

Integrated Resource Planning: Past, Present, and Future

Michigan State University

Institute of Public Utilities, Grid School

March 29, 2017

Rachel Wilson

www.synapse-energy.com | ©2017 Synapse Energy Economics Inc. All rights reserved.

Who we are

Synapse Energy Economics

- Research and consulting firm specializing in energy, economic, and environmental topics
- Services include economic and technical analyses, regulatory support, research and report writing, policy analysis and development, representation in stakeholder committees, facilitation, trainings, and expert witness services for public interest and government clients
- Synapse reviews and critiques electric utility plans in IRP and pre-approval proceedings. We routinely use electricity production-cost and capacity expansion models in these cases to investigate utility assumptions, analyses, and preferred resource options. We also evaluate alternatives that may provide greater benefits at less or equal cost to consumers.

Agenda

- What is IRP?
- IRP in practice
- Environmental regulations and risk
- Changing issues in IRP
 - Flat load, declining demand due to EE/DG
 - Environmental policies
 - Existing generation value
 - Competitive energy efficiency
 - Renewable integration & distributed generation
- Case study: Puerto Rico
- Next generation of resource planning

What is IRP?

What is IRP?

An IRP is a plan that seeks to find an optimal combination of resources to satisfy future energy service demands in an economic and reliable manner

- Variously includes requirement to examine both demand-side and supplyside resources on a "fair and consistent basis."
- Subject to constraints such as reliability, regulatory, environmental and operational requirements.

Meant to engage regulators and stakeholders in long-term planning decisions

- Generally presented before regulatory commission, may be litigated
- Stakeholder process varies across states and utilities
- Seeks to make robust short-term decisions in light of long-term uncertainty

IRP vs CPCN vs Rate Case

Integrated Resource Plan (IRP)

- A long-term utility plan to meet forecasted annual peak and energy demand, along with some established reserve margin, through a portfolio of supply-side and demand-side resources.
- Regulatory proceedings to approve or acknowledge IRP, but not legally binding.

Certificate of Public Convenience and Necessity (CPCN)

- Proceeding before a state utility commission in which a utility provides justification for a large capital investment in generation or transmission infrastructure.
- Legally binding and enforceable.

Rate Case

• Proceeding before a state utility commission in which a utility provides justification for a requested increase in consumer electric rates to cover that utility's cost of service.

A Short History of IRP

- 1970s: Rising fuel prices, increasing capital construction costs, and recognition of environmental costs drive new understanding of *least-cost planning*
- 1980: Pacific Northwest Electric Power Planning and Conservation Act
 - Addressed concerns about plateau in hydro construction and increasing demand
 - Sought to ensure orderly power acquisition by Bonneville
- Early 1990s: States begin promulgating IRP rules
 - Response to nuclear costs and massive stranded investments from cancelled projects
- Tools for least-cost long-term planning emerge to examine tradeoffs between capital investments vs. fuel and variable costs
 - Primarily examine requirement for <u>new</u> resources to meet demand, do not revisit existing resources
- Late 1990s: Electricity restructuring wipes out long-term resource planning in competitive access states
- Late 2000s: States begin re-visiting "procurement" planning

States with IRP Requirements (2015)



Source: US EPA. 2015. Energy and Environment Guide to Action, Chapter 7.1

www.synapse-energy.com | ©2017 Synapse Energy Economics Inc. All rights reserved.

IRP Varies from State to State

Integrated resource planning processes will vary from state to state with respect to:

- Regulatory requirements
 - Analysis period
 - Frequency of updates
 - Resources considered
 - Inclusion of externalities
 - Risk analysis
- Degree of rigor
- Stakeholder feedback process
- Degree to which they are subject to regulatory scrutiny

Policies Used by States to Integrate EE, RE, and CHP into IRP

Policy	Description	State Examples
Require third-party energy efficiency potential studies	Require, or have required, utilities to commission energy efficiency potential studies as part of planning process, or perform a statewide study for use in planning.	AR, CA, IA, IN, MA, OR, WI
Mandate all cost-effective energy efficiency in planning	Require that utilities plan for all achievable cost-effective energy efficiency, or demonstrate that all supply-side and demand-side resources have been evaluated on a consistent and comparable basis.	CA, IN, MA, OR, Northwest
Update assumptions for renewable energy capacity value, and supply and integration costs	Require or explicitly note that renewable energy costs and attributes change over time and should be kept up to date.	AZ
Quantify reasonably expected environmental regulations	Have policies requiring cost consideration for future environmental regulations.	IN, OR, WY
Tie investment decisions to planning processes and follow up on action plans	Require that integrated resource planning result in an action plan with resource activities the utility intends to undertake over the next 2 to 4 years. Test investment decisions against integrated resource planning results.	IN, OR
Leverage existing knowledge from state utility and environmental regulators.	Have mechanisms for coordinating environmental permitting and utility electric planning.	CA, CT
Promote meaningful stakeholder involvement.	Provide funding opportunities for public interest stakeholders and intervenors in planning cases.	IN, ME, NY, OR, WI

www.synapse-energy.com | ©2017 Synapse Energy Economics Inc. All rights reserved.

Oregon

- IRP rules mandate that the public participate in the planning process at its earliest stages
- PUC emphasizes the evaluation of energy conservation in a manner that is consistent and comparable to that of supply-side resources
- The definition of "least-cost" includes economic, environmental, and social uncertainties
- At a minimum, the following sources of risk and uncertainty must be considered: load, hydroelectric generation, plant forced outages, fuel prices, electricity prices, and costs to comply with GHG regulation

Colorado

- Utilities may choose their own planning and resource acquisition periods
- PUC must give the fullest possible consideration to the costeffective implementation of clean energy and energy-efficient technologies
- Resource plans must include the water intensity of resources and the generating system as a whole
- PUC must consider the likelihood of new environmental regulations and future costs when considering utility plans
- Three alternate resource plans that meet the same resource needs but include proportionally more renewable energy or demand-side resources

Puerto Rico

- IRP rules went into effect in 2015; PREPA submitted its first IRP
- PREPA must present a description of the planning and regulatory factors that affect the environment in which it operates, and the way in which these factors impact PREPA's system
- PREPA shall identify new DG and DSM resources and programs
 - PREPA shall seek to ensure that all potentially cost-effective measures are considered comprehensively
 - PREPA shall propose bundles of demand-side resources at varying levels of cost and effectiveness
 - PREPA shall prepare estimates of the cost of sufficient bundles of demand-side resources such that they utility could achieve 2 percent incremental EE savings per year, for at least 10 years
- Must use a capacity expansion model

IRP in Practice

Resource Planning Approach

A successful integrated resource planning approach includes:

- Meaningful participation from a diverse group of stakeholders, which includes, but is not limited to, the utility, state regulatory bodies, consumer advocates, and environmental advocates
- Development and screening of key input variables: forecasts of load, commodity prices, and market energy prices; costs and benefits of existing and future supply- and demand-side resources; and changes to the regulatory environment
- Use of an industry standard electric system model to develop resource plans to meet future requirements under probable future scenarios, and test their sensitivity to risk factors
- Selection of a preferred plan, and development of a short-term action plan

Participants

- Utilities
- Regional transmission organizations (RTOs)
- State Public Utility Commissions
- State environmental regulators
- State legislatures, governors, and energy offices
- Stakeholders and intervenors

Flow Chart for Integrated Resource Planning



Source: Hirst, E. (1992). A Good Integrated Resource Plan: Guidelines for Electric Utilities and Regulators. Oak Ridge National Laboratory.

www.synapse-energy.com | ©2017 Synapse Energy Economics Inc. All rights reserved.

Characterizing the Electric System

- Generator longevity
- Utilization rates relative to nameplate capacity
- Ramping abilities
- Emission rates and installed environmental controls
- Variable operating costs
- Purchase Power Agreements
- Transmission constraints
- Effectiveness of existing energy efficiency programs
- Current levels of distributed generation

Model Input Assumptions

- 1. Sales and peak load
- 2. Fuel prices
- 3. Capital costs of generation, transmission, and distribution equipment
- 4. Technology performance characteristics
- 5. Renewable energy potential
- 6. Energy efficiency potential and program cost
- 7. Avoided cost of generation
- 8. Resource availability and constraints
- 9. Transmission upgrades or constraints
- 10. Lead times for permitting and construction
- 11. Future regulations
- 12. Resource adequacy and reliability

Electric Sector Models

- Screening tools
 - Levelized cost tools
 - EPA's Avoided Emissions and geneRation Tool (AVERT) estimates the emissions implications of energy efficiency measures and new renewable capacity
 - Synapse's Clean Power Plan Planning Tool (CP3T) a spreadsheet tool that examines statewide compliance strategies with the Clean Power Plan
 - Advanced Energy Economy State Tool for Electricity Emissions Reduction (STEER) – an integrated resource planning model that calculates least-cost strategies for Clean Power Plan compliance

Electric Sector Models

Production cost models

• MIDAS, PROMOD, Market Analytics (PROSYM), GE-Maps

These models:

- Simulate hourly and sub-hourly system operation and dispatch, assessing reliability, resource adequacy, and transmission constraints
- Analyze the impacts of system changes on system operations
- Provide detailed emissions outputs

These models don't:

- Build new capacity
- Model the entire United States simultaneously, but instead by RTO or interconnect

CAISO: Ramping process of March 24, 2024 – 40% RPS scenario



Source: Liu, Shucheng. (2015). The CAISO Study of 2014 LTPP No Renewable Curtailment Sensitivity Cases. Prepared for the LTPP Study Advisory

Electric Sector Models

Capacity expansion models

- Regional: NEMS, IPM, ReEDS
- Utility: EGEAS, Strategist, System Optimizer

These models:

• Determine the optimal generation mix over time that will meet peak and annual energy requirements at the lowest cost, subject to any regulatory constraints.

These models don't:

 Have chronological unit commitment, but instead rely on a simplified dispatch methodology

Generation in RFC Michigan Region



Source: AEO 2015, Reference Case

Electric Sector Models

Models with both capacity expansion and production cost capabilities

- AuroraXMP
- PLEXOS
- EnCompass

Production Cost or Capacity Expansion?

- What is the least cost dispatch of ISO-NE to meet hourly load?
- What are the impacts of the MATS rule on capacity and energy generation?
- How do falling natural gas prices affect investments in generating capacity?
- What are the emissions impacts of coal retirements in a utility system?
- What are three different pathways to greenhouse gas compliance and how much will they cost?
- What are the efficiency and distributional effects of an increased Renewable Portfolio Standard?
- What are the avoided costs associated with energy efficiency programs?
- Can we quantify the maximum potential for redispatch from coal to natural gas in a region?

PacifiCorp Modeling and Risk Analysis Process – 2011 IRP



Risk Analysis

- At a minimum, important and uncertain assumptions should be tested with high and low cases to assess the sensitivity of results to changes in input values
 - Load forecasts
 - Fuel prices
 - Emissions allowance prices
 - Environmental regulatory regimes
 - Costs and availability of DSM measures
 - Capital and operating costs for new units
 - Actions for existing units

Many cases may warrant more sophisticated techniques

Choosing a Plan

- PVRR is the most common metric
- May be useful to evaluate plans along other dimensions
 - Environment cost or impact
 - Fuel diversity
 - Impact on reliability
 - Rate or bill increases
 - Meeting other state energy policy goals
 - Flexibility
 - Minimization of risk

Environmental Regulations and Risk

Impacts of Regulations in Planning

New Unit Selection

- Restrictions on unit types (e.g., NSPS for CO₂ bars new coal)
- Availability of permits (ozone, water)
- Preferred selection towards low-impact resources

Existing Units

- Capital expenditures
- Fixed operations and maintenance (O&M)
- Variable O&M
- Heat rate
- Capacity
- Operational limits
- Fuel sources
- Dispatch cost & loading order
- Wholesale energy prices
- Overall system cost

System

General Principles

- 1. A key purpose of system planning is to determine near-term actions.
 - Acquisitions, builds, sales, contracts, funding levels
- 2. In least-cost planning, existing units compete with new units and EE/RE programs.
- 3. Existing and new units may be subject to existing, proposed, and expected environmental regulations.
 - Existing regulations are (likely) the rule of law
 - Existing, proposed, and expected environmental regulations impose costs and restrictions

...therefore...

- 4. The purpose of examining proposed and expected regulations is to examine if different choices would be made in the near term in light of future risks—including retirement, new builds, EE/RE investments, etc.
- 5. The economic viability of existing units should be tested rigorously in the face of environmental regulations.

Assigning Costs & Impacts

Existing Regulations

- Engineering costs and estimates
- Known allowance costs for tradable emissions
- Permit conditions for restrictions

Proposed Regulations

- Proxy costs for capital
- Proxy allowance cost
- Proxy restrictions or caps
- Lenient and strict interpretations of final rule

Pending Regulations

- Estimated impact: general proxy cost
- Best guess on timing and magnitude

Assessing Probability of Impact

- Requires subjective probability of regulation
 - Is there significant momentum behind the regulation?
 - Is there a court order or consent decree requiring the regulation?
 - What is the current estimated date of finalization/implementation?
 - Will the rule really be held up in court?
- Probability and impact are separate items, and should not be confounded or combined in assumptions.
 - i.e., a modeled CO₂ price should not be the allowance cost times the probability of occurrence, it should simply be the allowance cost. Probability comes later.

Assessing Probability of Impact

A "reference" case is the expected, or mean, outcome.

Assuming that there is no impact of a regulation in the reference case implies:

- (a) There is absolute certainty that the regulation will not come to fruition;
- (b) There is an equal probability that the regulation will be beneficial as harmful.

Option Value

 Given significant uncertainty on future environmental regulations, how do we make resource decisions today?

Hypothetical Scenario:

- Need to decide this year if we install an expensive flue gas desulfurization (FGD) by 2018 for SO₂ NAAQS compliance.
- New ozone standard implies <u>potential</u> need to install selective catalytic reduction (SCR) in 2022.
- Installing both an FGD **and** SCR is non-economic.
- Once I install the FGD, the cost is sunk.
- Avoid a piecemeal solution.

What should we do? Option value.

Option Value



www.synapse-energy.com | ©2017 Synapse Energy Economics Inc. All rights reserved.

Option Value

A (install FGD and SCR)

C (install FGD, no ozone reg.)

Install FGD

= PVRR(A) * p(Ozone) + PVRR(C) * (1-p(Ozone))



D (retire today)

Install the FGD for today's regulation if the cost of the retiring and replacing the energy exceeds the cost of maintaining the unit.

Maintaining the unit accepts the risk that the ozone standard will require the installation of SCR.

Install FGD today if: PVRR(A) * p(Ozone) + PVRR(C) * p(Ozone) << PVRR(D)

Changing Issues in IRP

Flat and Declining Load

 Traditionally, IRP addressed one key question:

What is the optimal set of additional resources to meet increasing demand?

- IRP tools were designed to determine optimal capacity expansion
- But, recent years have seen flat or declining load in many regions
 - Impact of DG, EE, and changing economic conditions
- IRP must now evaluate cost-effectiveness of *existing* resources
- Planning must determine what units should be removed (retired) or modified (retrofit) in addition to considering unit additions



Environmental Policies

Pre-2010: Sector-wide blind spot

- Little practice in examining value of existing units
- NERC study (and contentious regulatory cases) catalyzed industry

2010-2014: Serious uncertainty

- IRPs variously included / neglected impending regulations and asset valuation
- Seeking clarity on probability, timing, cost, and risk

2014-2016: Standardization of practice

- Recognition of capital / operational impact of regulations & price changes
- Most high impact regulations settled except CO₂

Existing Generation Value

A plan cannot be least cost without having evaluated the cost-effectiveness of existing supply-side resources

Short-term (operational) challenges

- Solid-fuel units dispatching less today
 - Falling gas and electricity prices
 - Emissions control costs
 - Emissions prices
 - Increasing fuel costs
- Utilities historically gave little attention to short-term variable costs of "baseload" units in IRPs - no longer.
 - MISO CPP study (May 2016) finds coal units de-commit due to high variable price

Less competitive over long-term (planning)

- 2010 2014: utilities (slowly) start testing economic viability of individual units that require capital investments
- 2014 now: long-term revenue deficit for high fixed cost units (nuclear, coal) make these units less economically viable

Long-term fuel forecast is critical: will energy prices increase enough?

Competitive Energy Efficiency

EE as Load Reduction

• Traditional mechanism

Supply-Side EE

• Emerging mechanism

- Assumes that set amount of EE happens regardless of economics
- Simple implementation
 - Reduce load with EE profile
 - Assign cost per kWh

- EE can compete with new and existing resources as with any other supply-side resource
- Complicated implementation
 - Model individual programs?
 - What is the cost of a future program?
 - Can today's savings levels persist @ cost?

- Difficult to evaluate EE as a dynamic element of emissions compliance or portfolio buildout
- Requires multiple runs with various EE levels to determine system benefit
- Readily adapted to changing economic conditions
- Single model run could (theoretically) estimate correct EE level

Renewable Integration & Distributed Generation

Renewable energy in resource planning

- Historically, renewable energy played minor role in overall generation mix for most utilities = simplified representation
- Dropping costs + renewable policies = important to capture operational impacts, capacity contribution, and integration costs
- Simplified representations may be inadequate
- Emerging technology and mechanisms to model renewable energy and storage

Distributed generation

- Behind-the-meter generation previously regarded as small reduction to load (no longer)
- Difficulties:
 - Cost of resource plan may influence expected DG buildout
 - Distribution-level analysis may be required to determine local area needs and balancing

Source: Google Project Sunroo

www.synapse-energy.com | ©2017 Synapse Energy Economics Inc. All rights reserved.

Case Study: Puerto Rico

Background

- No historic oversight for PREPA
- Puerto Rico bankrupt
- Act 57 (2014) created the Puerto Rico Energy Commission
 - Finalized first IRP in late 2016
- PREPA has issues...
 - Big budget gap
 - Institutional corruption
 - Loss of staff over last five years
 - Big spending requests for MATS compliance
 - Basic lagged maintenance

Overview of PREPA's System

How Puerto Rico Generated Electricity in 2014



Puerto Rico's Main Power Plants



Analysis: PPAs

- Owned resources
 - Small hydro
 - Mix of oil and diesel units
- Two thermal PPAs
 - EcoElectrica: NGCC
 - AES: Coal steam
- Many renewable PPAs
 - 2 wind
 - 1 landfill gas
 - 10+ PV (not all are online)
 - RE prices of ~\$160-\$200/MWh



- PREPA load isn't just flat it's declining
- PREPA has to replace 80% of its fleet because it is not MATS compliant
- Not currently in compliance with the RPS
- Unclear whether PREPA's proposed solution (a \$500 million new natural gas terminal plus unit fuel conversions) is actually the most economic choice
- Failing infrastructure is the lynchpin of PREPA's operations

IRP Rules Didn't Work – Why?

- Poor communication
- Action plan was decided on prior to doing the analysis
- Stakeholder engagement was focused on issues that were not relevant to the proceeding
- IRP rules asked for information that PREPA did not have and could not obtain easily

IRP Rules Under Revision in Puerto Rico

Crafting IRP rules to reflect better planning questions

- How can PREPA integrate more renewables?
- How can PREPA meet MATS requirements?
 - Puerto Rico PUC, US EPA, US DOE, FERC, PREPA
- How can PREPA upgrade its transmission?

Not everything requires capital investments!

Next Generation of Resource Planning

Recent developments in planning models

Long term planning with hourly dispatch

- Simply meeting seasonal peak demands is not enough
- Operation details matter ramping, starts and startup times
- Computational power can still be limiting

Cloud based platforms

- Scalable computing capacity without persistent investment
- Reliability!

Gas supply integration

 Limits on peak day pipeline capacity are important – different than peak power day

Emerging planning issues present modeling challenges

How does distribution planning overlap with long term system planning?

 Rooftop PV can stress circuit level infrastructure, but provides broad system benefits (see California and New York)

Storage operation is tricky to model, particularly in long term models

• Key value can be peak hour operation, or intermediate ramping needs. Or ancillary services.

Inclusive stakeholder processes remain important

- Continued need for detailed publicly available datasets
- Must provide value and avoid protracted processes where data becomes stale

State energy planning to complement utility planning

States are increasingly influencing energy planning via policy – this should be done in an economic framework similar to IRP

- Historically energy efficiency and renewable portfolio standards
- Long term contract requirements (see Massachusetts)
- Nuclear incentives (New York, Illinois)
- Distributed generation incentives (and how they factor into system load forecasts)
- Clean Power Plan Planning

Examples include:

- New Jersey Energy Master Plan
- Connecticut IRP
- California Long Term Procurement Planning

Contact information

Rachel Wilson rwilson@synapse-energy.com

www.synapse-energy.com | ©2017 Synapse Energy Economics Inc. All rights reserved.

Rachel Wilson 56