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Geothermal Development and Environmental Considerations

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An Introduction to Geothermal Energy
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Presentation Overview

- Phases of Geothermal Development
- Regulatory Environment
- Environmental Impacts and Mitigation Measures
- Comparison of Impacts

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Phases of Geothermal Development

Development Scenario

Exploration

- Temp gradient holes (TGH)
- Well pads
- Deep wells
- Roads

Development

- Production wells
- Pipelines
- Power plant or direct use facility
- Transmission line

Utilization

- Power plant operation
- District heating
- Greenhouse, etc.

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Regulatory Environment

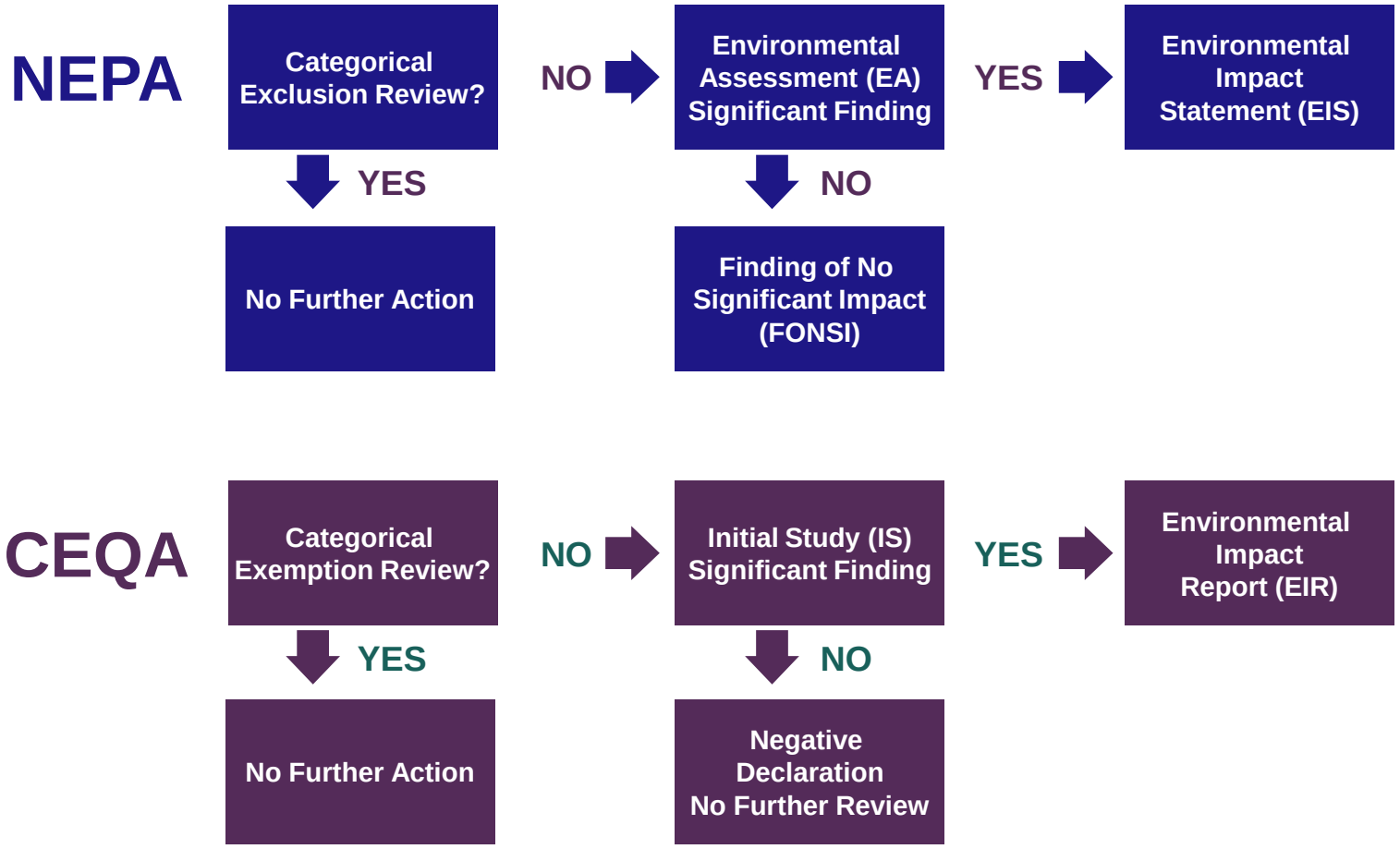
Regulatory Agency Involvement

- Federal land manager
- Use Permit from local jurisdiction
- Other permits (air, water, biological resources, well permits)

Key Regulations

- California Environmental Quality Act (CEQA)
- National Environmental Policy Act (NEPA)
- Clean Air Act
- Clean Water Act
- National Historic Preservation Act
- Endangered Species Act
- State and local ordinances and regulations

CEQA/NEPA Process



Public Involvement

What is public outreach?

- Public outreach is a process to inform and involve interested parties in the decision making process

Why is it required?

- Regulations
- Success and support of a project in a community

What is the purpose?

- Inform the public
- Develop an environmentally friendly and economically viable project

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Environmental Impacts and Mitigation

Definitions

Environment

- Physical conditions that exist within an area that will be impacted by a proposed project

Impact

- A change as a result of an action
- Direct and indirect

Mitigation

- Avoiding, minimizing, reducing or eliminating over time, or compensating for impacts on the environment

Determining Impacts

What goes in?

- **Water**
- **Fuel**

- **Emissions**
- **Waste**

What comes out?

Most Common Categories of Impacts

- Air quality effects
- Groundwater
- Induced seismicity
- Cultural resources disturbance
- Biological resources
- Noise
- Visual/Aesthetics

Addressing Environmental Issues

Impact	Approach to Mitigation
Air emissions	• Abatement and technologies for key pollutants • Monitoring program
Depletion of groundwater	• Identify long-term water needs • Consider cooling system • Early planning for long term needs • Re-injection for direct use
Induced seismicity	• Injection usually too shallow – site wells away from large faults • Analysis by expert • Usually no effect to property

Addressing Environmental Issues

Impact	Approach to Mitigation
Damage to resources or tribal concerns	• Understand issues early and consult with tribes • Avoid archaeological sites/have monitor • Reduce visibility of facility, provide access, monitor hot springs
Effects to Endangered Species	• Conduct surveys and consult with agencies • Avoid as feasible • Compensation
Noise pollution	• Address by phase of project, perform studies • Sound walls during construction or drilling • Noise muffling techniques • Design of turbine generator building

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Comparison of Impacts

Comparison of Impacts

- **Oil/Gas generation has:**
  - Greater effects from air pollution, greenhouse gas emissions, fuel resource transportation (trucking and pipelines)
- **Other renewable energy has:**
  - Much greater land area required, greater visual impacts, intermittent power (not baseload), effects to fish from hydropower

Comparison of Impacts

Impact	Traditional Fuels	Solar and Wind
Air emissions	Much More	Less
Biological	Similar or More	More
Cultural resources	Similar or More	More
Noise	Similar	Wind – More Solar – Less
Water Resources	More	Wind – Less Solar – Similar
Visual Effects	More	More
Land Use	Similar	Much More

Summary

- Key impacts of geothermal development are are emissions, land use conflicts, biology, potential seismicity
- Impacts can be mitigated
- Impacts less than traditional fuels