

U.S. Regional MARKAL Model Development



Presented At:
**Technical Conference of Energy Models Users' Group: Global and
Regional Energy Modeling**

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Presentation Overview

- U.S. MARKAL Background
- Objective
- Why Regionalize U.S. MARKAL
- Approach and Model Design

U.S. MARKAL Background

- The present U.S. MARKAL model operates at a national level with some regional characterization embedded in the underlying database
- The model assists the DOE Office of Energy Efficiency and Renewable Energy (EERE) and Office of Nuclear Energy in:
 - Program goal setting
 - Formulation of technology development programs and policies over the mid-to-long-term
 - Program benefits estimation

U.S. MARKAL Regionalization Objective

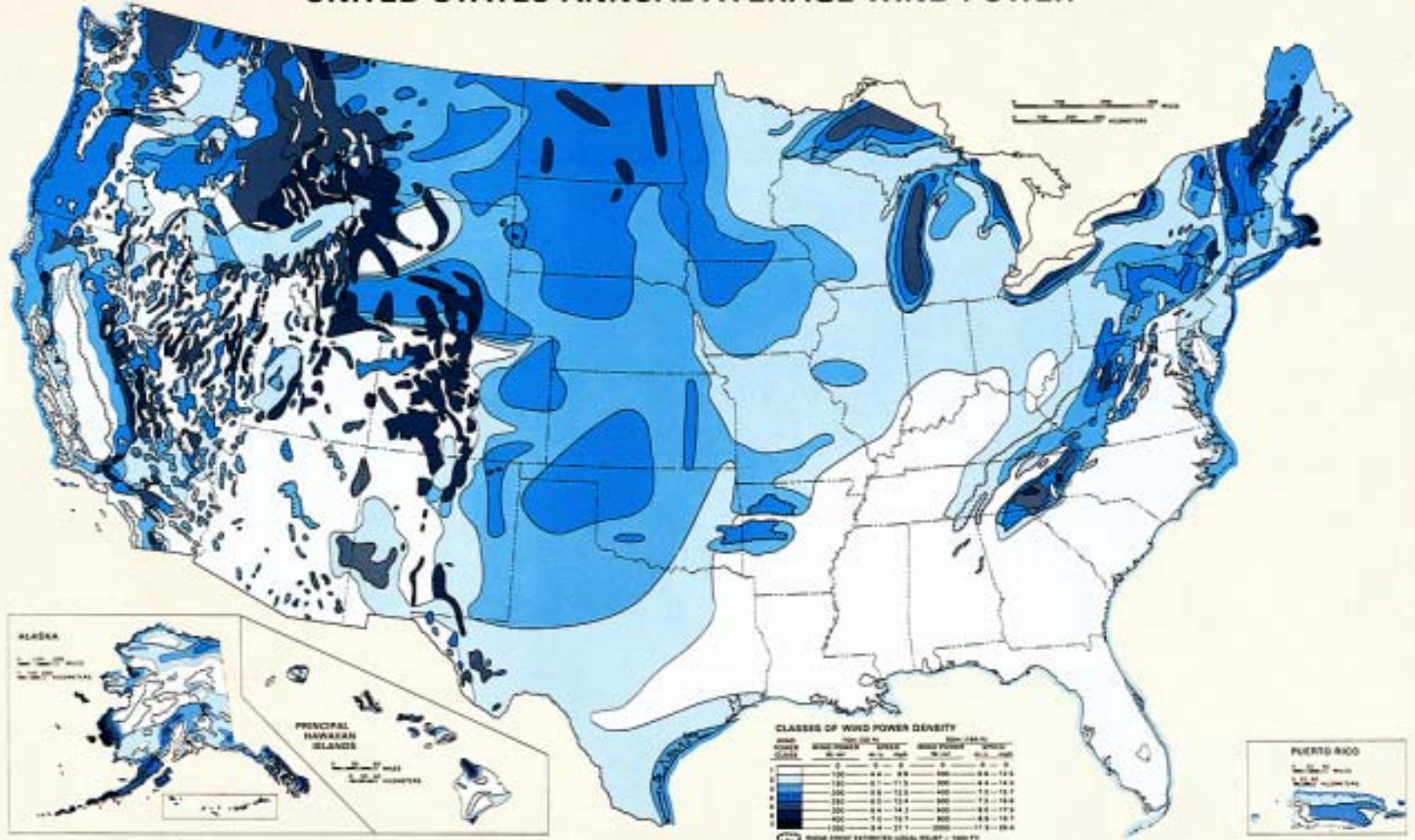
- Brookhaven National Laboratory proposes to use the fully regionalized MARKAL to examine energy technology and policy options to capture regional differences and inter-regional issues in a bottom-up integrated modeling framework.
- This includes the development of regional modeling capability with GIS tools and apply them to MARKAL in order to improve the underlying cost and demand curves, as well as benefits analysis for technologies with regional characterizations.

Why Regionalize U.S. MARKAL

- Cost and availability of energy resources and technologies, as well as the impacts of energy policies, often vary greatly from region to region. This situation necessitates the characterization of regional dynamics and analysis.
- Key Regional Differences
 - Fossil fuel and renewable resource availability
 - Economic and population growth rates
 - End-use demand patterns and levels of energy intensity
 - Energy infrastructure and transportation options and costs

U.S. Regional Wind Resource Availability

UNITED STATES ANNUAL AVERAGE WIND POWER

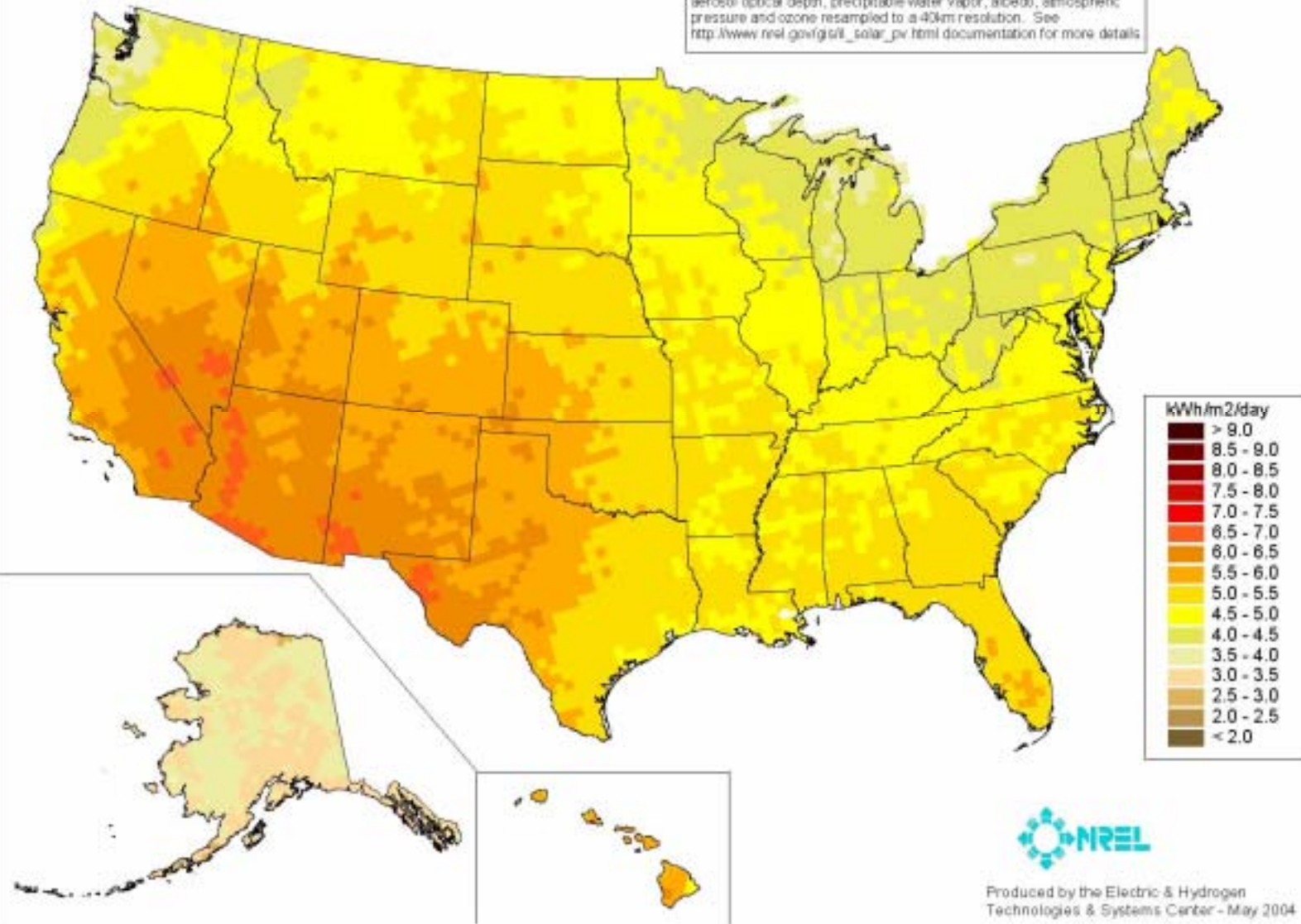


Source: NREL

PV Solar Radiation (Flat Plate, Facing South, Latitude Tilt)

Annual

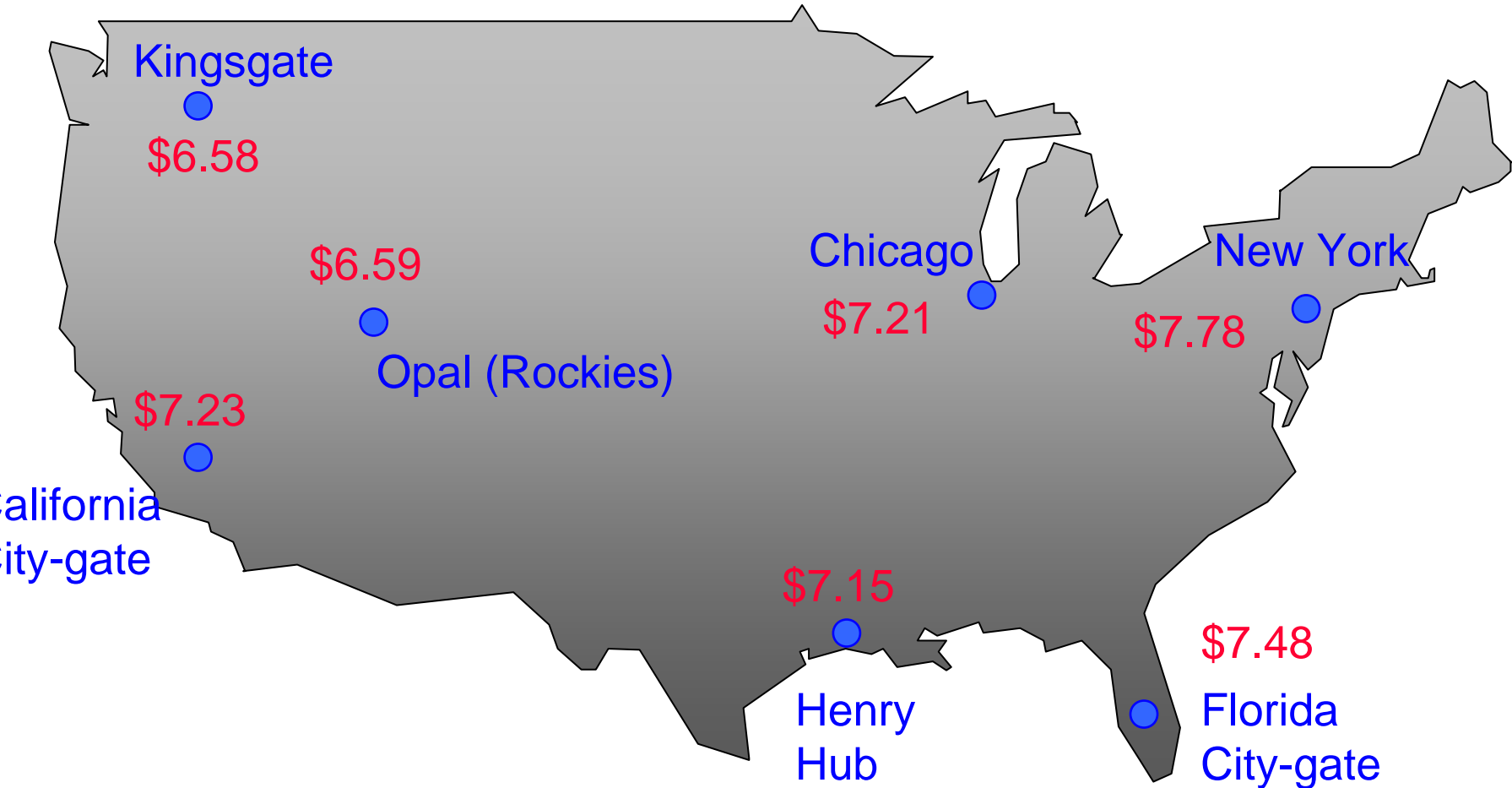
Model estimates of monthly average daily total radiation using inputs derived from satellite and/or surface observations of cloud cover, aerosol optical depth, precipitable water vapor, albedo, atmospheric pressure and ozone resampled to a 40m resolution. See http://www.nrel.gov/gis/solar_pv.html documentation for more details



Source: NREL

BROOKHAVEN
NATIONAL LABORATORY

Regional Natural Gas Prices in Major U.S. Market Hubs (\$/MMBtu)

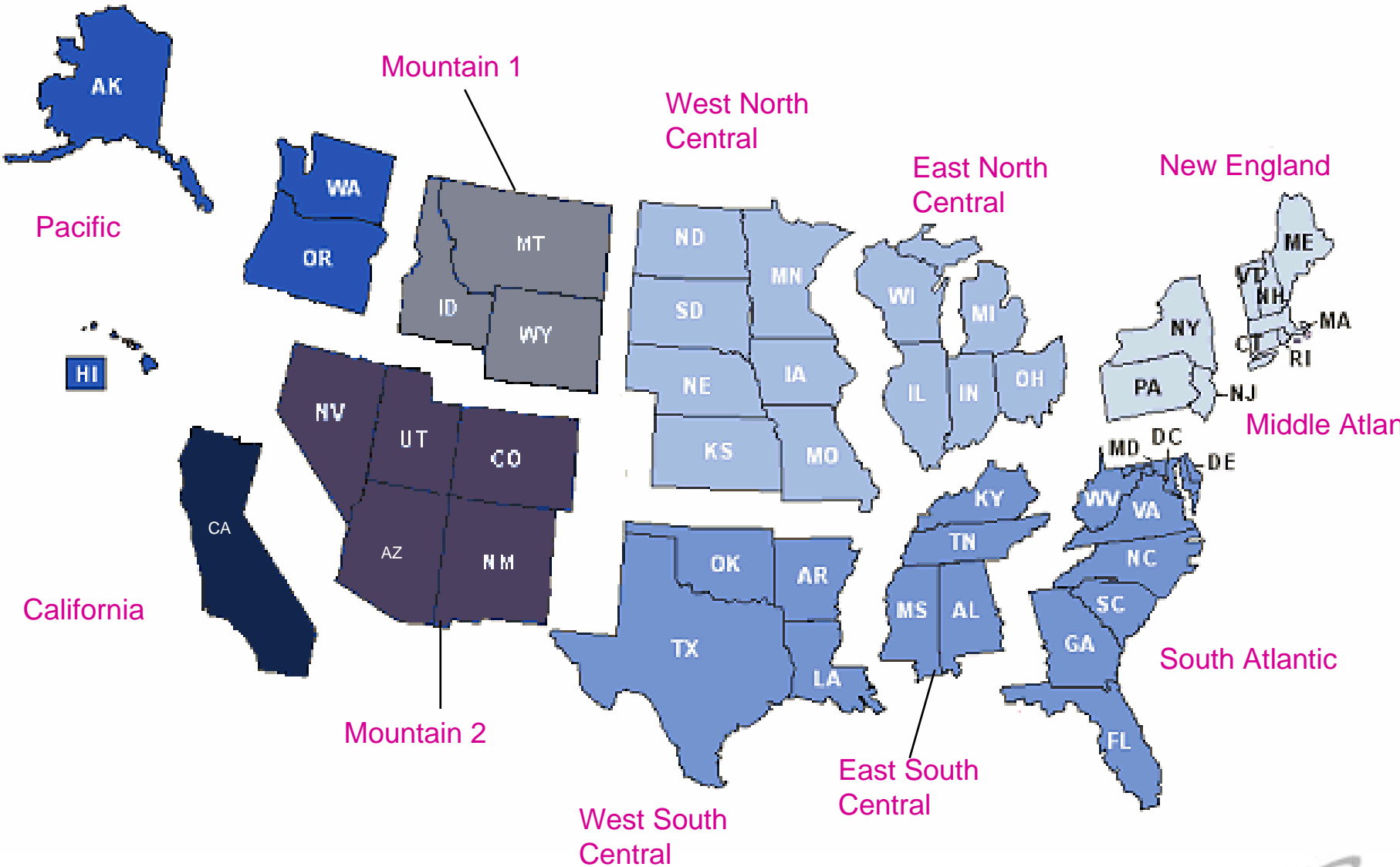


Source: Natural Gas Intelligence, Weekly average price for the week of March 21, 2005

Approach and Model Design: Three-Step Process

- Develop and test a single census region U.S. MARKAL model
- Construct a multi-region MARKAL model for the U.S. using either the SAGE or ETP model framework as a template
- Conduct a full multi-regional analysis following documentation and peer review of the multi-region model

Proposed U.S. MARKAL Regions



Approach and Model Design: Regional Disaggregation - Demand

- Further demand-side disaggregation will be done by adding new service demands
 - Separate regional service demands for residential space heating and cooling
 - Separate service demands for rural and urban Light Duty Vehicles (Vehicle Miles Traveled)

Approach and Model Design: Regional Disaggregation - Supply

- Supply-side disaggregation can be done by creating a step function to differentiate regional production or transmission costs
 - Aggregate development and O&M costs assumptions for 51 separate geothermal sites into two separate five-step supply curves for dual flash and binary cycle units
 - Represent differences in transmission or delivery costs by a similar step function

Meeting Data Requirements

As this process will be data intensive, BNL will utilize existing data sources such as:

- EIA's Annual Energy Outlook (AEO)
- EIA's Annual Energy Review (AER)
- Results of the H2A analysis
- Results of EERE's regionalization/GIS analysis



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