Low Temperature, Coproduced, and Geopressured Geothermal Technologies

Strategic Action Plan

DRAFT August 2010

Sponsored by
Geothermal Technologies Program
Energy Efficiency and Renewable Energy
U.S. Department of Energy

Prepared by
Energetics Incorporated

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

ENERGETICS
A Subsidiary of VSE Corporation

Project Summary

- Vision meeting in February 2010
- Follow-up to vision in May 2010
- Roadmapping workshop in July 2010
- ***Follow-up to workshop in August 2010***
- Final Roadmap complete in September 2010

Results of the Vision Meeting

Our vision is to provide the global geothermal community with the means to achieve development and widespread deployment of economically viable, innovative, and scalable technologies—including those involving coproducts—that will capture a significant portion of the low-temperature geothermal resource base over the next two decades.

LCOE

The first metric, levelized cost of energy (LCOE) accounts for costs of energy production over the lifetime of the system (30-year assumption).

Number of Projects Started

The desire to spread use of geothermal energy across a larger geographic area should result in increased projects.

Installed Capacity

Installed capacity measures rate of power generation for the plant.

Capacity Factor

Capacity factor paints geothermal in a favorable light as compared to other alternative energies, where actual power production rates depend on sunlight availability, wind conditions, and weather. Geothermal energy generation, however, continues during nighttime hours, in all types of weather, and during all seasons.

Goals of the LTCG Roadmap

- Keep the vision and goals as the underlying driver of the effort
- Develop a strategic line of sight
- Define specific efforts that DOE can focus on in partnership with other stakeholders

Key Characteristics Of the 3 GW Future

Six Main Themes Were Identified by Workshop Participants

Educated and Engaged Public

Citizens, investors, and lawmakers will be equipped with accurate data and knowledge to understand and support LTCG production and use.

Industry Engagement and Partnership

In addition to fully integrated systems, a 3 GW future for LTCG requires engagement of and partnerships with the oil and gas industry and other renewable industries as well as a broad range of industrial, residential, and commercial communities that can take advantage of widespread point of use generation.

Demonstration and Validation of Critical Advanced Technologies

Deployment and generation of LTCG power depends on industry and government to have demonstrated, tested and validated innovative technologies that meet the advanced criteria (e.g. improved efficiency for reducing O&M costs, increased success rates of trial wells) needed to bring costs down and reduce risk.

Fully Integrated Systems

When advanced LTCG is deployed on a large scale, it will be integrated into the existing energy infrastructure, for example, through connections to the grid and other industry processes (e.g. CO_2 sequestration, CHP, oil and gas wells).

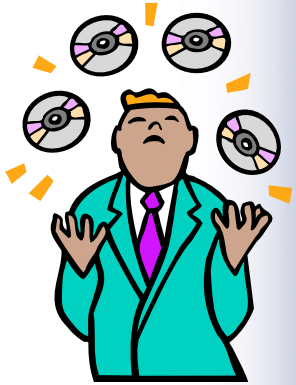
Defined and Predictable Risk

In a 3 GW future, potential geothermal resources are well characterized and risk mitigation strategies, including cost-sharing mechanisms, are widely available.

Improved Policy and Permitting Process

Streamlined permitting processes, financial incentives, and more supportive and efficient government operations will be in place to ease the financial burdens of deploying new, higher-risk LTCG technologies.

HIGH PRIORITY ACTIONS



The scope of the LTCG Subprogram's efforts is delimited by three areas of activity:

- **Advancing Technologies**
- **Fostering Deployment**
- **Informing Policy**

The strategic action plan identifies high priority actions in each of these areas, through which the subprogram will help the community reach the 3GW goal.

LTG Subprogram Strategic Framework

Vision & Goal

Widespread deployment of economically viable, innovative, and scalable technologies will capture a significant portion of the low-temperature geothermal resource.

3 GW of installed low-temperature geothermal capacity by 2020

Future Characteristics

- Educated and Engaged Public
- Industry Engagement and Partnership
- Demonstration and Validation of Critical Advanced Technologies
- Fully Integrated Systems
- Defined and Predictable Risk
- Improved Policy and Permitting Processes

High Priority Actions

Advancing Technology

- >Develop Full-Fledged Low-Temperature Geothermal Validation Facility
- >Innovative Cooling Systems (Reduced Water Consumption)
- >Conduct Subsurface Fluid Flow Reservoir Studies
- >High-Risk Research on Energy Conversion
- >Advanced Reservoir Simulation
- >Organic Ranking Cycle Development
- >Advance Technology that Fosters Development
- >Conduct and Industrial Demonstration Program

Fostering Deployment

- >Perform Techno-Economic Evaluations (Coproduction, Low-Temperature, and Geopressured Systems)
- >Identify and Address Technical and Economic Constraints
- >Develop Database/Tool-Portal (centralized data, tools, education)
- >DOE Internal Collaboration Between Low-Temperature, Geopressure, and Oil & Gas Coproduction
- >Gather Data to Develop National Database
- >Estimate Resource Potential

Informing Policy

- >Facilitate and Streamline the Permitting Process
- >Facilitate State Laws and Regulations Development
- >Conduct Public Education to Promote Geothermal Energy
- >Permitting Optimization and Automation

LT Geothermal Vision & Goal

Strategic Line of Sight

Subprogram Efforts

Advancing Technology

Advancing Technology – High Priority Activities

- Develop Full-Fledged Low-Temperature Geothermal Validation Facility
- Innovative Cooling Systems (Reduced Water Consumption)
- Subsurface Fluid Flow Reservoir Studies
- High-Risk Research on Energy Conversion
- Advanced Reservoir Simulation
- Organic Ranking Cycle Development
- Advancing Technology that Fosters Development
- Industry Demonstration Program

High Priority 3: Subsurface Fluid Flow Reservoir Studies
(understanding flow, permeability, size, lifetime/longevity of reservoir

Key Components/Tasks

- Model thermal properties of horizontal wells
- Develop new exploration tools and new subsurface working fluids (e.g., CO_2)
- Identify and explore a geopressured reservoir

Partners/ Stakeholders

- Oil and gas industry, national laboratories, and universities *(challenge 1)*
- Medical imaging community (for MRI) and Oil and Gas industry with national laboratories and universities *(challenge 2)*
- CO_2 regeneration partnerships (e.g., Plains CO_2 Reduction Partnership) and Oil and Gas and Coal industries (e.g., power plants or ethanol plants, national laboratories, and universities) *(challenge 3)*
- Oil and gas industry, national laboratories, and universities *(challenge 4)*

Initially: government, universities and labs in collaboration with industry. Later: transition to majority industry funding and involvement as otherwise not enough funds are available *(to address challenges 1–4)*

Results/Desired Outcome

- Improve heat extraction rates and render scalable
- Develop characterization of reservoirs and Minimize risks
- Improve (~double) heat mining efficiencies compared to water and reduce or eliminate water usage
- Add to U.S. Geological Society geopressured reservoir database

Challenges and Obstacles

- Lack of numerical simulators or input data
- Cultural noise, e.g., electromagnetic, seismic, and vibrations
- Obstacles associated with CO_2 sequestration and enhanced oil recovery, e.g., CO_2 leakage, establishment of carbon cap-and-trade market (not necessary), and CO_2 hydrocarbon mixing
- Difficulties identifying over-pressured formations

Milestones

1) Co-production base/applied

Start date: Oct. 2010 — End date: Sept. 2013

2) Low-temperature research

Start date: Oct. 2010 — End date: Sept. 2013

3) Geopressed

Start date: Oct. 2010 — End date: Sept. 2013

Fostering Deployment

Fostering Deployment – High Priority Activities

- Perform Techno-Economic Evaluations (Coproduction, Low-Temperature and Geopressured Systems
- Develop Database/Tool-Portal (centralized data, tools, education)
- DOE Internal Collaboration Initiative Between Low-Temperature, Geopressure, and Oil & Gas Coproduction
- Identify and Address Technical and Economic Constraints
- Gather Data to Develop National Database
- Estimate Resource Potential

High Priority 1: Perform Technoeconomic Evaluations
(Co-Production, Low-Temperature, and Geopressured Systems)

Key Components/Tasks

- Gather existing cost data for capital and drilling, and surface and subsurface
- Collect relevant reservoir data and develop design scenarios and reservoir simulations for subsurface scenarios
- Conduct sensitivity analysis on reservoir production, design scenarios, policy, or incentives to characterize uncertainty.
- Calculate financial or systems based on the sensitivity analysis cash flow, net present value, and payback
- Apply learning curves to cost curves

Partners/ Stakeholders

Co-produced and geopressured

- Oil and gas—need their data and their buy-in
- Local communities—have a demand for distributed electric on direct use needs

Low-Temperature

- Geothermal producers—have a Potential for bottoming cycles and wells of opportunity
- Manufacturers of plants
- Local communities

* both National Renewable Energy Laboratory analysis groups *[WHICH ONES]*

Results/Desired Outcome

- Providea rated list of options, in financial terms, of the benefits of deploying low-T, co-produced, or geopressured geothermal energy systems
- Help private industry make informed decisions for deployment and inputs to supply curves

Challenges and Obstacles

- Lack of availability or accuracy of data
- Uncertainty of the lifetime of reservoirs, analysis, and predictive methods
- Uncertainty in purchase power agreements (PPAs), requirement-type contracts (RTCs), etc.

Milestones

- Database of relevant existing cost data, reservoir, and available technology options completed
- Ranked list of technology scenarios based on economic evaluation completed
- Documented costs of a wide range of inputs (design scenarios)

Informing Policy

Informing Policy – High Priority Activities

- Facilitate and Streamline Permitting Process
- Facilitate State Laws and Regulations Development
- Conduct Public Education to Promote Geothermal Energy
- Permitting Optimization and Automation

High Priority 1: Facilitate and Streamline Permitting Process

Key Components/ Tasks

- Conduct background and literature studies based on wind and solar development challenges
- Identify relevant agencies and their respective requirements
- Map out current processes and highlight problem areas
- Create and release a funding opportunity announcement (FOA) based upon findings in above tasks.

Partners/ Stakeholders

- Developers—finance and approval
- Regulatory agencies
- Government and politicians

Results/Desired Outcome

- Streamline method for completing the permitting process
- Dramatically reduce time, money, and confusion
- Identify favorable opportunities regarding site, size, and etc.

Challenges and Obstacles

- Conflicts with existing bureaucracies
- Constantly changing regulations
- Interstate and interagency variations

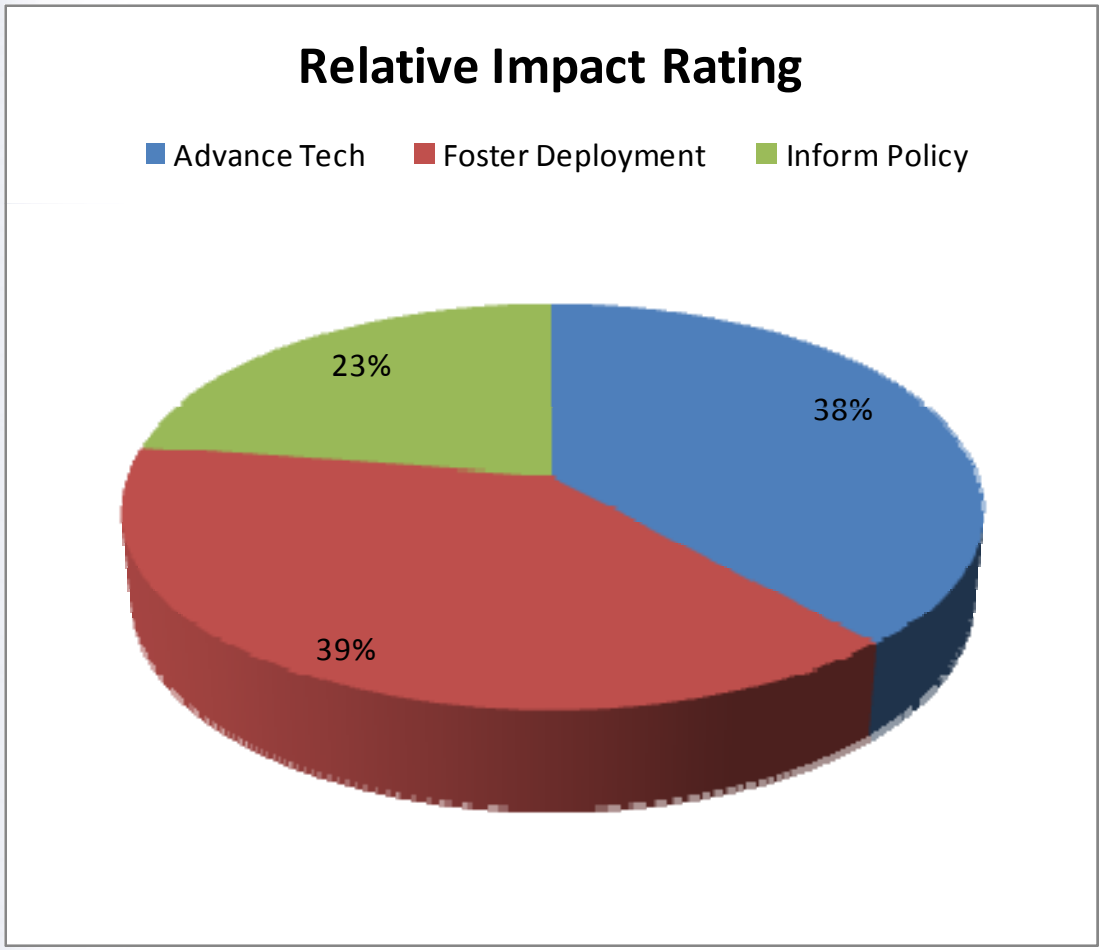
Milestones

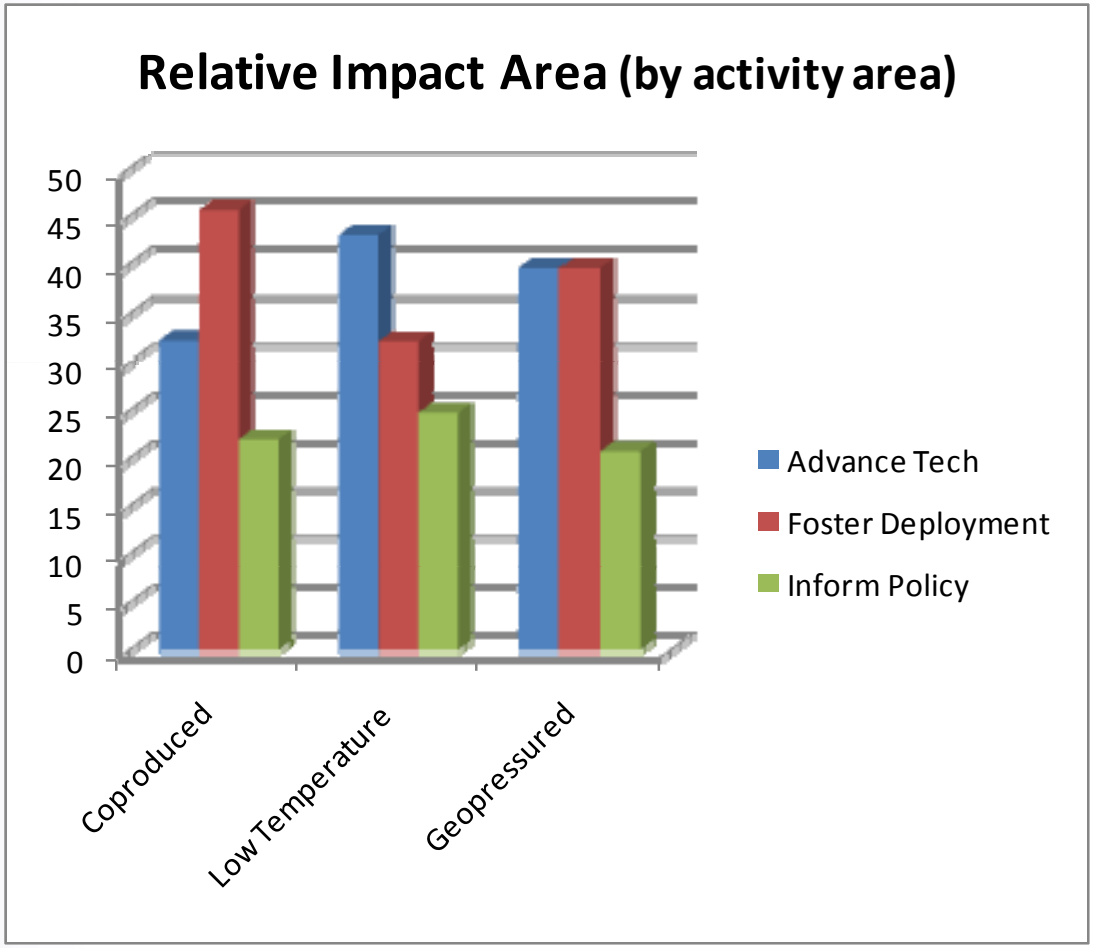
- Milestone 1: Complete background study (January 1, 2011)
- Milestone 2: Complete final deliverables (March 31, 2011)
- Milestone 3: Release FOA (April 1, 2011)

Milestone 1 ⟷ Milestone 2 / Milestone 3

Start Date: Oct. 2010 (1st quarter 2011)

End Date: March 31, 2011 (End of 2nd quarter 2012)


Relative Impact Rating
Advance Tech
Foster Deployment
Inform Policy
23%
38%
39%


Relative Impact Area (by activity area)
50
45
40
35
30
25
20
15
10
5
0
Coproduced
Low Temperature
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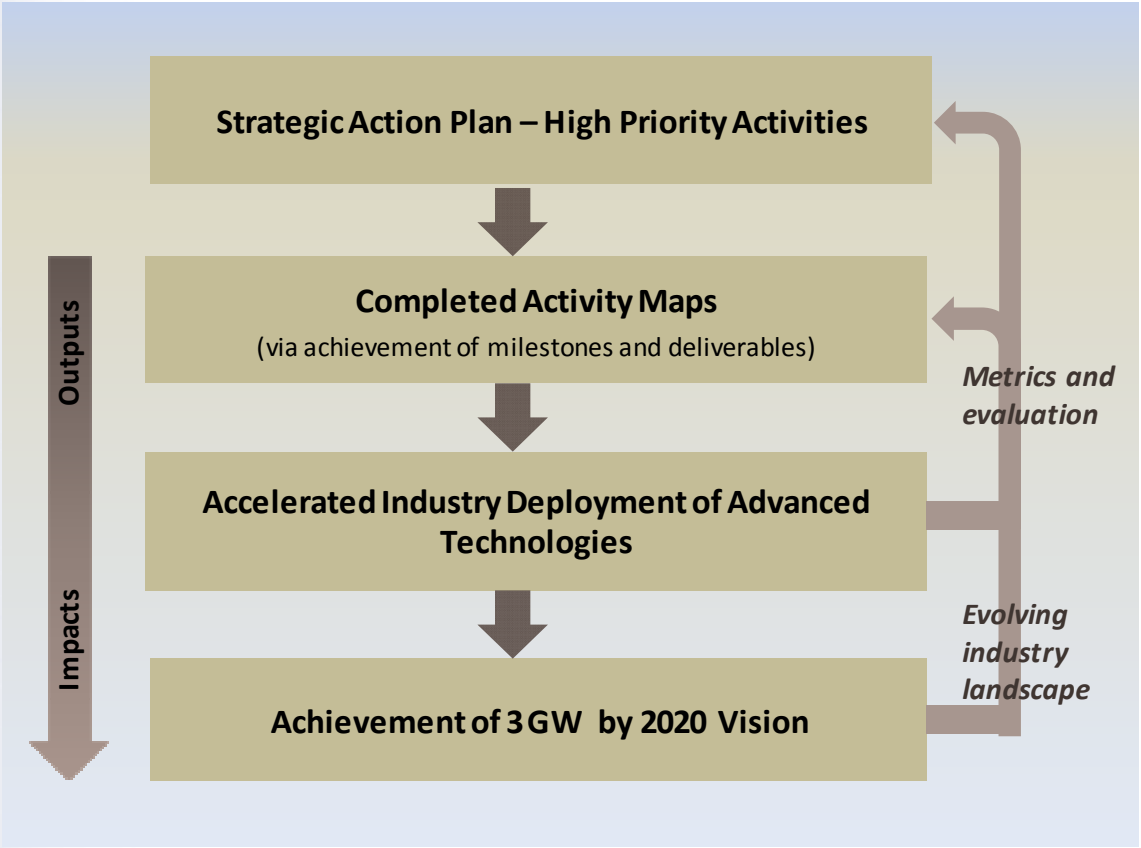
Going forward…



Goals for Next Review

- Review and comment on Draft document by visiting the DOE Geothermal Website
- Provide any comments directly to Chris Clark - cclark@energetics.com
- Questions