Construction and Availability Uncertainty in the Regional Portfolio Model

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for the
Northwest Power and Conservation Council
Generation Resource Advisory Committee
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Overview

- Supply and Technology Availability
- Construction Costs
- Economic Retirement
- Variable Capacity for Existing Units

Different Kind of Risk Modeling

- Imperfect foresight and use of decision criteria for capacity additions
- Adaptive plans that respond to futures
  - Primarily options to construction power plants or to take other action
  - May include policies for particular resources
- "Scenario analysis on steroids"
  - 750 futures, strategic uncertainty
  - Frequency that corresponds to likelihood

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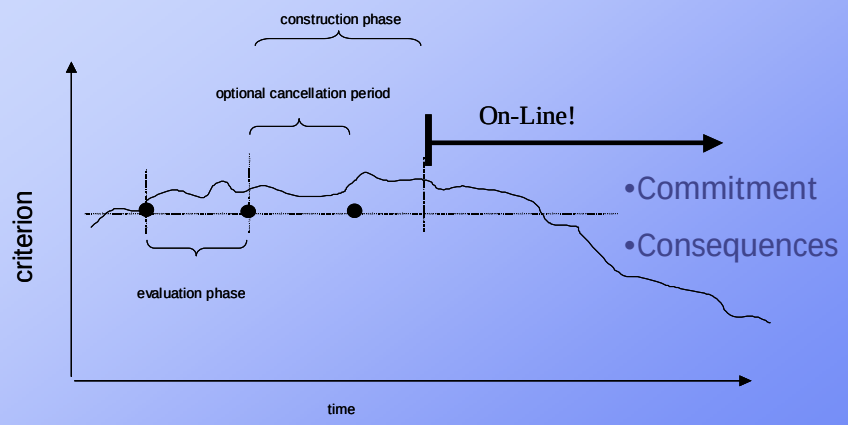
Decision criteria for each resource



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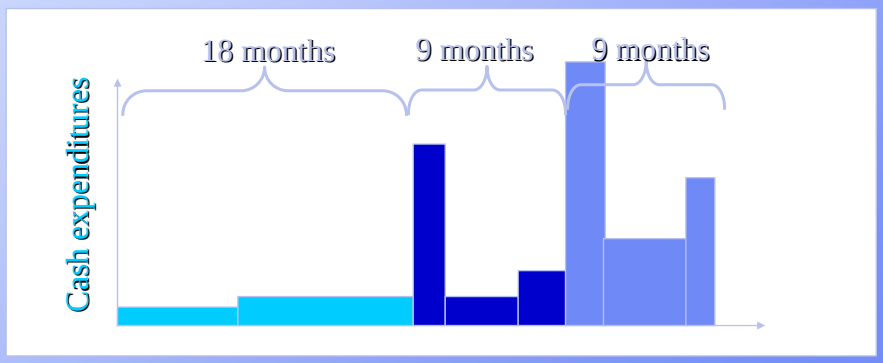
The Construction Cycle

- After an initial planning period, there typically large expenditures, such as for turbines or boilers, that mark decision points.



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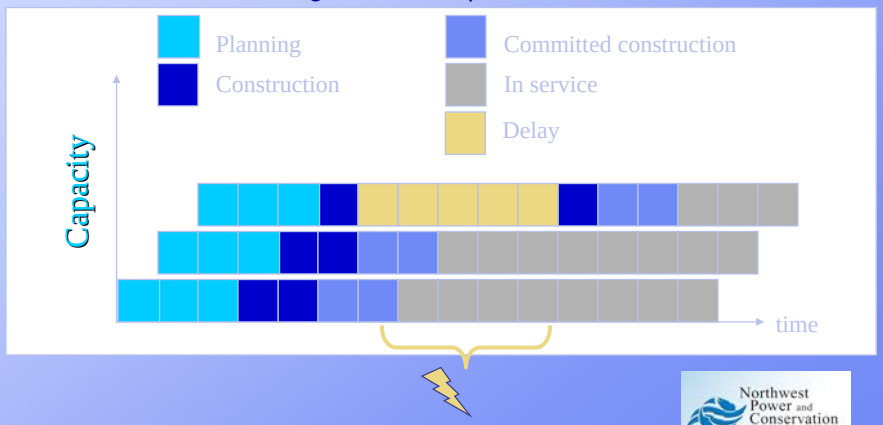
Modeling Cohorts

- Each period can have a cohort of plants, usually of different size or capacity
- All cohorts will be affected by changing circumstances, but may be at different stages of development



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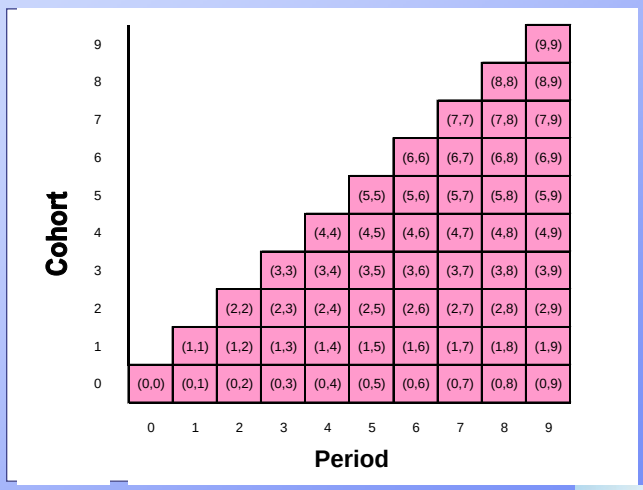
Fixed Cost Capabilities



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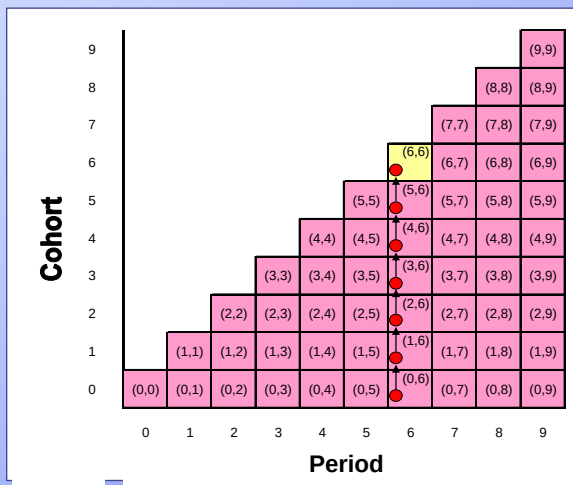
Fixed Costs Processed One Period at a Time



Processing cohorts for period 6

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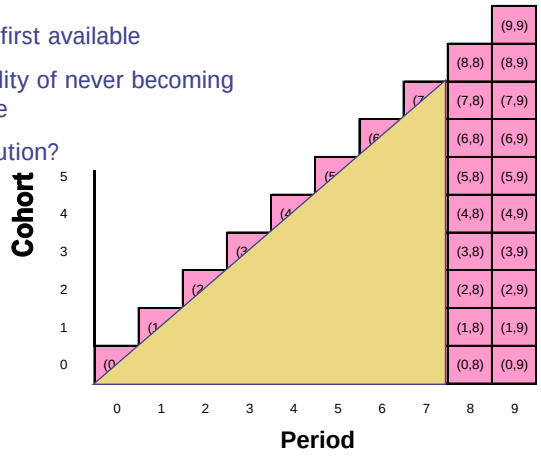
New Availability Modeling

Random variable:

- Period first available
- Possibility of never becoming available
- Distribution?



Future (game) = 1

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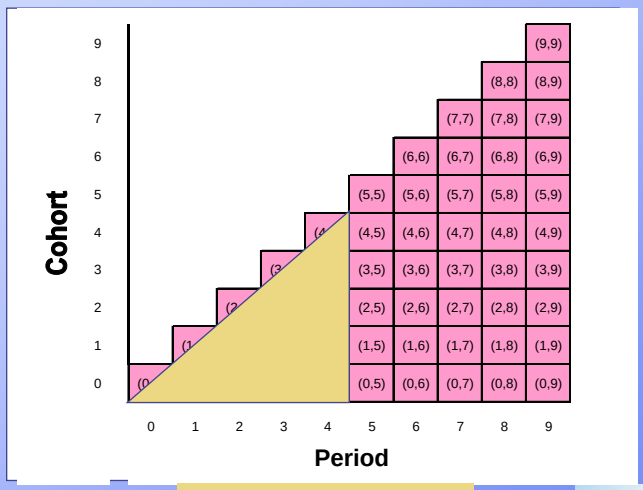
New Availability Modeling



Future (game) = 2

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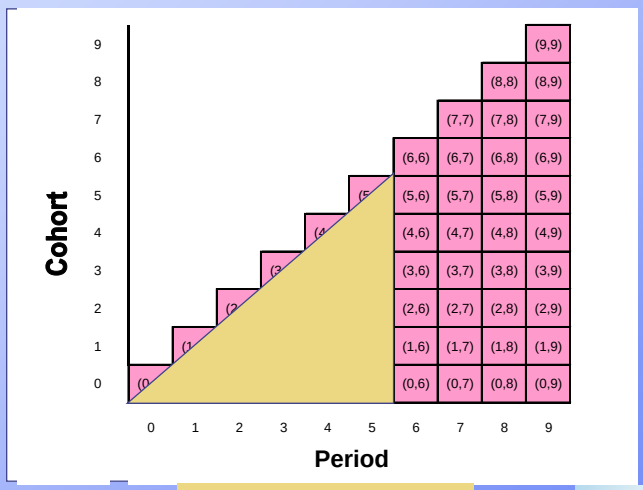
New Availability Modeling



Future (game) = 3

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Availability Uncertainty

- Consequences
  - Recovery of planning costs delayed by at least the number of periods unavailable
  - Delays counted against the maximum amount of time that a plant may be mothballed. The siting and licensing is presumed to have finite life.
- Others?

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Existing Features

- Planning – no delays or uncertainty
  - A feature we do not use for our planning: unplanned market additions, at a higher planning price
- Early construction – response to circumstances
  - Existing decision based on market viability and prospective adequacy of the system
  - Mothball and cancellation options
  - Option to incur all expenses in the first period
- Late construction – no delays or uncertainty

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New Features

- Overnight construction cost uncertainty
  - Would apply to mothball and cancellation costs as well
- Distinct costs if mothballed or cancelled in the first period of early construction
- Fixed operations and maintenance (FOM) cost uncertainty
- Decision criterion re-evaluated with revised going-forward cost only during early construction

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Alternatives for Representing Construction Cost Uncertainty

- CERA scenarios
- "1-dimensional" uncertainty
- "2-dimensional" uncertainty
- input-based uncertainty

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CERA Scenarios

Future Scenario Indexes by Fuel Source

	Asian Phoenix				Break Point				Global Fissures			
	2011	2013	2015	2018	2011	2013	2015	2018	2011	2013	2015	2018
Nuclear	343	334	350	334	394	415	436	451	248	233	206	162
Coal	212	220	226	222	201	212	214	217	172	165	155	152
Wind	235	230	208	195	249	264	276	302	176	166	155	144
Gas CC	203	207	209	202	212	223	231	232	170	161	149	138
Gas CT	217	220	223	214	225	237	247	249	179	170	158	146
Overall PCCI	288	283	296	283	324	342	358	369	213	201	181	153

Source: Cambridge Energy Research Associates.
Notes: All forecast figures in real terms (without inflation added)

November 2008 CERA Special Report *Capital Costs Analysis Forum–Power: Market Review*.

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CERA Scenarios

		Sensitivities 2011	2013	2015	2018
Nuclear	up	18%	24%	31%	35%
	down	-26%	-30%	-38%	-51%
Coal	up	-9%	-4%	-3%	-1%
	down	-22%	-25%	-30%	-31%
Wind	up	9%	15%	20%	32%
	down	-23%	-28%	-33%	-37%
Gas CC	up	2%	8%	12%	12%
	down	-18%	-22%	-28%	-33%
Gas CT	up	3%	8%	12%	13%
	down	-19%	-23%	-28%	-34%
Overall PCCI	up	14%	21%	27%	30%
	down	-25%	-29%	-36%	-46%

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Alternatives Consistent with CERA Scenarios

- "1-dimensional" uncertainty
- "2-dimensional" uncertainty

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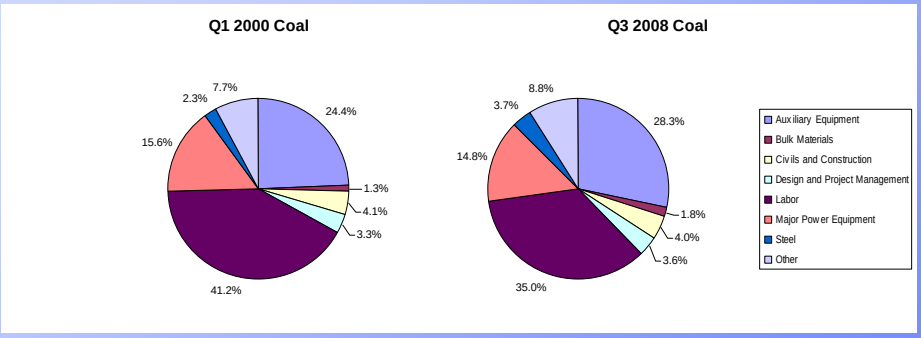
Input-Driven Behavior based on CERA Scenarios



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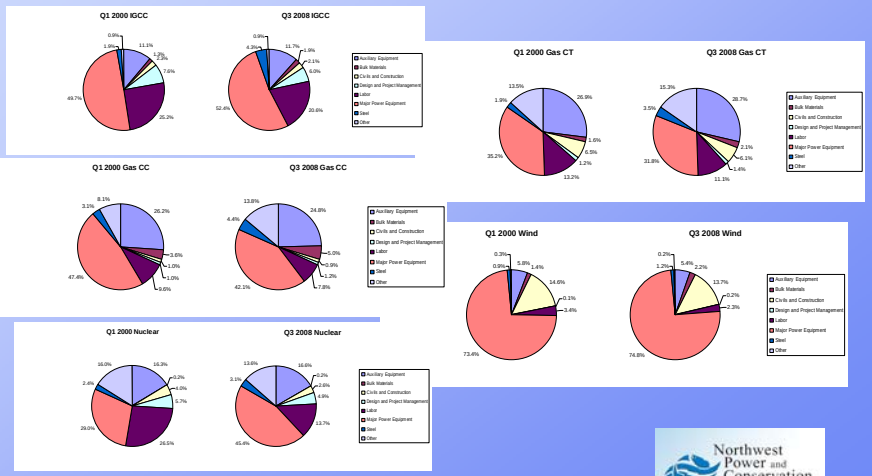
Input-Driven Behavior based on CERA Scenarios



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Input-Driven Behavior based on CERA Scenarios

	Auxiliary Equipment	Bulk Materials	Civils and Construction	Design and Project Management	Labor	Major Power Equipment	Steel	Other	MPE-BL	MPE-GT	MPE-NR	MPE-ST	MPE-WT
CCCT	24.8	5	0.9	1.2	7.8	0	4.4	13.8	0.0	0.0	0.0	42.1	0.0
Coal	28.3	1.8	4	3.6	35	0	3.7	8.8	14.8	0.0	0.0	0.0	0.0
IGCC	11.7	1.9	2.1	6	20.6	52.4	4.3	1.0	0.0	0.0	0.0	0.0	0.0
Nuclear	16.6	0.2	2.6	4.9	13.7	0	3.1	13.5	0.0	0.0	45.4	0.0	0.0
SCCT	28.7	2.1	6.1	1.4	11.1	0	3.5	15.3	0.0	31.8	0.0	0.0	0.0
Wind	5.4	2.2	13.7	0.2	2.3	0	1.2	0.2	0.0	0.0	0.0	0.0	74.8

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Alternatives Consistent with CERA Scenarios

- input-based uncertainty

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Issues

- Are the construction cost uncertainty representations realistic?
- What are mothball and cancellation costs during construction, and should there be a separate value in the first period of construction?
- Is fixed O&M primarily labor cost?

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Retirement Decision

- Prescribed number of evaluation and mothball periods for each plant
- If decision criterion, using only forward-going FOM is negative, begin evaluation
- Once evaluation period is over, begin mothball state (no generation)
- Once mothball periods have passed, decommission and incur cancellation cost
- If any period yeilds a positive decision criterion value, reset all the counters above

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Issues

- What kind of costs, in addition to normal operating costs, would be incurred in each phase?
- Is there a better representation of the retirement decision?

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New Capability

- Only for existing plants with a single cohort
- Variable capacity could be stochastic
  - Representing uncertainty about whether anticipated capacity will materialize
  - Each future's capacity different
  - Can increase or decrease during over the study within a future
- Capacity would affect only FOM costs
- Could be used to model RPS development uncertainty, if restricted to the case of increasing capacity over the study

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Issues

- Are there other aspects of a plant with varying capacity, such as construction cost?

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End

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