



# **IPM<sup>®</sup> Modeling Overview**

**Presented to**

**Regional Greenhouse Gas Initiative  
Stakeholders' Group**

**April 2<sup>nd</sup>, 2004**

**ICF Consulting**

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# Outline

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➤ IPM® Overview

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- IPM® Model Regions

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# ICF Overview

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- 25 years of Generation Sector Consulting
- ICF as a company and through its modeling is set up to perform integrated analysis of electric, fuel, environmental, and transmission markets
- 100 plus power market and valuation studies each year, including numerous due-diligence projects
- Wholesale reliability, stranded cost, and bankruptcy testimony
- Supported financing of over \$1 billion in power plant assets – close rating agency interaction
- ICF proprietary wholesale power, natural gas, coal and environmental allowance models
- Consultant to federal and state governments on generation sector analysis, particularly on environmental issues
- Most accurate track record of allowance market forecasting for both SO<sub>2</sub> and NO<sub>x</sub>
- Environmental compliance planning
- Gas and coal market forecasting

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# The Challenge of Forecasting

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- Forecasting is extremely useful in determining directionality and cause and effect.
  - Forecasting serves the need to test the impact of environmental policies and address inherently uncertain issues that have definitive impacts on the future operation of the power system.
  - No one forecast is going to be “right” because no one has a crystal ball regarding many of the key underlying issues. Through sensitivity analysis, however, key points of uncertainty can be examined to bound the analysis.
- Policy analysis requires two things:
  - a Reference Case on which to base comparisons; and
  - scenarios that examine the impact of changing policy, technical and market parameters.
- The purpose of a Reference Case is twofold:
  - to understand system operations under existing, or expected, regulations; and
  - to establish points of comparison for policy analysis – in the end, it’s the deltas that matter.

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# RGGI Assumptions and Scenario Development

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- ICF will be working with the RGGI Staff Working Group to analyze the impact of a carbon cap and trade policy on the electric generation sector in the Northeast, Mid-Atlantic and surrounding regions.
- ICF's proprietary modeling system, IPM<sup>®</sup>, will be used to estimate these impacts on power, fuel, and emission market dynamics.
- The analysis that will be produced will be driven by two key issues: the **Assumptions** used and **Scenarios** examined
- Given the public nature of this analysis, the RGGI Staff Working Group needs to carefully consider the choice of assumptions used. Once approved, the assumptions used in the analysis will be the sole responsibility of the RGGI Staff Working Group.
  - ICF works hard to maintain an 'honest broker' position in the regulatory debate. Part of how we do this is by performing analysis but not taking specific positions regarding results or assumptions.
  - By having the Staff Working Group adopt a set of assumptions as its own, the analysis will belong to the Group. ICF will be able to objectively analyze the results given this set of assumptions.
- For an analysis of this type, both regulatory policies and technical/market assumptions must be defined.

# IPM<sup>®</sup> – Key Input Assumptions

- The assumptions used in the analysis will have a large impact on the directionality of the results. Careful development of assumptions is important in order that the end product is widely seen as legitimate.
- Key assumptions include:

Technical/Market Assumptions	Policy Assumptions
Gas price forecast	National air regulatory framework
Demand forecast	State air regulatory framework
Renewable generation technology cost and performance	Renewable Portfolio Standards – state and national
Renewable resource availability	Renewable production tax credit
Conventional generation technology cost and performance	CO <sub>2</sub> cap and allowance of offsets
Transmission capabilities	Energy efficiency measures
Finance costs	Nuclear relicensing

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# RGGI Scenario Development

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- The scenarios will be designed to analyze the impact of a carbon cap and trade program on the electric sector.
- They will examine a range of cap levels to project the impacts of varying caps on allowance prices, energy prices and other system results.
- Scenarios will also be developed to analyze how different policy measures (e.g., RPS and efficiency measures) change the cost of compliance with the carbon emissions caps.

# IPM<sup>®</sup> – Key Outputs

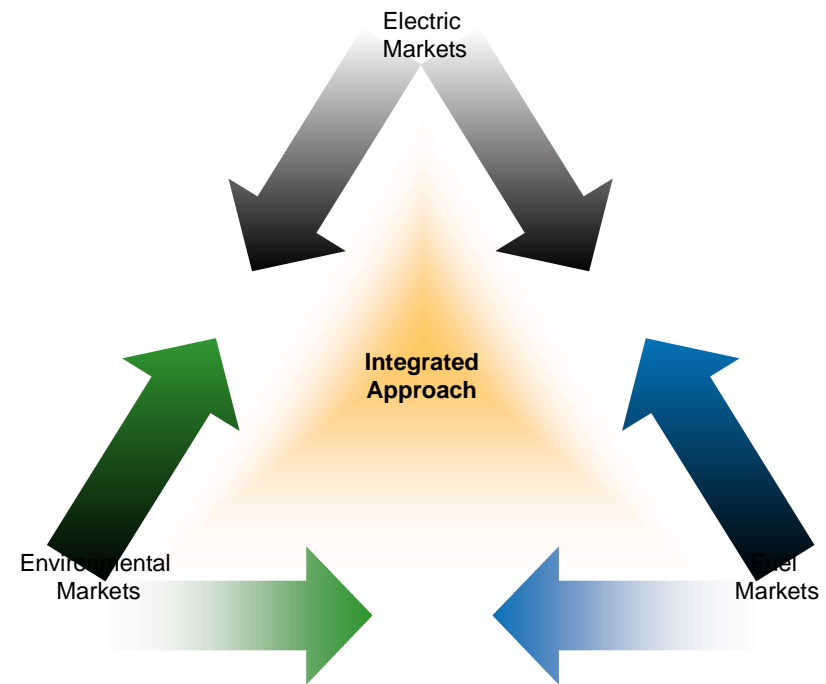
➤ IPM<sup>®</sup> produces a wide range of results for the electric sector. Included among these are:

Key IPM <sup>®</sup> Outputs
Power prices
Fuel prices
Dispatch decisions
Compliance decisions
Capacity build decisions (including renewables)
Plant retirement decisions
Emissions (SO <sub>2</sub> , NO <sub>x</sub> , Hg, CO <sub>2</sub> )
Allowance prices (under cap & trade)
Renewable energy credit prices (under RPS)
Compliance costs
Asset values

# **IPM<sup>®</sup> Overview**

# Understanding the Impacts of Environmental Regulations Require an Integrated Approach

- Air and other environmental policies have direct impacts on the electric sector and lead to many things moving at once
  - Allowance prices
  - Electric prices
  - Fuel prices
  - Dispatch order and capacity factors
  - Transmission flows
  - New unit build decisions
- Need an integrated and consistent approach that:
  - captures these impacts and integrates them into a complete sectoral response in order to understand the full impact of policy initiatives.
  - Provides a defensible analytical framework to quantify the costs of these policy initiatives.



# IPM<sup>®</sup> Analytic Framework

## IPM<sup>®</sup> Modeling Structure



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# IPM<sup>®</sup> Forecasts Emission Prices and Power System Dynamics in a Fully Integrated Framework

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- ICF uses its Integrated Planning Model (IPM<sup>®</sup>), a detailed engineering-economic production costing model, to estimate the marginal cost of emission reductions for the electric generating sector.
- IPM<sup>®</sup> determines the least-cost means of meeting the environmental regulatory requirements, such as CO<sub>2</sub> emissions caps, and forecasts allowance prices for each cap and trade market and compliance costs, unit dispatch, and retrofit decisions for each boiler and generator.
- Carbon prices in the electric sector are determined, absent technologies that remove carbon from the post-combustion process, by the increased system costs of building and operating lower-carbon intensive generation, as well as existing unit dispatch changes.
- IPM<sup>®</sup> can also incorporate renewable portfolio standards. In these cases, a required amount of renewable generation is specified as a percentage of electric demand and is met through the construction and operation of renewable technologies.
- Results are provided for key years over the time horizon of the analysis.

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## For More Information

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# Appendix

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# IPM<sup>®</sup> Applications

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- ICF originally developed IPM<sup>®</sup> in the 1980's to do integrated resource planning, but its applications have greatly expanded since then.
- Wholesale power market analysis
  - Power price forecasting and analysis
  - Financial due diligence and asset valuation
  - Rate Case support
- Environmental Analysis
  - Emission allowance market analyses
  - Renewable generation market analyses
  - Compliance strategy
  - Environmental policy analysis and regulatory development support
- Litigation Support
  - Rate structure analysis
  - Stranded cost recovery
  - Bankruptcy
  - Power purchase agreement valuation and arbitration

# IPM<sup>®</sup> Policy and Regulatory Pedigree

## ➤ EPA policy and regulatory analysis

- CAAA 1990
- OTAG
- SIP Call
- 1997 NAAQS
- Clear Skies
- Mercury MACT
- Interstate Air Quality Transport

## ➤ FERC wholesale power market rulemaking

- EIS for Order 888, Order 2000
- Cost Benefit Study for Standard Market Design

## ➤ State policy analysis

- NY GHG Task Force
- CT GHG Stakeholders
- WRAP Regional Haze and RPS analysis

## ➤ State regulatory proceedings

- Virginia - air emissions impacts of AEP transmission line
- Minnesota - air emissions impacts of MN Power's Arrowhead-Weston transmission line
- Minnesota – coal plant
- Ohio – First Energy stranded cost
- New Jersey – PSEG stranded cost
- California – CPUC coal plant
- South Carolina – Power plant siting
- Louisiana – coal plant
- New York – cost impact of Renewable Portfolio Standard

# IPM<sup>®</sup> Analysis “Levers”

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## ➤ Environmental or Energy Policy Levers

- Command and control emissions policies (unit specific or plant averaging)
- Cap and trade programs (including offsets and banking provisions)
- Allowance allocation mechanisms
- Emissions or energy taxes
- National or regional in scope
- Renewable Portfolio Standards
- Generation Performance Standards (e.g., heat rate, emissions rate)

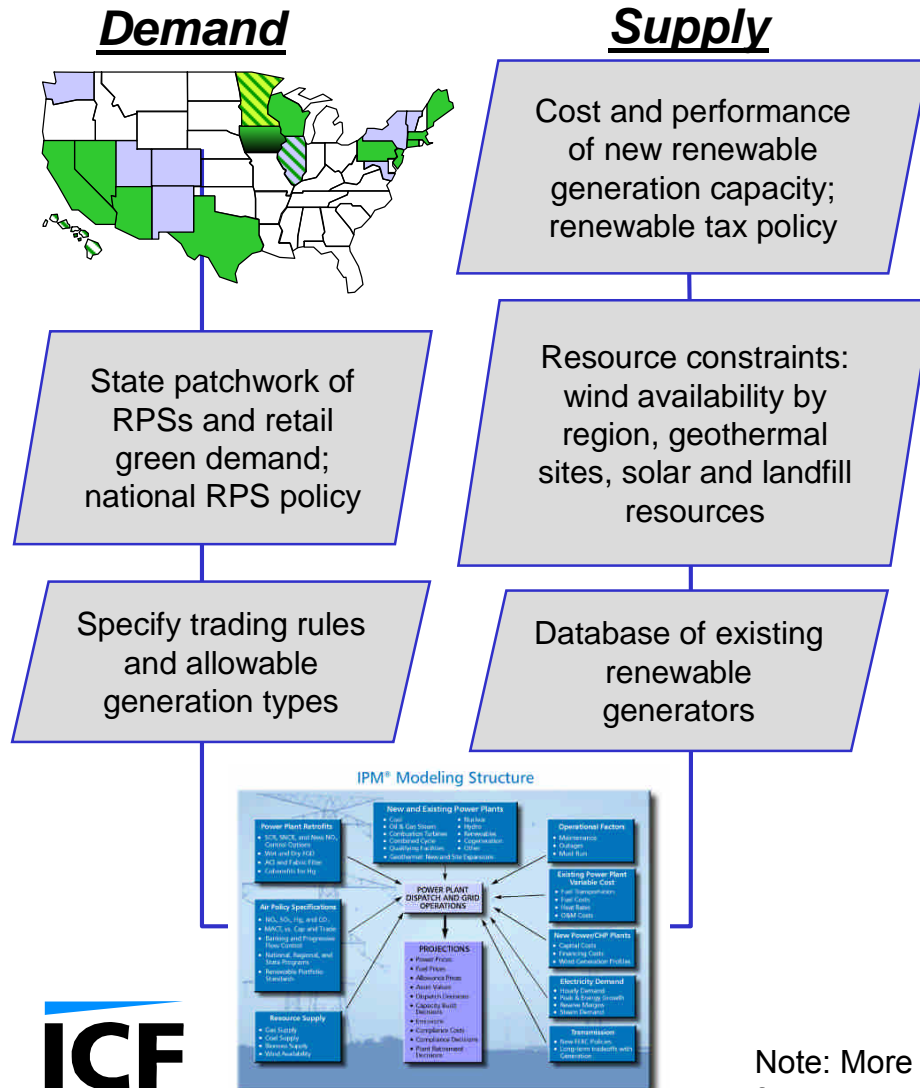
## ➤ Economic and financial incentives

- Tax credits (for new construction; repowering, life extension)
- Production credits
- Early retirement tax credits
- Changes in depreciation rules

## ➤ Market Sensitivities

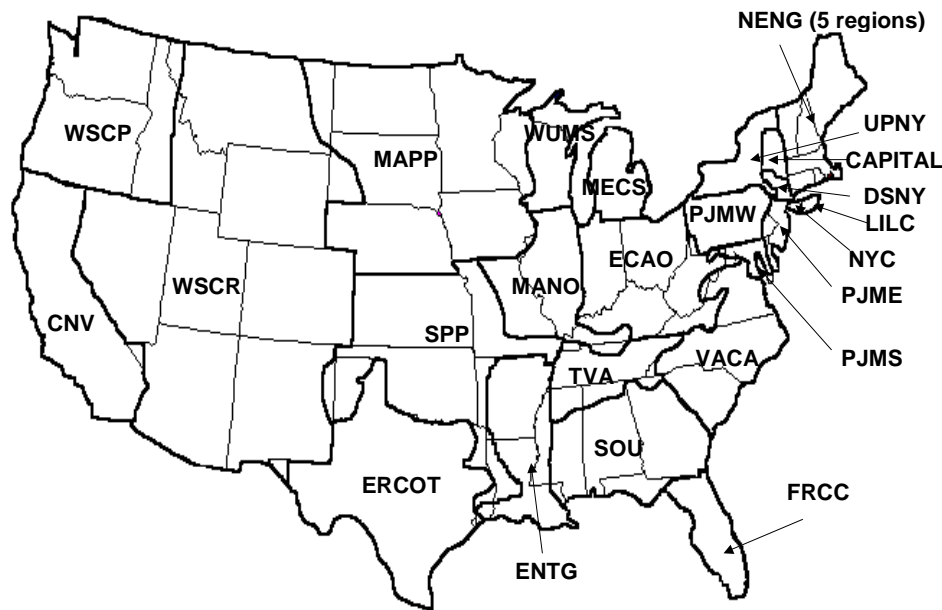
- Gas Prices
- Demand forecast
- Transmission pricing and availability
- Technology cost & performance
- Nuclear relicensing & updates
- Financing costs

# IPM<sup>®</sup> Layers Rich Detail of Renewable Supply and Demand into the Broader Power Market Specification



- Renewable energy credit values are determined by the *demand* for green power and the characteristics of sources available to *supply* that demand.
- The demand for green power will consist of a grassroots component – the generation required to satisfy consumer interest in non-emitting electric power – and a mandated component – the generation required to comply with renewable portfolio standards
- The total demand will be met by existing and new renewable generators specified by cost, performance, and resource availability.
- IPM<sup>®</sup> brings together these essential components of renewable power development in a single integrated structure to determine market equilibrium conditions within the broader context of the electric, fuel, and environmental markets.

# IPM<sup>®</sup> Model Regions



- IPM<sup>®</sup> divides the United States into regions, closely resembling NERC regions. These regions are further divided based on ICF's assessment of commercially significant transmission bottlenecks (i.e., sub-regions in which spot prices are expected to diverge significantly), or when clients request specific regional breakouts. Canadian provinces and interconnections can also be included.
- For the purpose of national level analysis, IPM<sup>®</sup> is often disaggregated into 24, or more, model regions, although specific regions can analyzed with additional granularity.
- All IPM<sup>®</sup> regions have a representation of the electric transmission system that connects them to neighboring regions. The inter-regional transmission connections allow for the transfer of both capacity and energy and allow for broad price equilibration when transmission capacity is available.