

# Supply-side Resources & Planning Assumptions

## Generating Resources Advisory Committee

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## What is this about?

- **Power generation resources:**
  - Central-station and distributed
  - Energy
  - Capacity (peaking and flex)
  - Storage
- **Resource assessment data needs and applications**
- **Resources proposed for assessment**
- **Proposed depth of assessment**
- **Topics of special interest**



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## NPCC applications of resource planning assumptions

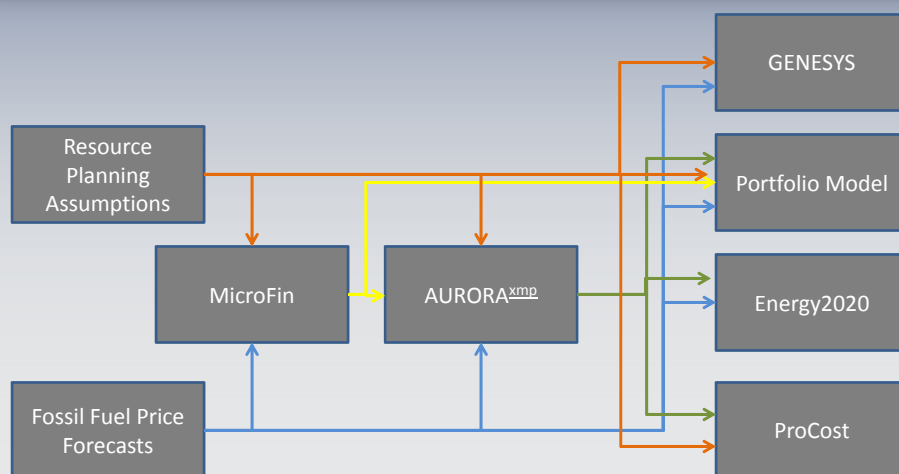
- **MicroFin** – Preliminary assessment of comparative generating resource costs; configure AURORA<sup>xmp</sup> and RPM cost inputs
- **ProCost** – Calculate EE measure cost-effectiveness
- **AURORA<sup>xmp</sup>** – Forecast wholesale power prices, various system wide operational analyses
- **GENESYS** – Assessment of system adequacy & reliability
- **Regional Portfolio Model (RPM)**– Evaluate cost and risk of alternative resource portfolios



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## Information flow



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## Resource data & planning assumptions

- Reference plant (New resource options)
- Technology status & development timeline
- Costs – current and future
- Fuel prices – current and future
- Development & construction schedule & cash flow
- Financing & incentives
- Operating characteristics
- Project Inventory - existing & confirmed, RPS
- New resource development potential – PNW & WECC



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## Example Reference Plant: Central-station Solar PV (from 6th Plan)

- 25 MW dc/20 MW net ac output using flat plate, non-concentrating, single crystalline Si modules on single-axis trackers.
- Scope: step-up transformers, switchgear and interconnection facilities and security, control and maintenance facilities.
- PNW reference locations: Billings, MT; Boise, ID; Burns, OR; Yakima, WA and Ely NV (w/interconnection to PNW main grid)




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## Technology status & development timeline

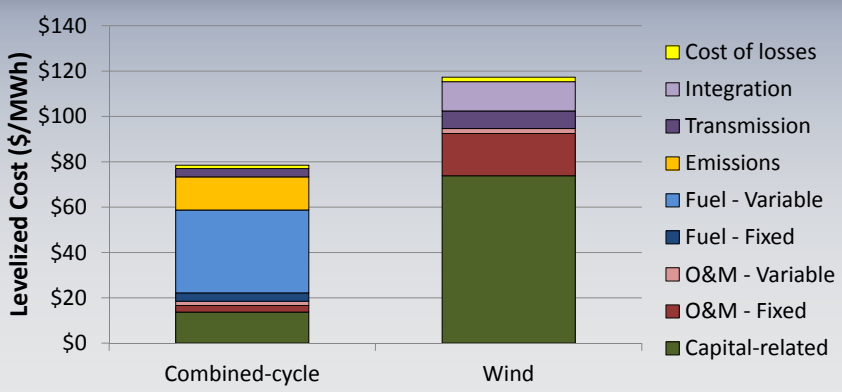
- **Technology status:**
  - Conceptual
  - Development
  - Early commercial
  - Mature commercial
- **Development timeline**
  - Earliest service year for new commercial units
- **Inventory of proposed PNW projects**
  - Announced
  - Developed (Shovel-ready)
  - Under construction



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## Cost components



Component	Combined-cycle (\$/MWh)	Wind (\$/MWh)
Capital-related	~15	~75
O&M - Fixed	~5	~20
O&M - Variable	~5	~5
Fuel - Fixed	~5	0
Fuel - Variable	~35	0
Emissions	~15	0
Transmission	~2	~10
Integration	~2	~10
Cost of losses	~2	~5
<b>Total</b>	<b>~78</b>	<b>~118</b>

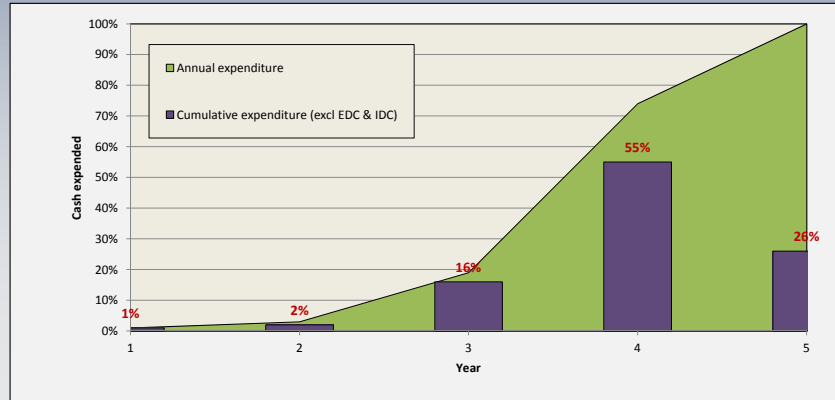
Costs estimated for 2012 base year with forecast escalation/de-escalation.  
Capital cost expressed as “overnight” total plant cost; w/uncertainty.



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### Construction schedule & cash flow: Combined-cycle example for levelized cost analysis



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### Construction schedule & cash flow: Combined-cycle example for risk analysis

Phase >>	Development	Early Construction	Committed Construction
Milestone	Conceptualization	Notice to Proceed	Major Equipment Delivery
Periods (mo)	24	12	18
Expenditure (Lev. \$/kW-yr)	\$6	\$55	\$78
Uncertainty	+30%/-30%	+30%/-30%	+30%/-30%
Suspension (\$/kW)	Negligible	\$162	--
Hold (\$/kW-yr)	\$2	\$13	--
Termination (\$/kW)	Negligible	\$95	--
Life (mo)	60	--	--



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## Financing assumptions & Incentives

- Developer type (Muni, IOU, IPP, other)
- Debt/Equity ratio
- Debt interest rate
- Return on equity
- Debt term
- Tax obligations (Federal, State, Local; Income, Property)
- Incentives (Production and investment tax credits)
- Discount rate



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## Operating characteristics

- Heat rate (thermal technologies)
- Forced outage rate; mean time to repair
- Scheduled outage rate
- VER\* capacity factor (hourly ideal, seasonal OK, annual if that is all that is available)
- Other seasonal and elevation factors
- Min up time, min down time, ramp rate (flex capacity resources)

\*Variable Energy Resource (wind, solar, wave, tidal)



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## Project inventory & development potential

- **Project inventory (PNW, WECC)**
  - Committed (operating, under construction, planned)
  - Planned retirements
- **RPS obligations**
- **New resource options:**
  - Earliest service year
  - Total potential for future development
  - Maximum development rate



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## Significant components of future system

- **Proposed resources:**
  - Natural gas combined-cycle
  - Wind plants
  - Solar photovoltaic plants
  - Natural gas peak and flex capacity
    - Simple-cycle gas turbines (frame, aero, intercooled)
    - Reciprocating engine plants
  - Hydropower upgrades?
  - Storage technologies?
- **Proposed Assessment: In-depth quantitative characterization to support system integration and risk analysis modeling**



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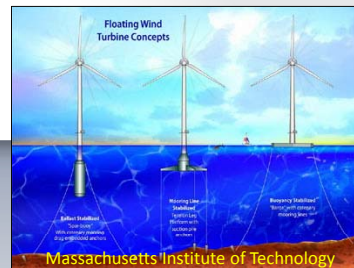
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## Commercial w/Limited PNW availability



- **Proposed resources:**
  - Biogas technologies
    - Landfill
    - Wastewater treatment
    - Animal, commercial & household wastes
  - Woody residues (mill & forest residues)
  - Geothermal (conventional hydrothermal)
  - New hydropower
  - Waste heat recovery and other CHP options
- **Proposed assessment: Quantitative characterization sufficient to estimate leveled costs**

## Longer-term PNW potential



- **Proposed resources:**
  - Engineered geothermal
  - Offshore wind
  - Modular nuclear units
  - Wave energy conversion
  - Tidal energy conversion
  - Coal technologies w/CO<sub>2</sub> separation
  - CO<sub>2</sub> sequestration
- **Proposed assessment: Qualitative discussion of status & PNW potential; key numbers as available**



## Rest-of-WECC potential

- Proposed resources:
  - Coal steam-electric
  - Solar-thermal
  - Large-scale advanced nuclear plants
- Proposed treatment: Qualitative discussion; sufficient quantitative assessment to represent in AURORA<sup>xmp</sup>.



## Proposed topics: Resource characterization

- Photovoltaic capital cost and trends
- 8760 hourly output estimates for solar technologies
- Combined-cycle models with rapid-response capability vs: bulk energy production
- Natural gas peaking and rapid-response technologies
- Storage technologies
- Development and construction schedules
- Additional PNW wind development potential
- CHP and distributed generation potential.
- Hydropower upgrade potential.

## Proposed topics: Resource & system planning issues

- Accounting for speculative project development
- Current and forecast wind and solar integration costs; demand for and sources of balancing reserves.
- Current and forecast CO2 cost; plausible scenarios
- “Total Fuel cycle” GHG production
- Natural gas price forecast (from NGAC)
- Wholesale electricity price forecast
- Who develops? Who builds? Who owns and operates?
- Financial characteristics Should resources be differentiated?
- Consideration of incentives; plausible scenarios
- WECC retirements and replacements (coal , OTC, other?)