Electric Company Technoeconomic Analysis Overview

Power Generation & Storage Cost and Performance

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Today's Agenda

Organizational Overview

Relevant Tools

Technology Costing Overview

Example

Housed within EPRI's *Integrated Grid & Energy Systems*

Strategic Energy & Env Planning | **Long-Term System Planning** | **Real-Time Operations**

Corporate Strategy and Policy Analysis

Renewables, Storage, and DER Integration

- Strategic Planning
- Technology Assessment
- Resource Adequacy
- Trans & Dist Planning
- System Protection
- Operations Planning
- Real-Time Operations

Integrated Resource Planning

Energy, Environment & Climate Policy

Resource Planning for Electric Power Systems

Transmission Operations

Transmission Planning

Market Operations & Design

Bulk System DER & Renewables Integration

Distribution Operations & Planning

Distributed Energy Resource Integration

Energy Storage Systems Integration

The *Energy Systems & Climate Analysis* Research Area (ESCA) is Composed of Research Program 178 and Program 201

Energy Systems & Climate Analysis Group

Resource Planning for Electric Power Systems (P178)

- **Focus:** Long-term resource planning; Technology R&D strategy; Corporate risk management
- **Audience:** Resource Planners, Fuel Managers, Asset Managers, Corporate Strategy, and Engineering and Construction.
- Integrated resources planning
- Integrated Generation, Transmission and Distribution Planning
- Fuel and Power Market Analysis
- Technology Cost and Performance (TAG)
- TAGWeb™ Software
- Electric Generation Expansion Analysis System Software (EGEAS)

Electric Company Planning & Decision Making

Energy, Environmental, and Climate Policy Analysis (P201)

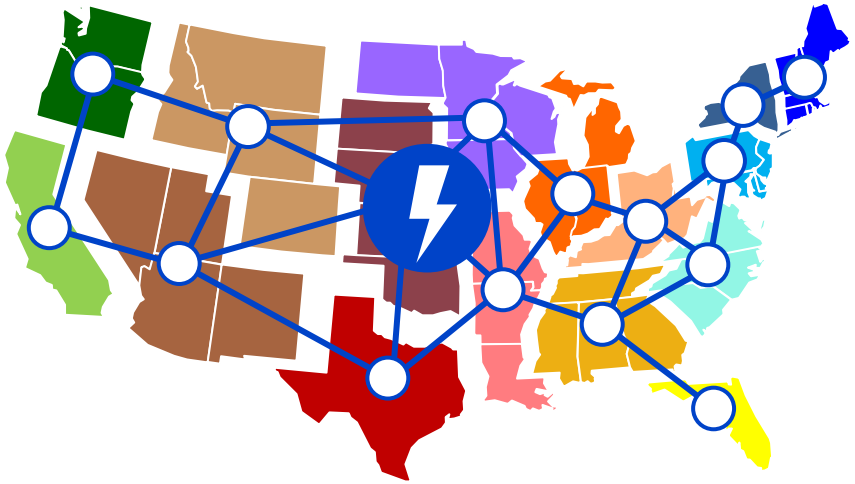
- **Focus:** Long-term evolution of the U.S. generation and capacity mixes and impacts of changing regional and national policies.
- **Audience:** EH&S staff; Corporate Strategy; Regulatory Affairs, Sustainability, Resource Planning.
- Energy & Environmental Analysis Common Capabilities
- Electric Sector Environmental & Policy Analysis
- Emerging Technologies Analysis: Drivers and Impacts
- Economy-wide Analysis and Electrification
- Global Policy and Market Analysis
- Energy & Climate Seminar

Global / National / Regional Perspective

US-REGEN

Regional Economy, GHG, and Energy

Electric Generation



Detailed representation of:

- Energy and capacity requirements
- Renewable integration, transmission, storage
- State-level policies and constraints

Synchronized

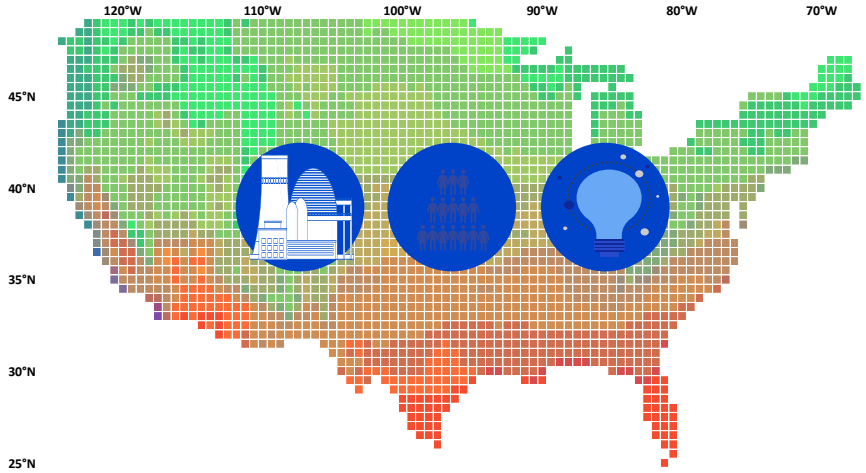
Hourly Load, Renewables, and Prices

Model Outputs:

Economic equilibrium for generation, capacity, and end-use mix

Emissions, air quality, and water

Energy Use

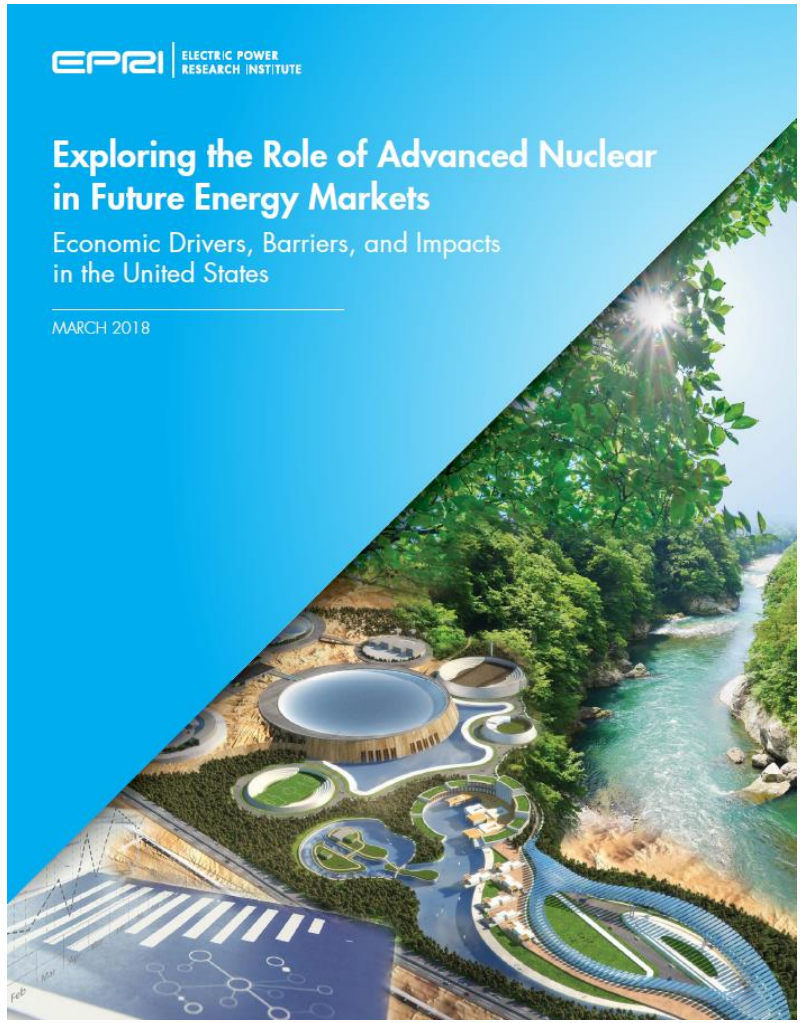


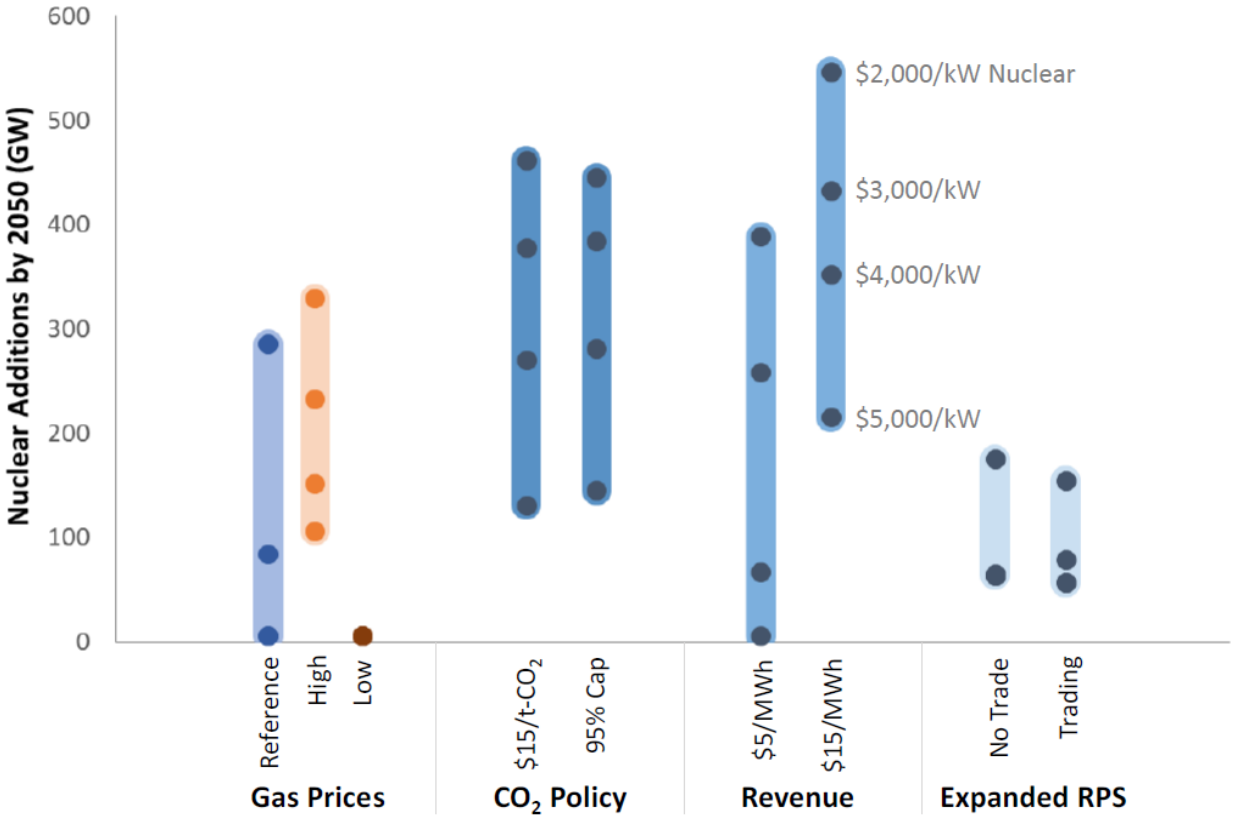
Detailed representation of:

- Customer heterogeneity across end-use sectors
- End-use technology trade-offs
- Electrification and efficiency opportunities

Documentation, articles, and reports available at https://esca.epri.com

Example of US-REGEN in the Nuclear Space

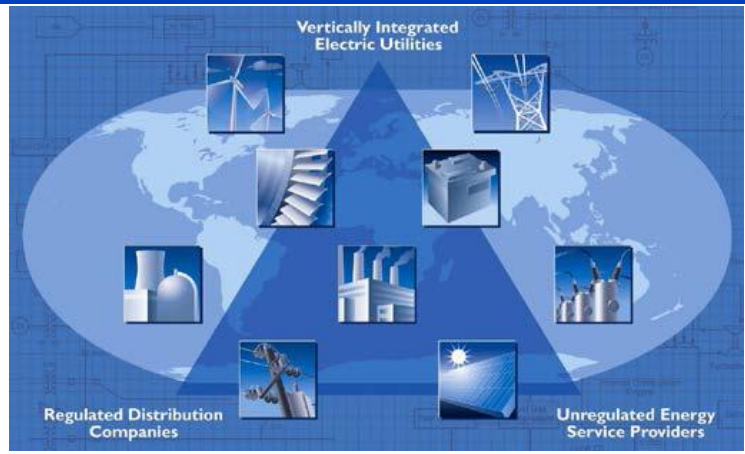




Exploring the Role of Advanced Nuclear in Future Energy Markets: Economic Drivers, Barriers, and Impacts in the United States. EPRI, Palo Alto, CA: 2018. 3002011803

Example of Scenario Driven Technology Cost Targets

Electric Generation Expansion Analysis System (EGEAS) Software



- EPRI's renowned, commercially-available, electric company **production cost** and **long-term capacity expansion** software
- **EGEAS version 13 was published in Nov 2018**.
- EGEAS is used by utility planners to produce integrated resource plans, evaluate independent power producers, develop avoided costs and environmental compliance plans, and analyze life extension alternatives.
- Optimum expansion plans are developed in terms of annual costs, operating expenses, and carrying charges on investment.
- The objective is to find an integrated resource plan that meets the objective function specified by the user. The two objective functions in EGEAS include: **minimizing total present worth costs** and **minimizing levelized annual customer rates**.
- EGEAS is licensed by 13 state PUCs and regulatory agencies in the US, and a variety of EPRI members and others in the US and internationally.

EPRI's TAGWeb® Software: Cost and Performance Data for Power Generation and Storage Technologies

- **Objective**: Provide independent, reliable and relevant cost and performance data for a comprehensive suite of power generation and storage technologies, and their various configurations including leading edge options.
- **Technologies Included:**
  - **Central Stations**
    - Pulverized coal (w/ CCS)
    - Fluidized bed combustion
    - IGCC
    - Nuclear
    - CT/CC (w/CCS)
    - Reciprocating engines
    - Coal to gas conversions
  - **Distributed Generation**
    - Fuel cell
    - Internal combustion engine
    - Small combustion turbine
    - Micro turbine
  - **Renewables**
    - Wind
    - Solar photovoltaic (PV)
    - Solar w/ storage
    - Solar thermal
    - Geothermal
    - Renewables combustible
  - **Storage**
    - Compressed Air Energy Storage (CAES)
    - Pumped hydro
    - Flywheel
    - Batteries (Li-Ion; Flow; Metal Air; Sodium-based)
    - Superconducting Magnetic Energy Storage (SMES)

Technology Costs in the Utility Planning Process

Technology Analysis

- Comparative Analysis
- Screening Assessments
- Market studies

IRP & Financial Analysis

- Location Specific Cost & Performance
- Model down select
- Flex & Resiliency Options

Plant Design & RFP

- Tech. Specifications
- Thermodynamic Analysis
- Cost Benchmarking
- CPCN

Regulatory

- Defendable data
- Objective
- Clearly Stated Assumptions

Transparency & Consistency

Duty Cycle	Unit Size	Location Assumptions	Cost Boundary
Ambient Conditions	Fuel Delivery Configuration	Fuel Storage Specifications	Raw Materials and Water Storage
Part-Load, Load Following, Degradation	Start-up Requirements	Spare Equipment and Design Redundancy Philosophy	Emissions

Consistent Assumptions are Required for Accurate Analysis

Technology Assessment Guide Costing Approach

Capital costs are updated by obtaining budget and performance quotes from a number of suppliers.

Construction-labor costs and operating- labor costs are periodically updated by conducting surveys of labor rates for multiple city locations in all 50 states.

The average of the overall city rates for respective states within an EPRI region becomes the labor rate used for that region, including base labor rates, fringe benefits, taxes, and all other items that reflect realistic total hourly rate.

Evaluate costs from various contractors by obtaining the design basis, evaluating what is included and excluded, understanding the unit rates for labor, obtaining bulk quantities and bulk unit costs, and comparing the estimates to internal & independent sources.

All costs are adjusted to the same year dollars using the gross domestic product (GDP) deflator.

Interest rates during construction and cost escalation rates during construction are consistent and based on TAG values.

Operating labor rates, maintenance costs, consumables charges, and overhead rates are calculated consistently.

Fuel composition is handled consistently.

Adjustments are made for location factors where possible.

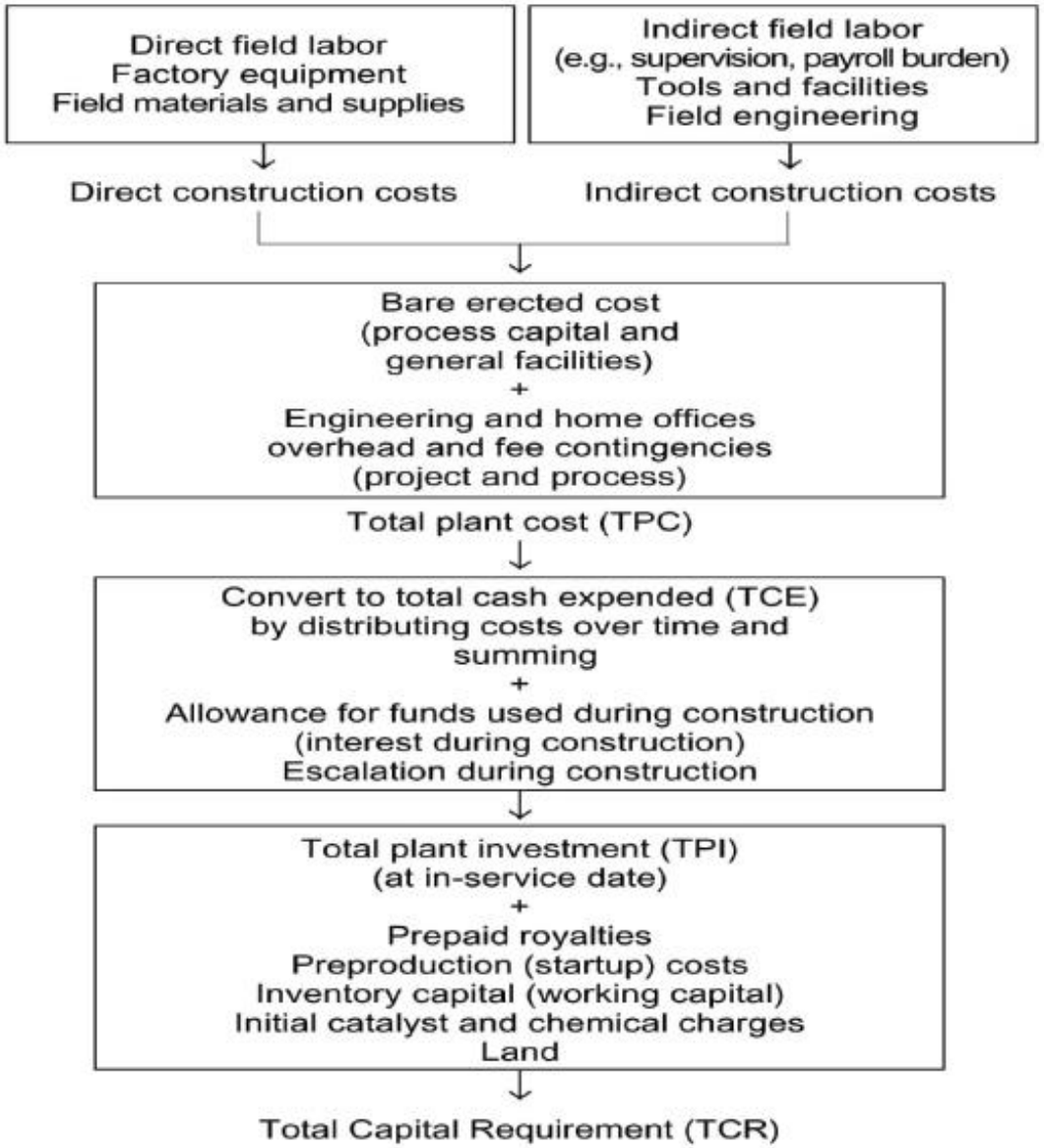
Contingencies, construction periods, and general design criteria are examined for consistency and adjusted where possible.

Common Sources of Inconsistency

- The design approach, cost estimating methodology, and level of contingency of different contractors
- The number of projects included in the historical databases used to develop estimate(s) and the experience to understand how to adjust the design and cost factors for the particular characteristics of a new location
- The different approaches between owners regarding the level and number of spare equipment
- Inadequate or inconsistent information regarding site conditions, including topography, soil characteristics, or unrecorded underground obstructions or conditions
- Normal owner-preference items—such as building enclosures, instrumentation, extra space for maintenance—and design allowances for fuel variability can vary for different designs and contractors
- Inconsistent assumptions on fuel/input characteristics can lead to cascading divergence in both design and cost estimates

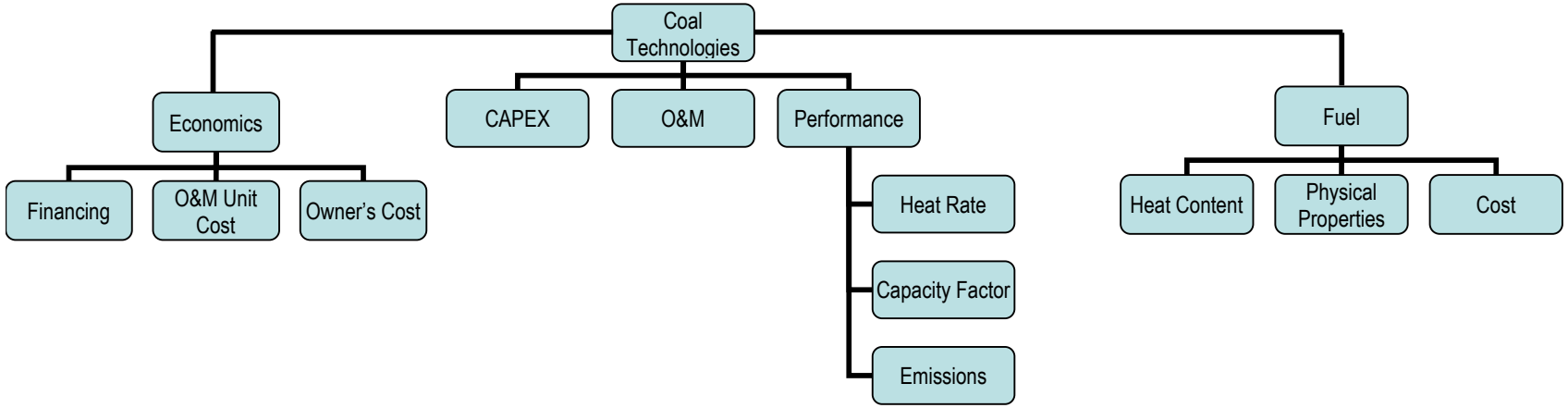
Centralized Approach Can Ensure Consistent Cost Estimate Development

Capital Cost Build Up

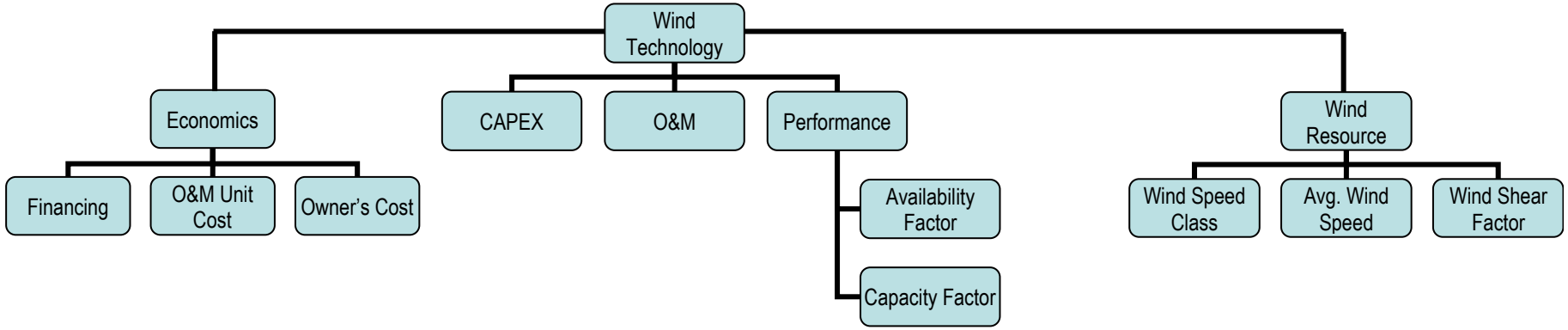


Cost and Performance Case Structure Examples

- Central, fuel-based technologies



- Renewables technologies



Technology Cost and Performance Reporting - Example

Study	19.0	2019 Tech Cases
Technology	1920.3	Wind, EWC (IA), 2.8 MW x 54
Economics	1920.5	2019 Econ EWC Wind (IA)
Resource	1024.3B	2010 EWC Wind (IA)
Region	E/W Central	
State	Iowa	
Unit Size (Net MW)	2.38	
Number of Units	54	

Availability Factor (%)	97.00
Capacity Factor (%)	49.94
Pre-construction Time (Yrs)	1
Plant construction Time (Yrs)	2
Unit Life (Yrs)	25
Technology Development Rating	Commercial
Design, Cost Estimate Rating	Simplified
Commercial Service Year	2020
Tech Input Year $	Dec, 2019
Econ Input Year $	Dec, 2016
Reference Year $	Dec, 2019
Time-dependent Input Type	Annual

Fixed O&M ($/kW-yr)	50.06
Variable O&M ($/MWh)	0.00
Consumables ($/MWh)	0.00
Land Required (acre)	9072.0
Water Makeup @ 100% capacity (1000 gal/yr)	0

Wind Turbine Generator	850.0
Balance of Plant	400.0
Total Process Capital (R)	1250.0
General Facilities & Site Specific (R)	0.0
Engineering Fee & Constr. Man. (R)	89.0
Project Contingency (R)	0.0
Process Contingency (R)	0.0
Total Plant Cost(R)	1339.0
AFUDC (M)	212.5
Total Cash Expended (M)	1288.0
Total Plant Investment (M)	1500.5
Total Owner Costs (R)	60.0
Total Capital Required (M)	1560.6

Example of CT performance data:

Net Heat Rate (Btu/kWh):	
25% Load	
50% Load	7117
75% Load	
Full Load	6627
Average	6825

Unit Availability:	
Equivalent Planned Outage Rate (%)	4.5
Equivalent Un-planned Outage Rate (%)	2.0
Equivalent Availability (%)	93.6
Capability Ratio	1.0
Capacity Factor (%)	85.00
Minimum Load (%)	1.0

Comprehensive Summary Providing CAPEX, OPEX, Performance, and Financial Data

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