MARKET PENETRATION OF GEOTHERMAL ENERGY FOR INDUSTRIAL AND RESIDENTIAL APPLICATIONS

PREPARED BY:

RONALD J. THOMAS

AND

RICHARD A. NELSON

TECHNICAL RESEARCH ANALYSIS

COMPANY

PURPOSE OF ANALYSIS

- Investigate the Feasibility of Applying a General Market Penetration Procedure to Residential and Industrial Direct Heat Geothermal Applications in the United States

- Provide the Division of Geothermal Energy (DGE) with a Policy Planning Tool Based on:

  — Market Penetration Estimates for Mid- and Long-Term Time Periods (1985-2010)

  — Method for Assessing Market Impacts Resulting from Changes in Energy and Economic Variables

STATES CONSIDERED FOR MARKET PENETRATION ANALYSIS

● = Geothermal—Eastern United States
▲ = Geothermal—Western United States

EASTERN STATES
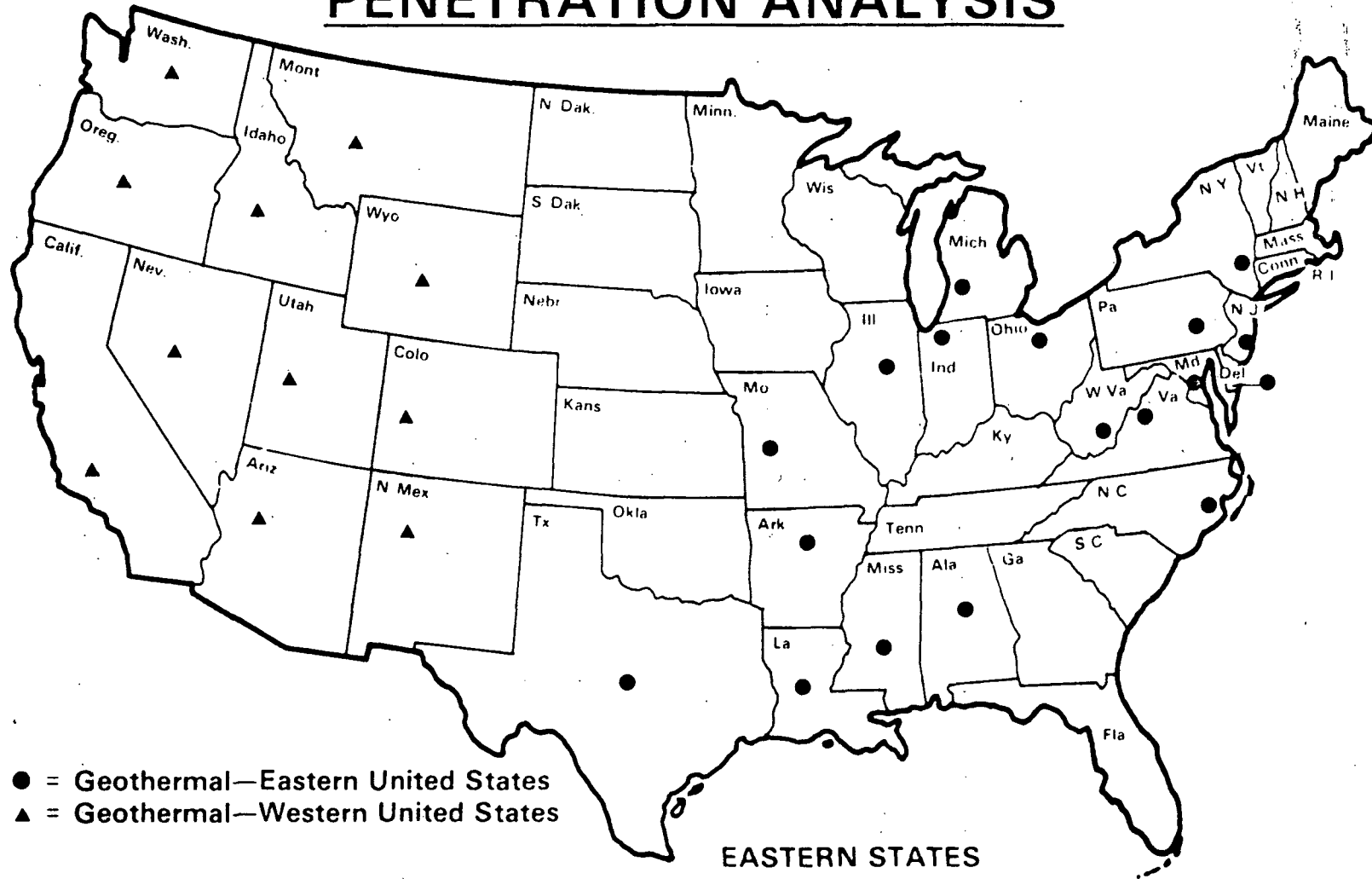
Alabama	Maryland	North Carolina
Arkansas	Michigan	Ohio
Delaware	Mississippi	Pennsylvania
Illinois	Missouri	Texas
Indiana	New Jersey	Virginia
Louisiana	New York	West Virginia

ASSESSMENT METHODOLOGY

- Implement a Procedure that Accounts for:
  - Consumer Uncertainty
  - Diffusion of Geothermal Energy into the Energy Market

- Develop a Logistic Model:
  - Linked to a Dynamic Adjustment Process to Generate Model Estimates on a State and Regional Basis
  - Based on a State/Regional Comparison of Resource Characterizations and Market Conditions for Geothermal Direct Heat Versus Conventional Applications

FOCUS OF THE MARKET PENETRATION ANALYSIS

- Compare the Attractiveness of Geothermal Energy Relative to Conventional Energy Sources for Particular Market Applications.

- Determine the Rate of Penetration of Geothermal Systems into the Residential Space and Water Heating Market and the Industrial Low Temperature Process Heat Market

COMPARATIVE STATIC MODEL ASSUMPTIONS

- Consumers are Fully Informed about the Relative Costs of Geothermal and Conventional Energy Sources

- Consumers Will Seek Out Sources of Energy Which Have Lower Costs

- Market Conditions Would not Impede Instant and Total Conversion to the Lowest-Cost Source of Heating

- Eventual Equilibrium Market Share for Geothermal Energy Will be that Share of the Market for which Geothermal Provides the Lowest Cost Alternative

DYNAMIC PROCESS CONDITIONS

- Consumer Uncertainty Exists for a New Unproved Technology

- Large Initial Capital Investment Implies a Greater Risk Factor

- Consumer Confidence in Geothermal Energy Applications Will Increase Over Time

- Learning Process Will Generate an Accelerating Market Penetration Rate

- Market Saturation Will Occur when the New Installation Market is Greater than the Replacement Installation Market

GENERALIZED MODEL FORMAT

$$\bullet \; MSE = \frac{1}{1 + [ACG_{i,t}/ACC_{i,t}]^{a}}$$

WHERE:

MSE = Equilibrium Market Share

$ACG_{i,t}$ = Annualized Cost of Geothermal Energy (ACG) for a Particular State (i) Over a Given Time Period (t)

$ACC_{i,t}$ = Annualized Cost of Conventional Energy (ACC) for a Particular State (i) Over a Given Time Period (t)

a = Response Parameter (Elasticity of Substitution Between Geothermal and Conventional Energy Sources)

GENERALIZED MODEL FORMAT

● $dy/dt = A \; [(P_t \; (1 - P_t)]$

WHERE:

dy/dt = Rate of Conversion to Geothermal Energy

A = Market Adjustment Coefficient

P_t = Proportion of the Market Already Converted to Geothermal at Time t

COMPILATION OF GEOTHERMAL ENERGY COSTS

$$\bullet \ ACG_j = \frac{1}{EG_j} [KG_j \bullet CRF \bullet (OM - TC + D_j)]$$

WHERE:

KG_j = Capital Cost of the Geothermal System for State j

EG_j = Energy Output of the Generic System for State j

CRF = Capital Recovery Factor

OM = Operation and Maintenance Costs

TC = Investment Tax Credit

D = Combined Effect on the Amount of Revenue of Interest Payments on the Debt, Depreciation, and Cost of Capital for State j

CONCLUDING REMARKS

- Generalized Market Penetration Approach is Feasible

- Specific Results will be Generated in Phase II of the Project

- Model Significance for Policy Planning Purposes is Based on the Relative Values and Sensitivities as Opposed to the Absolute Values of the Forecast Data

- Approach Provides a Low Cost Procedure to Test Significance of Key Market Variables

- Improved Data and Information from State Geothermal Participants will Enhance the Market Penetration Effort, and Aid DGE in Commercialization Efforts