



heet

Geothermal Energy Networks: Transforming our Thermal Energy System

January 30-31, 2024



Source: public domain

MIT Environmental Solutions Initiative (ESI)



- The ESI Education Program aims to collaborate with MIT and the **broader community** to assess, innovate, and expand climate education across **disciplinary** and **institutional** contexts.
- This workshop stems from other collaborations with **HEET & ESI**:
 - **New Course:** Massive Open Online & In-Person (**Department of Urban Studies and Planning**)
 - **K-12** Curriculum on Geothermal Energy Networks (**Open Learning**)



MIT OpenCourseWare

- Empowering **learners & educators** with free open-licensed materials
- Global **open knowledge ecosystem**: open education+science+data+tools
- OCW's reach & impact (2024 stats)
 - Website: 15M unique visits, 7.5M learners
 - YouTube: 5.5M subscribers, 47M views
 - 70% from outside the US

The screenshot shows the MIT OpenCourseWare website for the course "Climate Action Hands-On: Harnessing Science With Communities To Cut Carbon" (RES.ENV.001 | January MAP 2017 | Non-Credit). The page layout includes a top navigation bar with the MIT OpenCourseWare logo, a search icon, and links for "GIVE NOW", "ABOUT OCW", "HELP & FAQ", and "CONTACT US". The course title is prominently displayed in a blue header. Below the header, the page is divided into several sections: "Syllabus" on the left, "Course Description" in the center, "Course Info" on the right, and a "Download Course" button at the bottom right. The "Syllabus" section lists four sessions: Session 1: Citizen Science and Climate Action, Session 2: Methane Leaks Hackathon, Session 3: Methane Leaks Field Trip "Safari", and Session 4: Legal and Business Actions, Methane Leak Data Detrital. The "Course Description" section explains that the course explores how citizen science can support community actions to combat climate change, with participants learning about framing problems, design ways to gather data, and consider how the results can enable action. The "Course Info" section lists the instructors: David Darm, Lubr, Hareesh, Kasturangan, Zeyneb, Maseel, Chris, Nidel, Nathan, Phillips, Audrey, Schulman, Britta, Voss, Jeff, Warner, and Ony, Zik. It also lists the topics: Energy, Climate, Fossil Fuels, Engineering, and Social Science. A video player at the bottom shows a session titled "Session 2: Methane Leak Measurement Hackathon" with a video player interface and a YouTube logo.

MIT OpenCourseWare

RES.ENV.001 | January MAP 2017 | Non-Credit

Climate Action Hands-On: Harnessing Science With Communities To Cut Carbon

Syllabus

- Session 1: Citizen Science and Climate Action
- Session 2: Methane Leaks Hackathon
- Session 3: Methane Leaks Field Trip "Safari"
- Session 4: Legal and Business Actions, Methane Leak Data Detrital

Course Description

This course explores how citizen science can support community actions to combat climate change. Participants will learn about framing problems, design ways to gather data, and consider how the results can enable action. Leaks in the natural gas system—a major source of methane — [Show more](#)

Course Info

INSTRUCTORS

- David Darm, Lubr
- Hareesh, Kasturangan
- Zeyneb, Maseel
- Chris, Nidel
- Nathan, Phillips
- Audrey, Schulman
- Britta, Voss
- Jeff, Warner
- Ony, Zik

TOPICS

- Energy
- Climate
- Fossil Fuels
- Engineering
- Social Science

[Download Course](#)

Session 2: Methane Leak Measurement Hackathon

MIT OpenCourseWare
5.5M subscribers

YouTube

HEET team here to help over the two days:



Zeyneb Magavi
Executive Director



Isabel Varela
Science Director



Kari Bender
Assistant to ED



Eric Juma
Technology



Angie Alberto Escobar
Community Gas-To-Geo



Molly Fairchild
Healthy Homes



Rachel Wheeler
Logistics



Andrew Iliff
Policy Director



Mike Ring
Funding



Tony Berry
Communications Director



Stacy Kinnaly
Project Director



Rebecca Brenneis
Scientist

Course Overview

Day 1



Framing the Challenge



People Landscape for GENs



Policy Landscape for GENs



Scaling GENs

Day 2



Design Principles of GENs



Construction of GENs



GENs Research and Impact



GENs Case Studies

Guest Lecturers

Day 1



Zeyneb Magavi, **HEET**
Jason Jay, **MIT**
Christoph Reinhart, **MIT**
Jonathan Buonocore, **BUSPH**



Nathan Phillips, **Boston University**
Chris Rabe, **MIT**
Kelsey Wirth, **Mothers Out Front**



Lorig Charkoudian, **MD State Delegate**
Ryan Murphy, **Climate Jobs**
Ania Camargo, **BDC**
James Van Nostrand, **Chair of DPU MA**



Sanjeev Kumar, **European Geothermal Council**
Nikki Bruno, **Eversource Energy**
Don Lessard, **MIT Emeritus**
Hela Cheikhrouhou, **IFC, World Bank Group**

Day 2



Connor Dacquay, **GeoFease**
Nick Fry, **Jacobs**
Brian Urlaub, **Salas O'Brien**



Garen Ewbank, **GreyEdge Group**
Mark Metzner, **Endurant Energy**
Brock Yordy, **Geothermal Drilling Association**
Eric Bosworth, **Eversource Energy**



Xiaobing Liu, **ORNL**
Isabel Varela, **HEET**
Juliet Simpson, **NREL**



Cary Smith, **Sound Geothermal Corporation**
Mark Metzner, **Endurant Energy**
Jay Egg, **EggGeo**
Susan Murcott, **MIT**

Housekeeping



This course is being recorded for sharing freely with the world through MIT OpenCourseWare



**Each session has brief presentations
Q&A at the end of each session - please participate !**

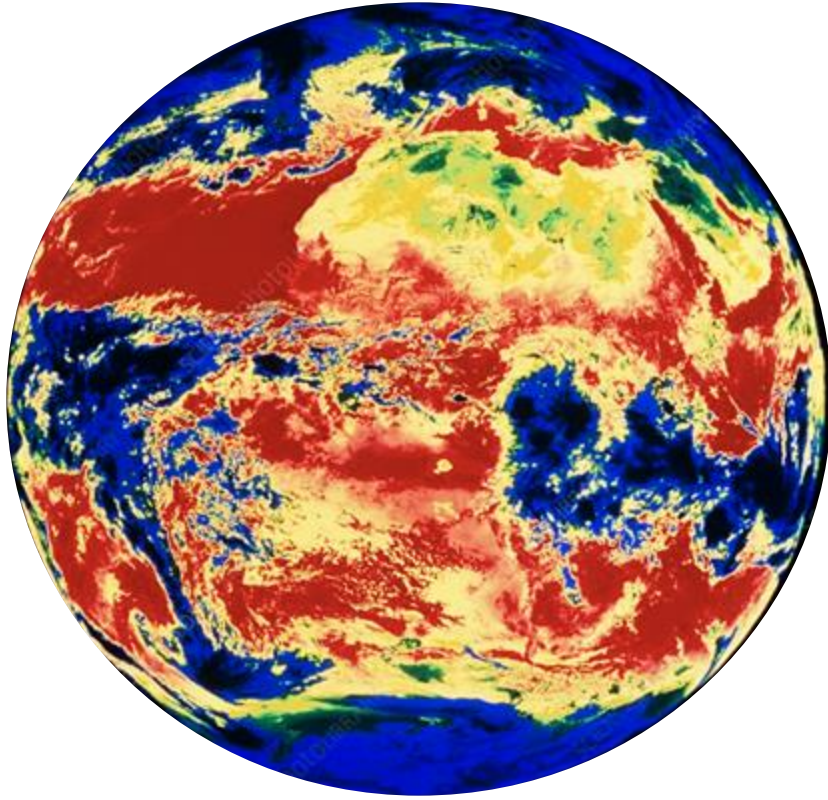


**First time offering this course
Evolving content - please provide ideas and feedback !**

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#ThinkThermalTogether



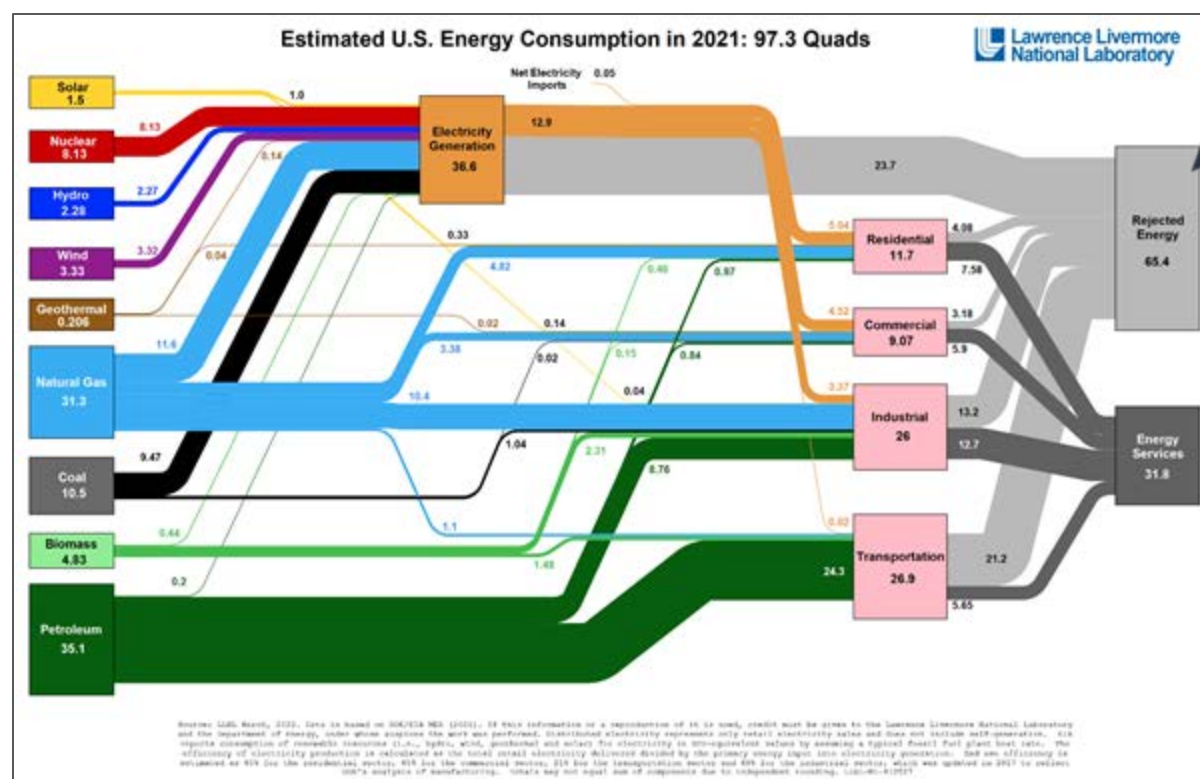
THINK THERMAL ?

“The technical potential of geothermal would be more than enough to meet all heat demand in Africa, China, Europe, Southeast Asia, and the United States.”

- IEA December 2024

The majority of the energy we use is wasted, much of it is

Thermal energy.



Source: public domain

UTILITY-SCALE
ELECTRICITY
(GEO POWER)

DISTRICT
HEAT
(GEO DIRECT USE)

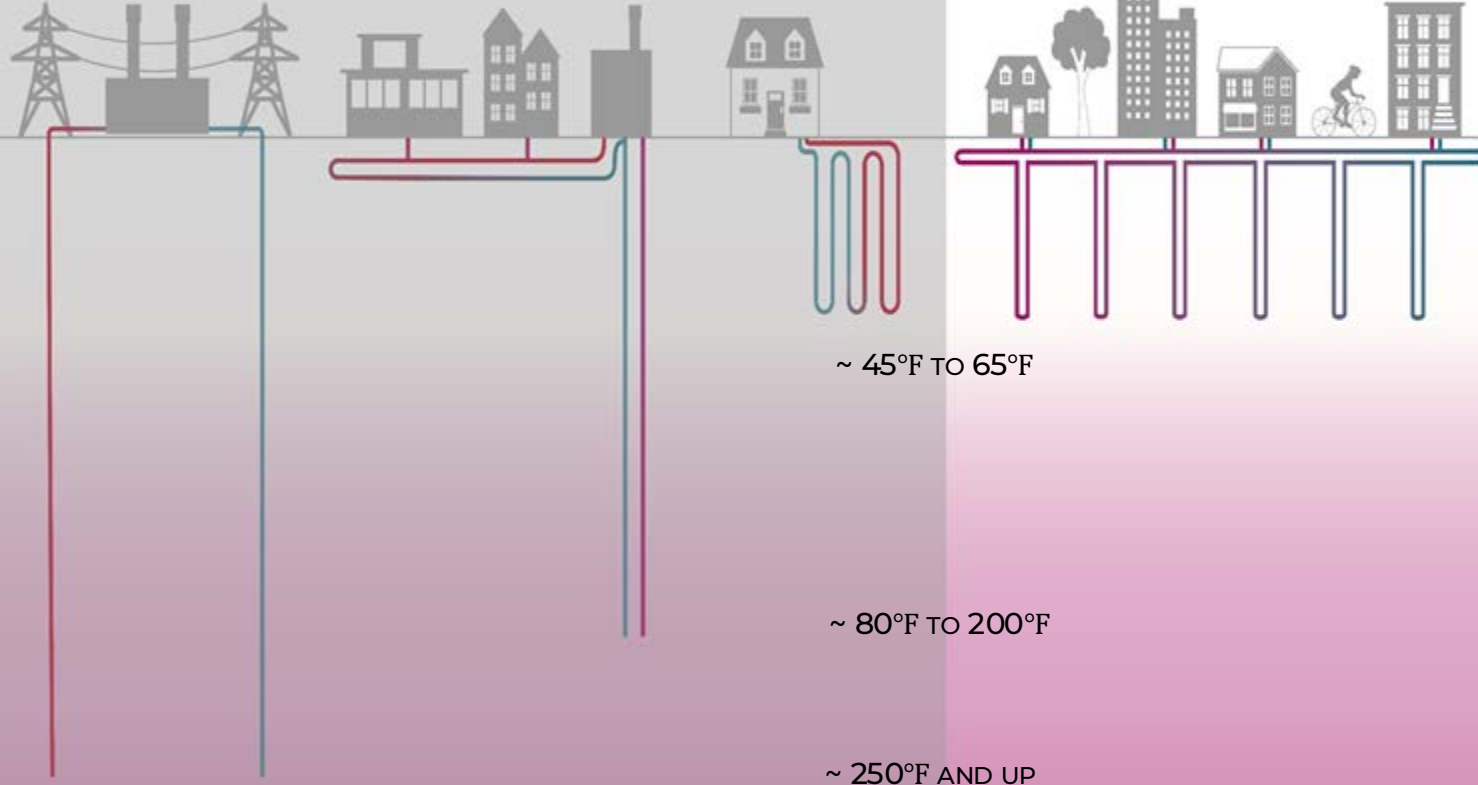
HEAT & COOLING
(GEO HEAT PUMP)

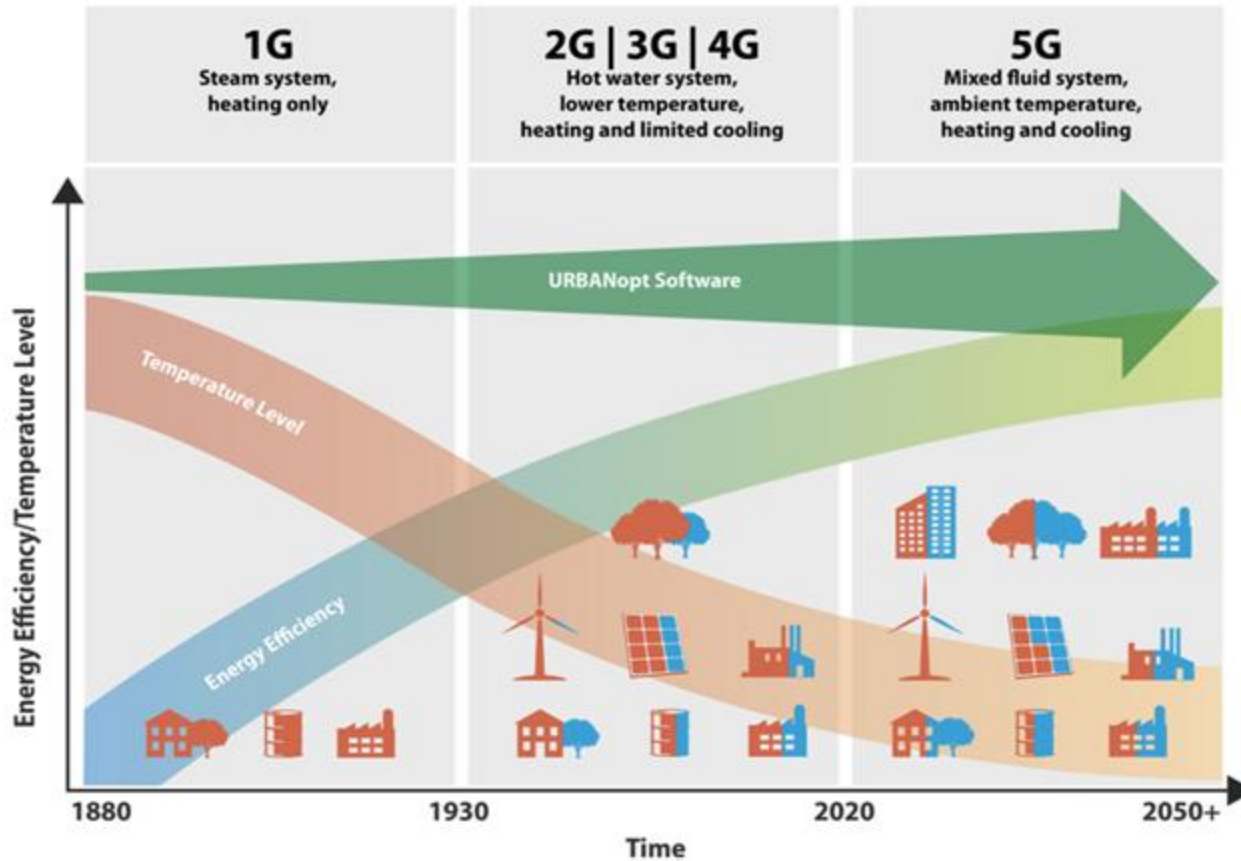
UTILITY-SCALE
HEAT & COOLING
(GEO NETWORK)

GEOTHERMAL ?

All Geothermal Technologies provide **STABLE** non-intermittent energy

- Shallow or Deep
- Ambient or Hot
- Everywhere or Not

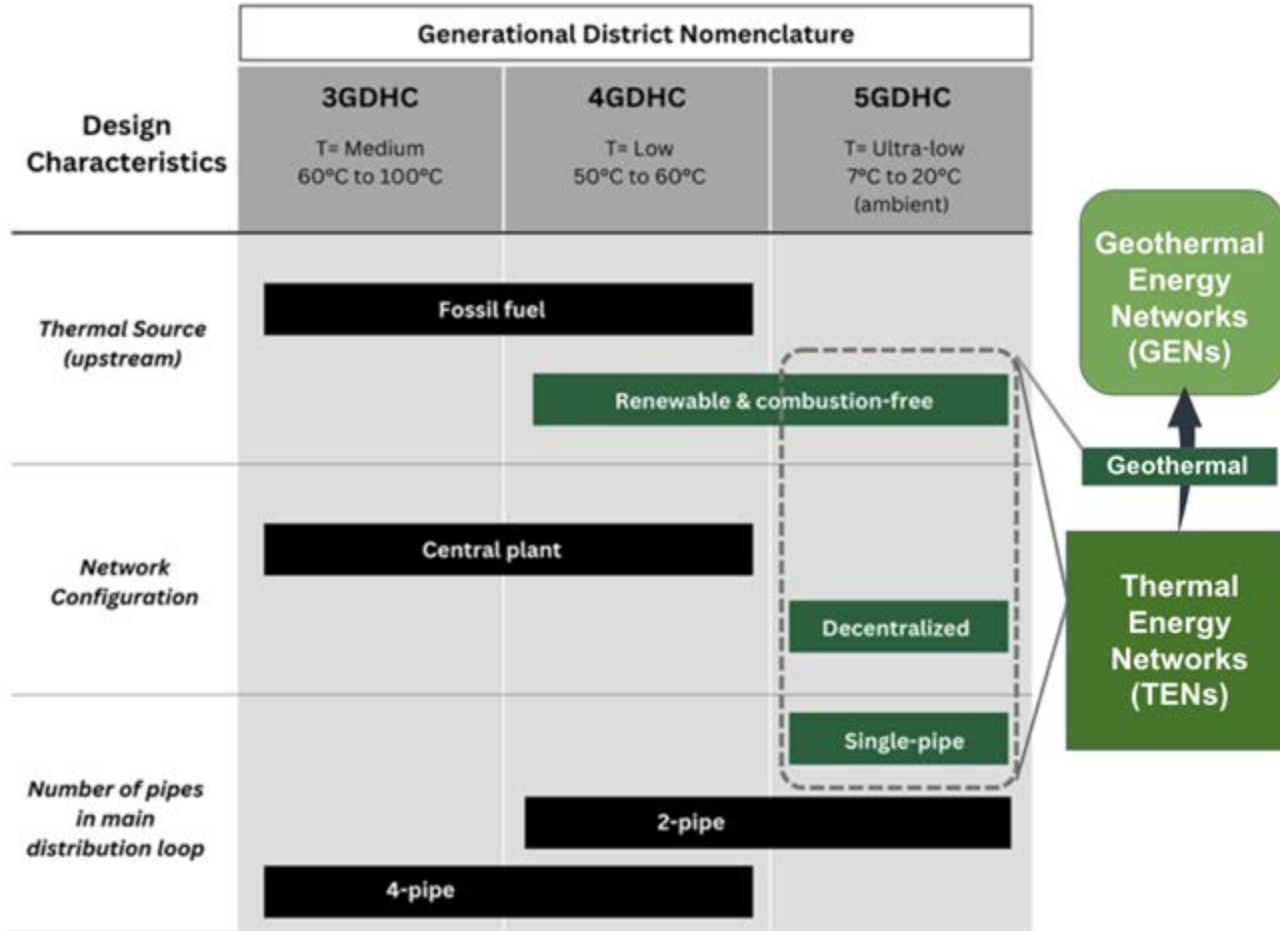




Source: public domain

DISTRICT ?

A simplified diagram of district energy from NREL (U.S. National Renewable Energy Labs)



ENERGY
NETWORK ?

Geothermal Energy Networks (GENs)

are a subset of

Thermal Energy Networks (TENSs)

which are a
subset of

5G Districts.



Engage All
Stakeholders



Innovate &
Iterate

MOVES AT
SPEED OF TRUST

Identify Leverage
Points



HEET's Approach
to Designing &
Driving Systems
Change

Used to develop
Geothermal
Energy Networks
& the Gas to Geo
Pathway

UTILITY-SCALE
ELECTRICITY
(GEO POWER)

DISTRICT
HEAT
(GEO DIRECT USE)

HEAT & COOLING
(GEO HEAT PUMP)

UTILITY-SCALE
HEAT & COOLING
(GEO NETWORK)

GEOTHERMAL ?

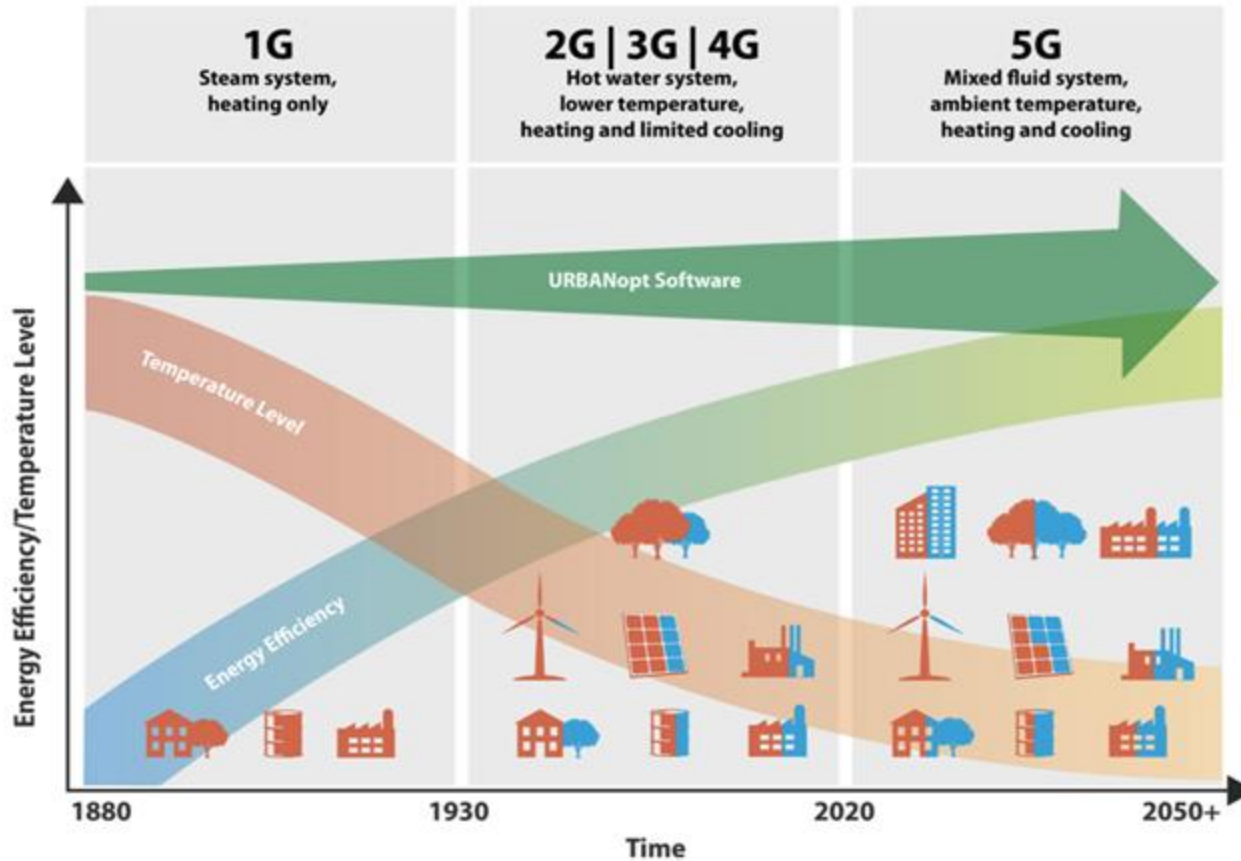
All Geothermal Technologies provide **STABLE** non-intermittent energy

- Shallow or Deep
- Ambient or Hot
- Everywhere or Not

~ 45°F TO 65°F

~ 80°F TO 200°F

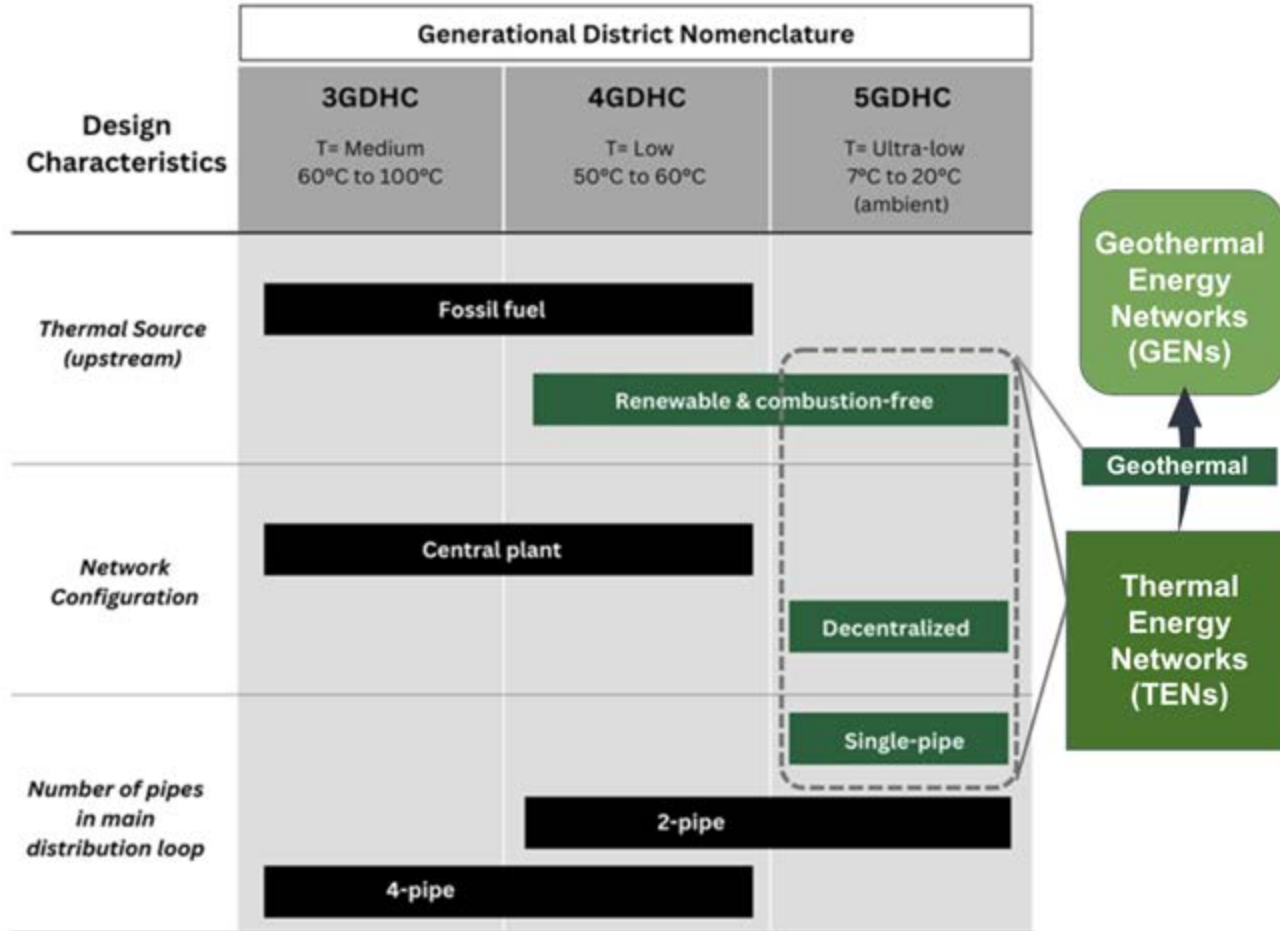
~ 250°F AND UP



Source: public domain

DISTRICT ?

A simplified diagram of district energy from NREL (U.S. National Renewable Energy Labs)



ENERGY
NETWORK ?

**Geothermal
Energy
Networks (GENs)**

are a subset of

**Thermal Energy
Networks (TENs)**

which are a
subset of

5G Districts.

Slido Quiz !





Session 1: Framing the Challenge

Moderator: Zeyneb Magavi, HEET

- A Systems View of the Energy Transition and Role of Methane Emissions, Jason Jay, MIT
- Carbon Reduction Pathways for Building Stocks, Christoph Reinhart, MIT
- Climate, Energy and Health Nexus for GENs, Jonathan Buonocore, BUSPH



SLIDO: What challenge are YOU trying to solve ?



Coffee Break





Session 2: People Landscape for GENs

Moderator: Ania Camargo, Building Decarbonization Coalition

- An Ecological View of the Energy Transition, Nathan Phillips, Boston University
- How GENs Can Meet Environmental Justice Priorities, Chris Rabe, MIT
- GENs Origins from Moms Searching to Protect Their Children's Future, Kelsey Wirth, Mothers Out Front



SLIDO: Brainstorm the key stakeholders



Lunch Break





Session 3: Policy Landscape for GENs

Moderator: Andrew Iliff, HEET

- Policy Case Study on the WARMTH Act, Lorig Charkoudian, Maryland State Delegate
- How Thermal Energy Networks (TENs) & GENs Can Meet Workforce Needs, Ryan Murphy, Climate Jobs
- The Rapidly Evolving Policy Landscape for GENs & TENs, Ania Camargo , Building Decarbonization Coalition
- The Potential Role of GENs in the MA Natural Gas Transition, James Van Nostrand, Chair of Department of Public Utilities Massachusetts



SLIDO: What is the largest policy challenge you see?



Coffee Break





Session 4: Scaling GENs

Moderator: Zeyneb Magavi, HEET

- The Growth of GENs in Europe, Sanjeev Kumar, European Geothermal Energy Council
- Utility Perspective on Scaling GENs, Nikki Bruno, Eversource Energy
- Business Models for Deploying GENs, Don Lessard, MIT (emeritus)
- Expanding GENs at a Global Scale, Hela Cheikhrouhou, International Finance Corporation, World Bank Group



SLIDO: Say it is a race - where will GENs get to scale first ?



Closing Day 1



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#ThinkThermalTogether



Session 5: Design Principles for GENs

Moderator: Juliet Simpson, NREL

- **Introduction to Geothermal Heat Pumps, Connor Dacquay, GeoFease**
- **Systemic Differences Between Geothermal Heat Pumps and GENs, Nick Fry, Jacobs**
- **Introduction to Design of GENs, Brian Urlaub, Salas O'Brien**



SLIDO: What advantages does a single-pipe ambient-temp loop design provide?



Coffee Break





Session 6: Construction of GENs

Moderator: Isabel Varela, HEET

- **Thermal Response Tests for Geothermal Boreholes**, **Garen Ewbank**, GreyEdge Group
- **Emerging Code & Standards for Ambient Temperature Loops**, **Mark Metzner**, Endurant Energy
- **Introduction to Drilling Geothermal Boreholes**, **Brock Yordy**, Geothermal Drilling Association
- **Constructing and Commissioning a GEN**, **Eric Bosworth**, Eversource Energy



SLIDO: What innovations are most needed to build more, faster, for less ?



Lunch Break





Session 7: Researching GENs & Impacts

Moderator: Zeyneb, HEET

- Discussion on existing grid impact knowledge with guests, **Xiaobing Liu**, ORNL
- Learning from GENs, **Isabel Varela**, HEET
- Techno-Economic Modeling of GENs, **Juliet Simpson**, NREL



SLIDO: What data is needed to unlock investment and scaling?



Coffee Break





Session 8: Case Studies of GENs

Moderator: Nick Fry, Jacobs

- **Colorado Mesa University, CO, Cary Smith**, Sound Geothermal Corporation
- **Framingham, MA, Mark Metzner**, Endurant Energy
- **Penn South Cooperative, Manhattan**, Jay Egg, EggGeo
- **MIT Thermal Energy Network (MITTEN) Plan, Susan Murcott**, MIT



SLIDO Plusses, Deltas, and Key Learnings



THANK YOU to the Guest Lecturers - Thursday

8:45 AM Breakfast and Registration

9:15 AM 1) Framing the Challenge



Moderator: Zeyneb Magavi, HEET

A Systems View of the Energy Transition and Role of Methane Emissions, Jason Jay, MIT

Carbon Reduction Pathways for Building Stocks, Christoph Reinhart, MIT

Climate, Energy and Health Nexus for GENS, Jonathan Buonocore, Boston University School of Public Health

10:30 AM Coffee Break

11:00 AM 2) People Landscape for Geothermal Energy Networks (GENs)



Moderator: Ania Camargo, Building Decarbonization Coalition

An Ecological View of the Energy Transition, Nathan Phillips, Boston University

How GENs Can Meet Environmental Justice Priorities, Chris Rabe, MIT

How GENs Arose out of Moms Organizing to Protect Their Children's Future, Kelsey Wirth, Mothers Out Front

12:00 PM Lunch

1:00 PM 3) Policy Landscape for Geothermal Energy Networks



Moderator, Andrew Illif, HEET

Policy Case Study on the WARMTH Act, Lorig Charkoudian, Maryland State Delegate

How Thermal Energy Networks (TENS) & GENs Can Meet Workforce Needs, Ryan Murphy, Climate Jobs

The Rapidly Evolving Policy Landscape for GENs & TENS, Ania Camargo, Building Decarbonization Coalition

The Potential Role of GENs in the Massachusetts Natural Gas Transition, James Van Nostrand, Chair of Department of Public Utilities MA

2:30 PM Coffee Break

3:00 PM 4) Scaling Geothermal Energy Networks



Moderator, Zeyneb, HEET

The Growth of GENs in Europe, Sanjeev Kumar, European Geothermal Energy Council

Utility Perspective on Scaling GENs, Nikki Bruno, Eversource Energy

Business Models for Deploying GENs, Don Lessard, MIT (emeritus)

Expanding GENs at a Global Scale, Hela Cheikhrouhou, International Finance Corporation, World Bank Group

4:10 PM Closing

4:30 PM Adjourn

THANK YOU to the Guest Lecturers - Friday

8:45 AM Welcome and Breakfast

9:15 AM **5) Design Principles of Geothermal Energy Networks**



Moderator, Juliet Simpson, NREL

Introduction to Geothermal Heat Pumps, Connor Dacquay, GeoFease

Systemic Differences Between Geothermal Heat Pumps and GENs, Nick Fry, Jacobs

Introduction to Design of GENs, Brian Urlaub, Salas O'Brien

10:30 AM Coffee Break

11:00 AM **6) Construction and Commissioning of Geothermal Energy Networks**



Moderator, Isabel Varela, HEET

Thermal Response Tests for Geothermal Boreholes, Garen Ewbank, GreyEdge Group

Emerging Code & Standards for Ambient Temperature Loops, Mark Metzner, Endurant Energy

Introduction to Drilling Geothermal Boreholes, Brock Yordy, Geothermal Drilling Association

Constructing and Commissioning a GEN, Eric Bosworth, Eversource Energy

12:30 PM Lunch

1:30 PM **7) Researching Geothermal Energy Networks and their Impacts**



Moderator, Zeyneb, HEET

Discussion on existing grid impact knowledge with guests, Xiaobing Liu, ORNL

Learning from GENs, Isabel Varela, HEET

Techno-Economic Modeling of GENs, Juliet Simpson, NREL

2:30 PM Coffee Break

3:00 PM **8) Case Studies of Geothermal Energy Networks**



Moderator, Nick Fry, Jacobs

Colorado Mesa University, CO, Cary Smith, Sound Geothermal Corporation

Framingham, MA, Mark Metzner, Endurant Energy

Penn South Cooperative, Manhattan, Jay Egg, EggGeo

MIT Thermal Energy Network (MITTEN) Plan, Susan Murcott, MIT

4:10 PM Closing

4:30 PM Adjourn

THANK YOU to ALL of you for #ThinkingThermalTogether



Until Next Year !



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<https://ocw.mit.edu/>

RES.ENV 007 Geothermal Energy Networks (GENs): Transforming our Thermal Energy System

IAP 2025

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