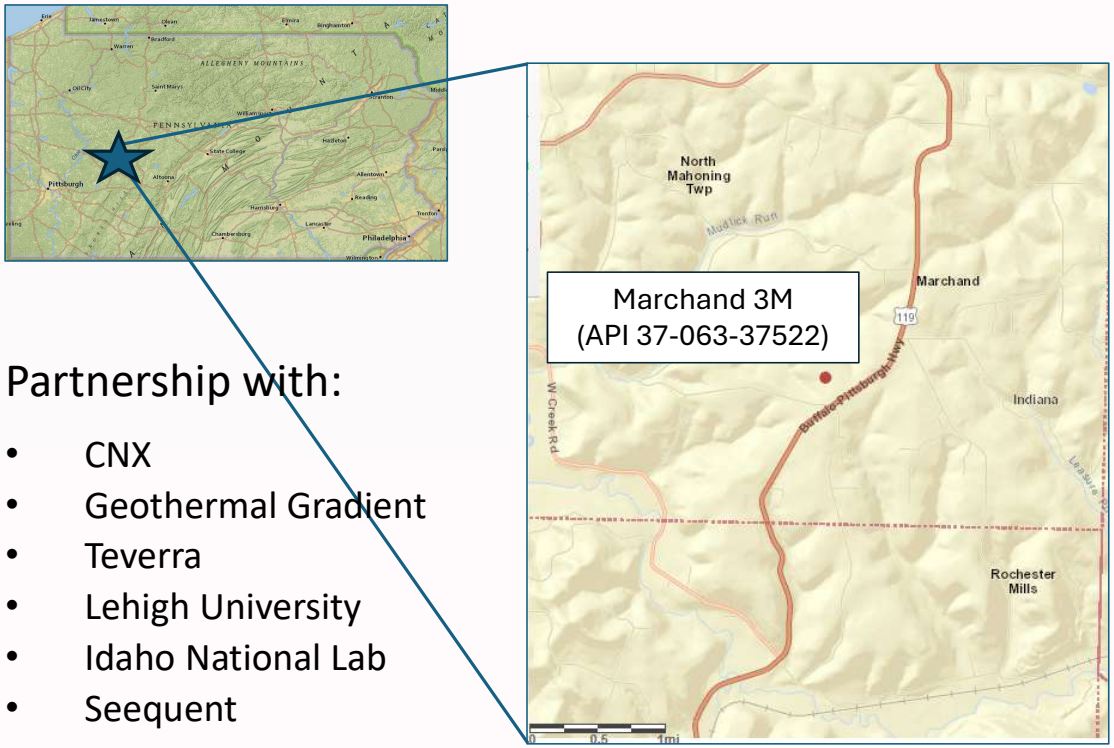
# EGS Pilot Demonstration




Partnership with:

- CNX
- Geothermal Gradient
- Teverra
- Lehigh University
- Idaho National Lab
- Seequent

- Project Goal: Leverage the existing Marchand Utica well to demonstrate effective geothermal heat extraction and 1-3 MW power generation from a shale reservoir
- FOA#: DE-FOA-0002826: Bipartisan Infrastructure Law Enhanced Geothermal Systems (EGS) Pilot Demonstrations

# Legacy Wells

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# Oil and Gas Development in PA

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# Pennsylvania's Legacy

| | Oil Well Completions | Gas Well Completion | Dry Well Completions | Total |
|---|---|---|---|---|
| Historical Completions through 1956 | 172,750 | 11,720 | 31,936 | 216,398 |
| PA*IRIS/WIS Completions (1957 and beyond) | 38,732 | 63,010 | 12,412 | 114,154 |
| Total Completions | 211,482 | 74,730 | 44,348 | 330,560 |

Source: Carter, Kristin, 2024, An Historical Perspective of Oil and Gas Development in PA: adapted from extended abstract based on oral presentation given at 2024 Orphan Wells Conference, Feb. 27-28, Cranberry Township, Pennsylvania: AAPG Search and Discovery Article #80748 (2024)

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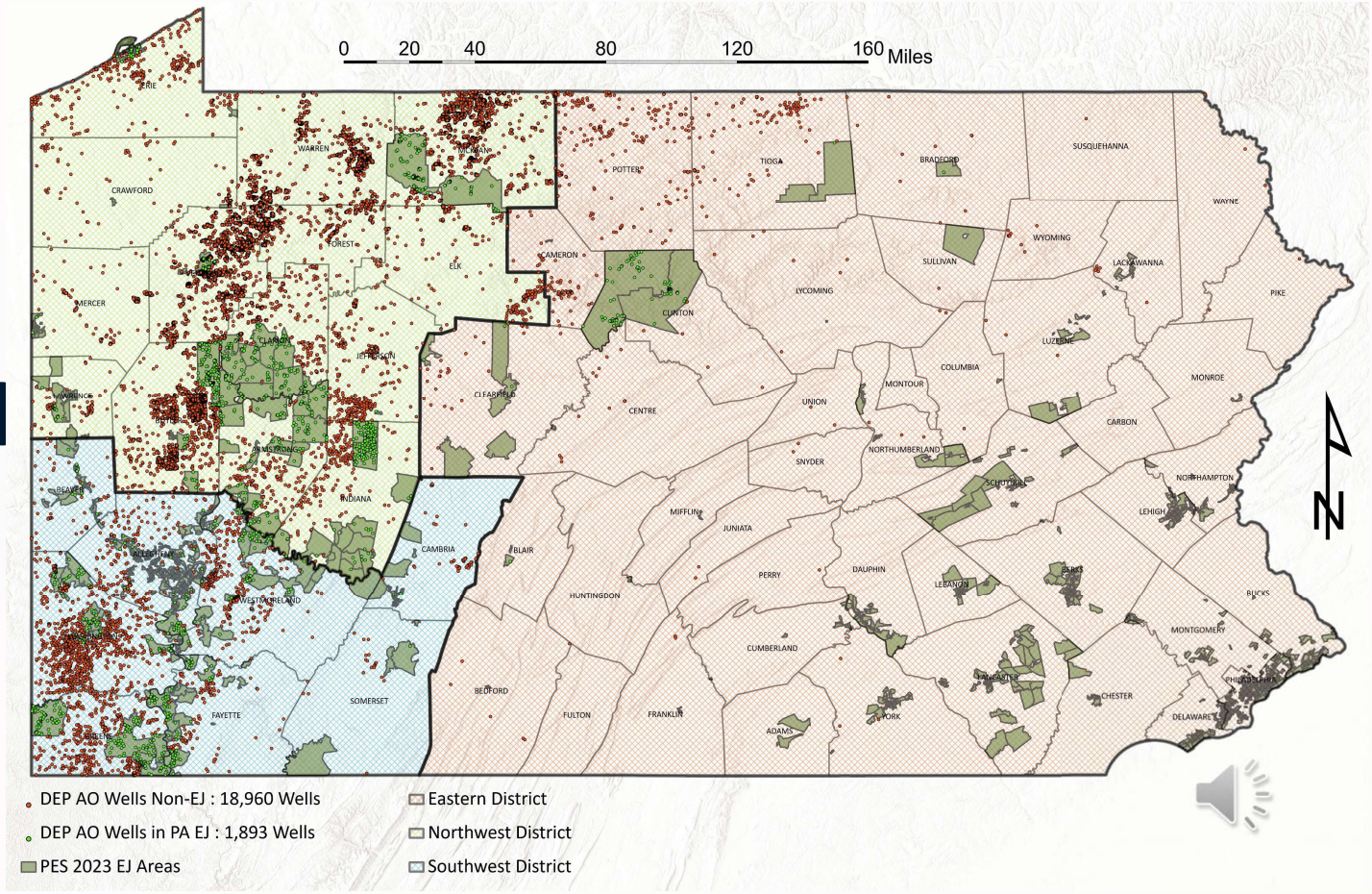
# Abandoned and Orphaned Wells in Pennsylvania



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# Historic Plugging Activity

Typically limited by funding ($1MM/year average funding) to emergency situations

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# IIJA Funding for Orphan Well Plugging

- >$400 million is available to Pennsylvania through Initial Grant, Formula Grants and Performance Grants
- DEP has been awarded ~ $101 million to date
  - Initial Grant - $25 Million awarded November 2022 – 221 wells plugged @ ~$105k/well
  - Phase 1 Formula Grant - $76 Million awarded September 2024
- Phase 2 Formula Grant Application submitted December 2024 - $114 Million award pending
  - Phase 3 and 4 Formula Grants - $114 Million

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# IIJA Funding for Orphan Well Plugging

- Performance Grants – Matching Grant - $30 Million
- Regulatory Improvement Grants – 40 Million
- DEP has entered an Agreement with United States Forest Service (USFS) utilizing federal IIJA funding obtained by USFS for plugging wells on federal lands in PA – Currently $13 Million

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# IIJA Funding for Orphan Well Plugging

- Lump Sum Low Bid Contracts Bids – Existing method used for Initial Grant projects
- Request for Proposal (RFP) – Underway for Formula Grants
  - Well Plugging Services Contracts (WPSC)
  - Multi Professional Services Contracts (MPSC)
- Orphan Well Grant Plugging Program – PA Acts 96 and 136 -Effective: January 3, 2023
- Master Service Agreements – Colleges and Universities
- Cost Share Agreements – DEP Plugging contract oversight on federal lands

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# Orphan Well Grants

- Orphan Well Grant Plugging Program - PA Acts 96 and 136 - Effective: January 3, 2023
- Available for wells that were abandoned before 1985 (DEP Orphaned).
- Grants up to $40,000 for wells 3,000 feet deep or less, and
- Up to $70,000 for wells deeper than 3,000 feet
- Applications opened on October 9, 2024, through DEP's website
  - 32 applications to date
  - 152 wells total - 29 wells with methane detected

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# Related Activities

- Multi Professional Services Contract (MPSC)
  - Engineering/Permitting
  - Methane Quantification
  - Abandoned Well Health Study
  - Workforce Development

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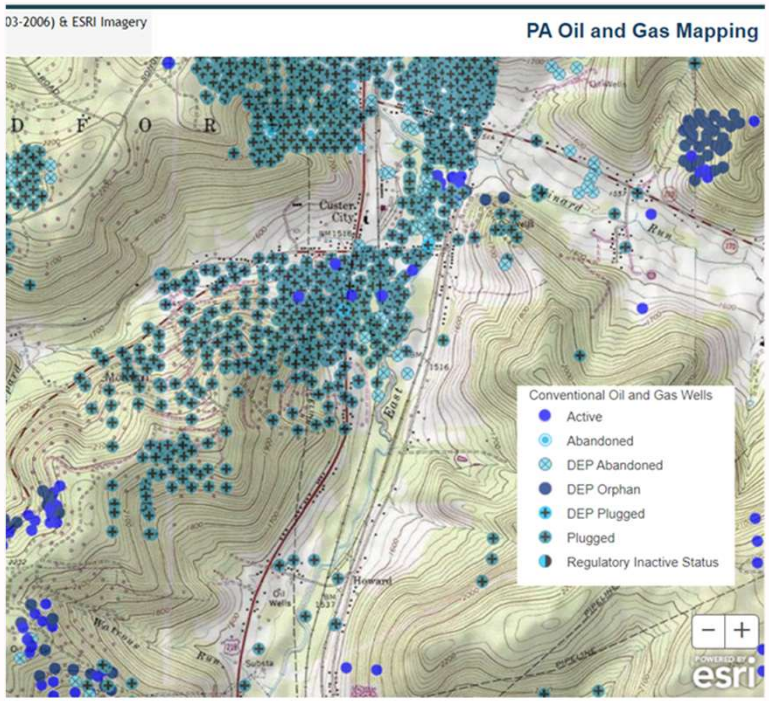
# Related Activities




## Undocumented Well Location

- 300,000+ Undocumented Wells in PA
- Contractors will locate poorly and/or undocumented wells:
  - Desktop/well record review and georeferencing of poorly documented records
  - Drone/field surveys
  - Field verification
- Well prioritization by DEP staff
  - Survey 123 environmental assessments

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# Related Activities

**Environmental Remediation**

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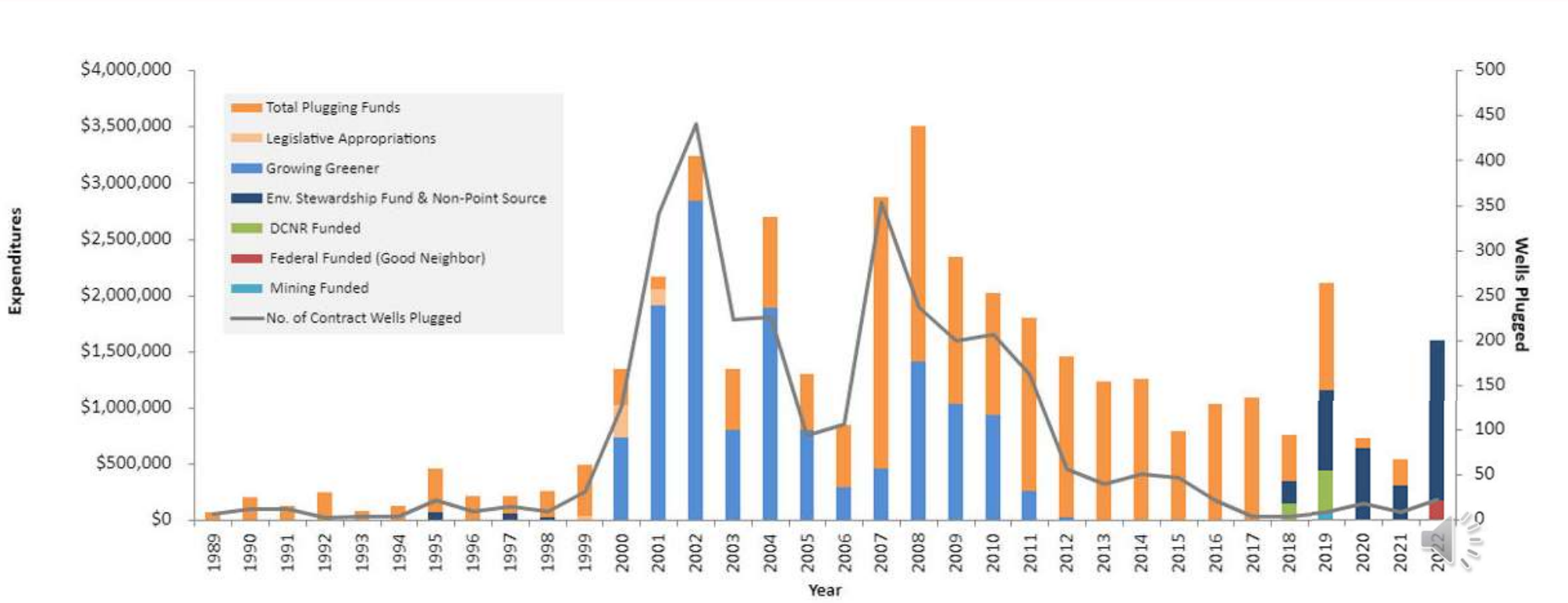
# Historic Plugging Activity



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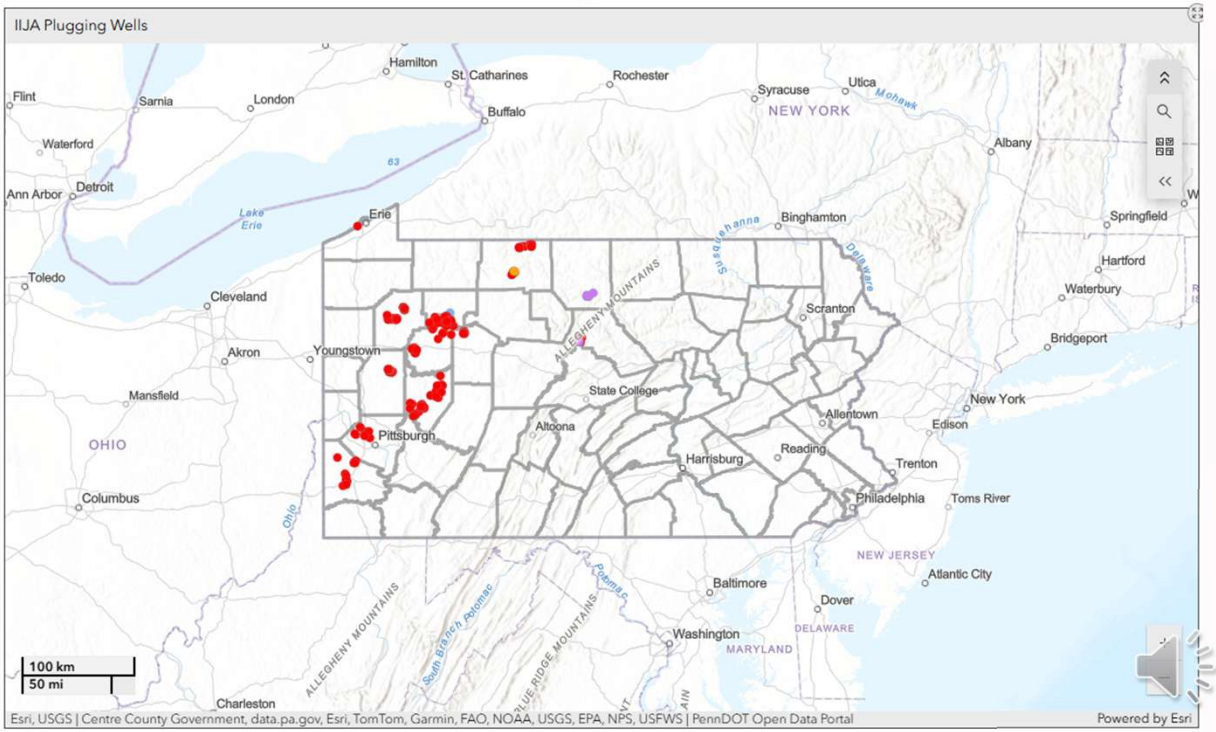
# IIJA Plugging Activity

| Wells Plugged | Wells In Progress |
|---|---|
| 227 | 43 |




Learn more at https://www.pa.gov/agencies/dep/programs-and-services/oil-and-gas/legacy-wells

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# In Conclusion

The present…

…is the key to the past…


…but the past is the key to the future.

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# Get In Touch


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The Department of Environmental Protection's mission is to protect Pennsylvania's air, land and water resources and to provide for the health and safety of its residents and visitors, consistent with the rights and duties established under the Environmental Rights Amendment (Article 1, Section 27 of the Pennsylvania Constitution).