Incorporating an Adequacy Standard into Resource Expansion Planning for the Pacific NW

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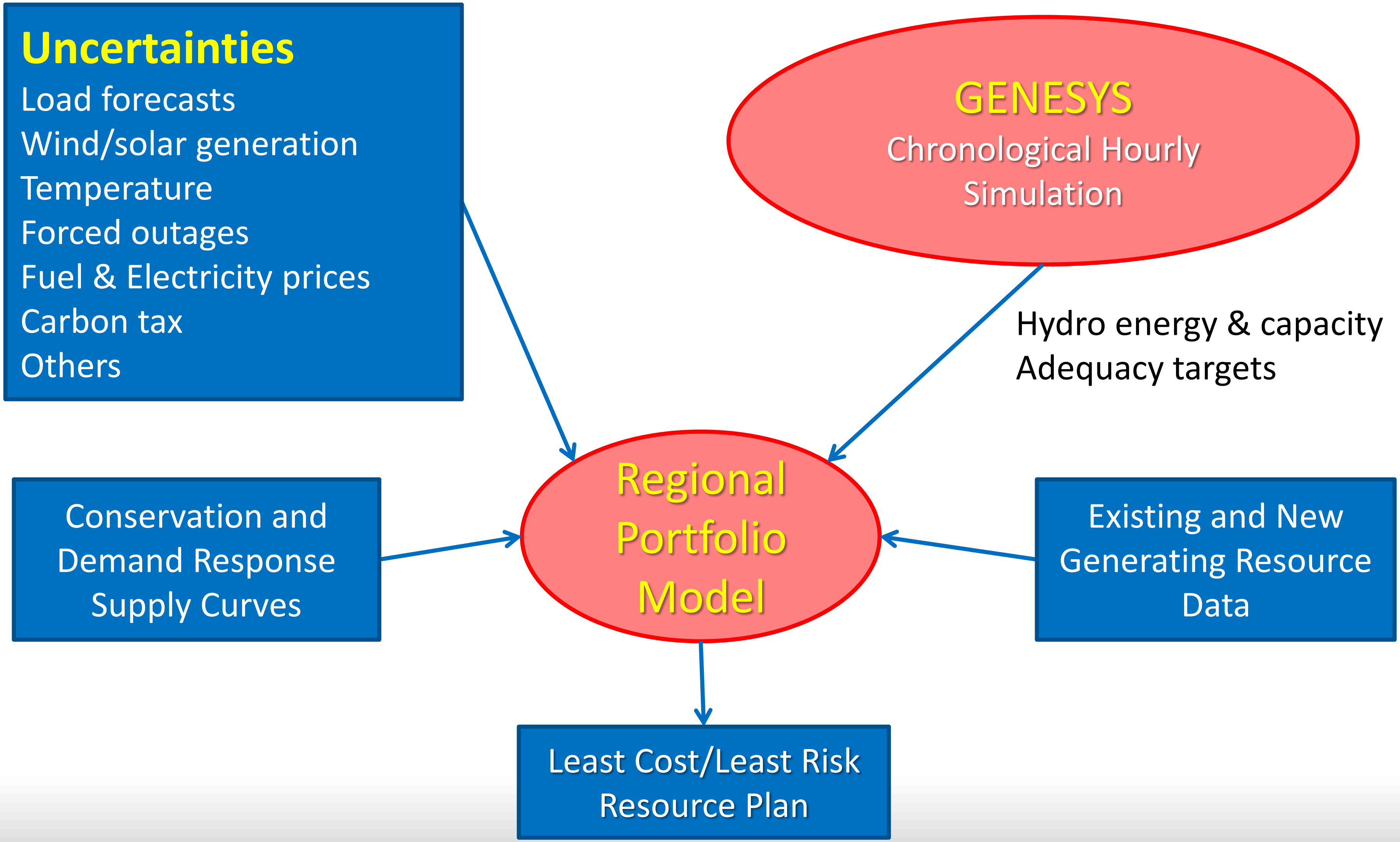
Resource Planning Methodology



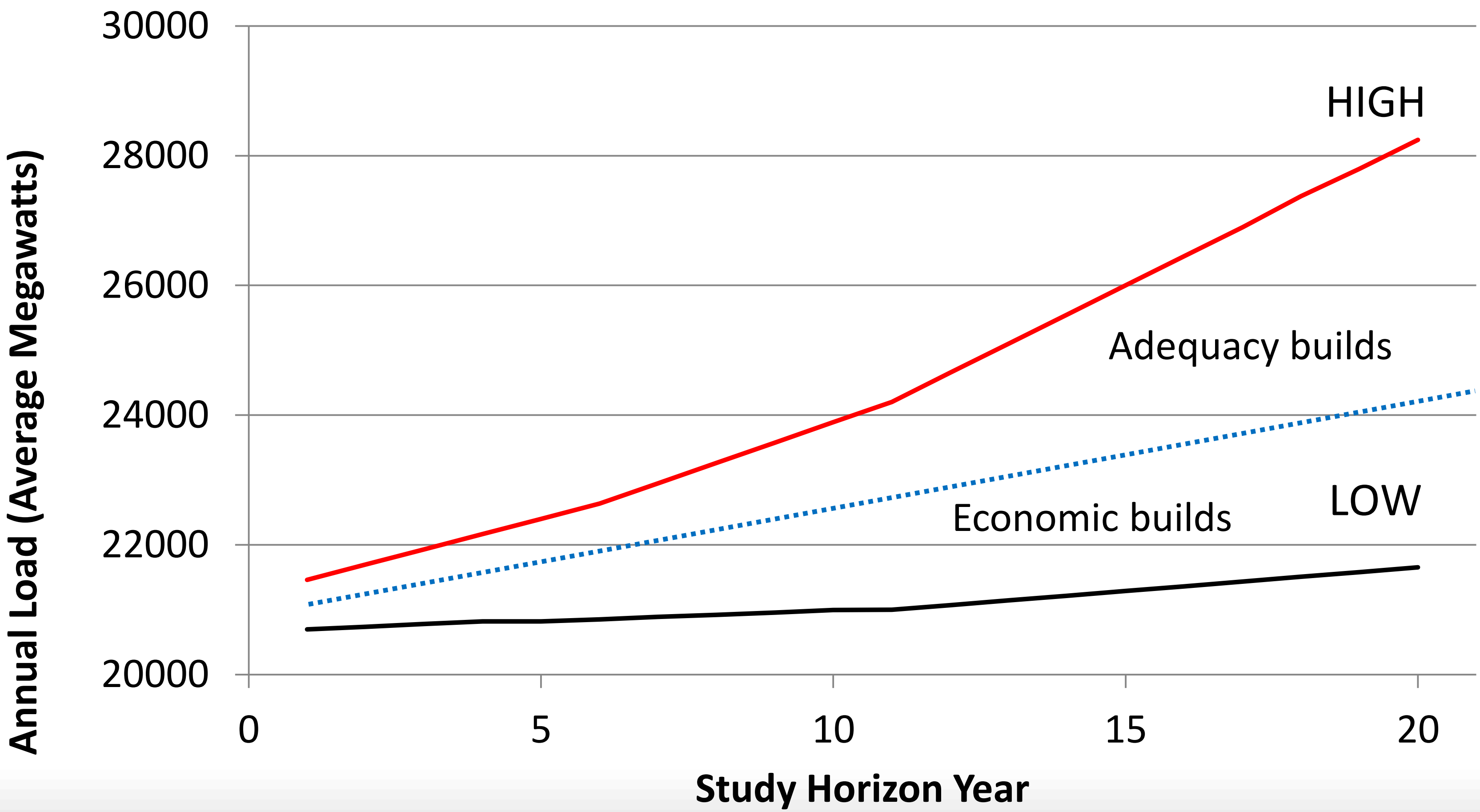
Regional Portfolio Model

- A "plan" is defined as a resource supply curve
  - Containing a specific set of resources with
  - An earliest build date for each resource

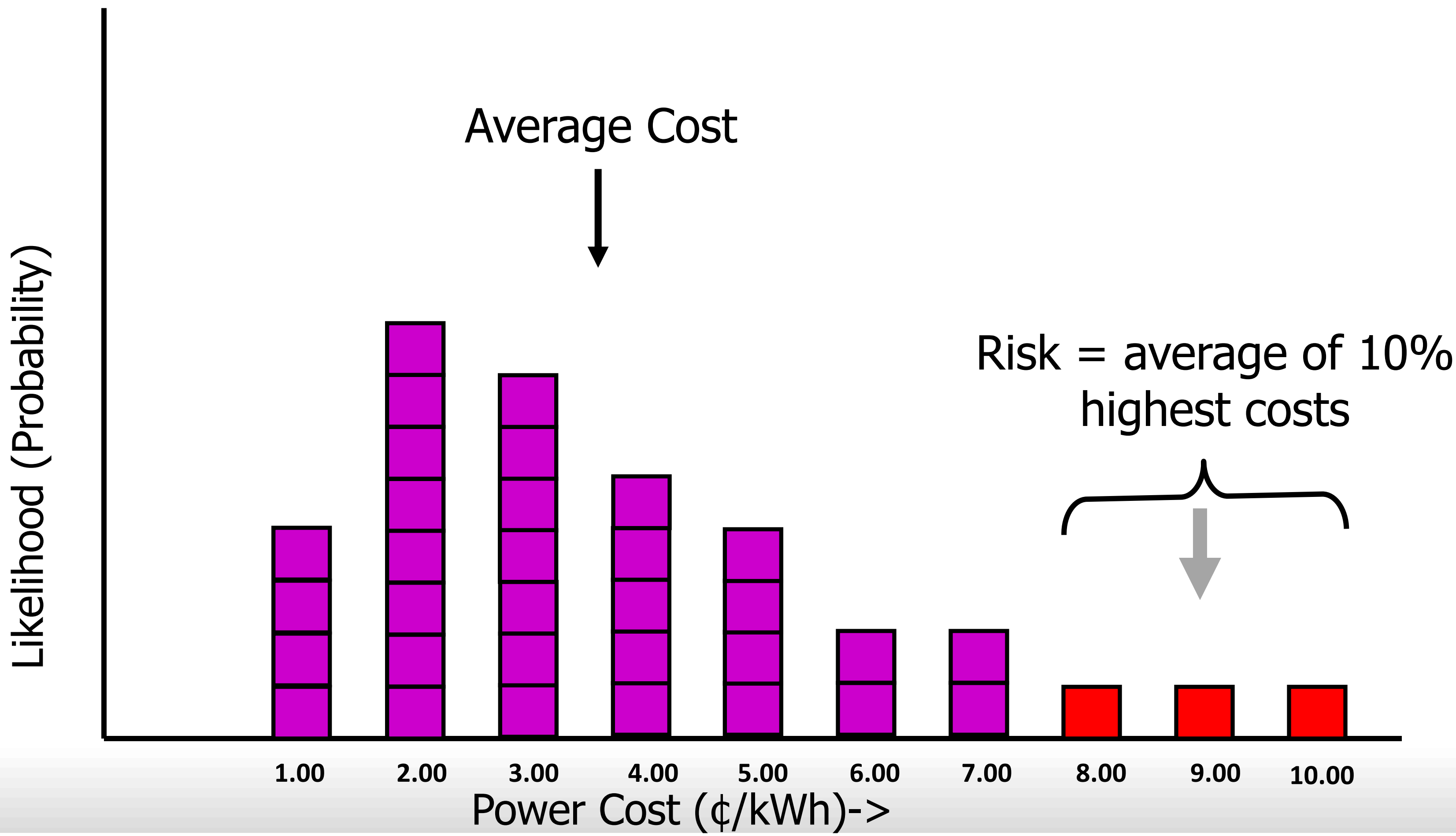
- Each plan is examined over 800 20-year futures

- Build decisions (using resources from the supply curve) are made if;
  1. A resource is projected to be economical, or
  2. A resource is needed for adequacy

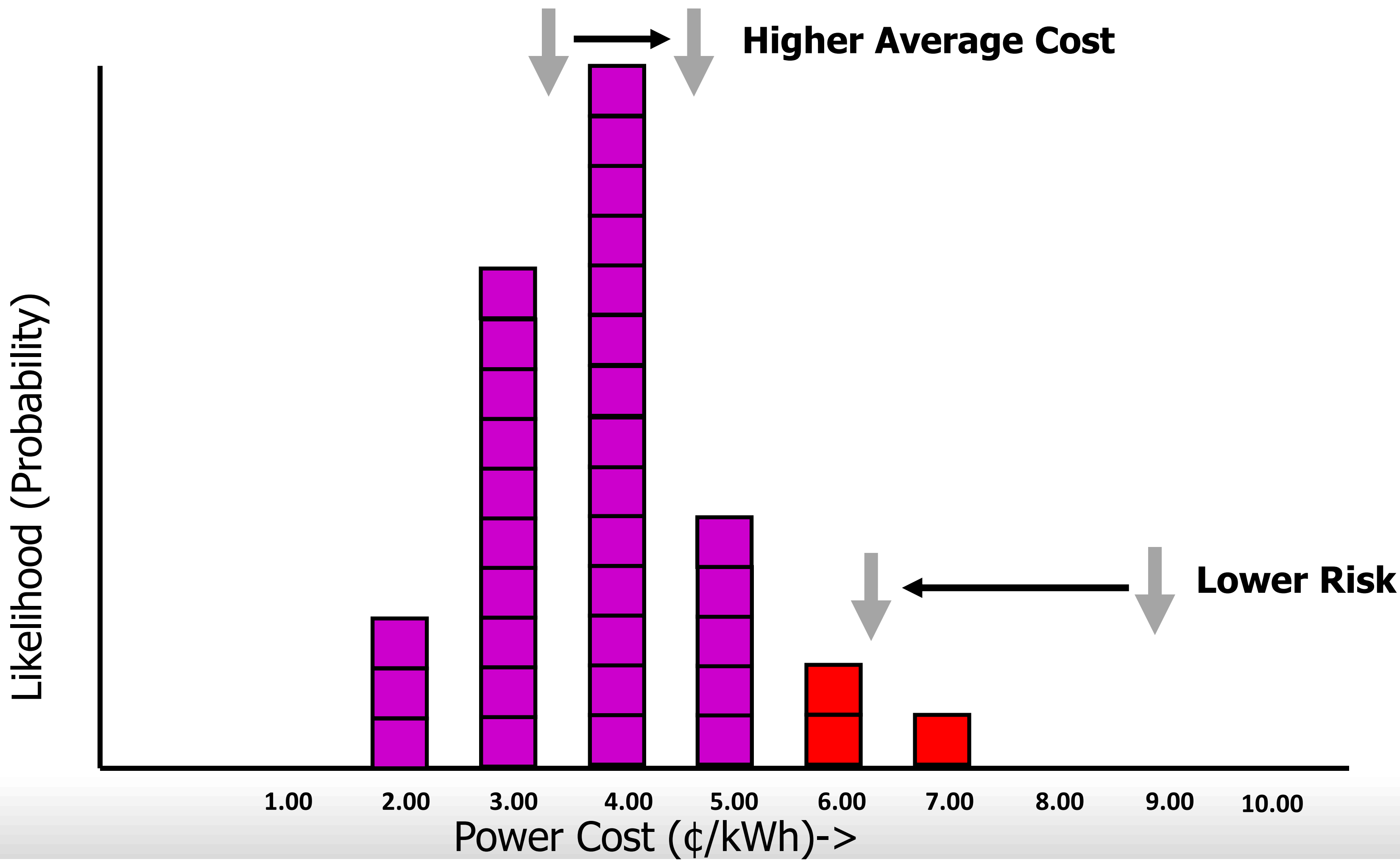
General Build Tendencies



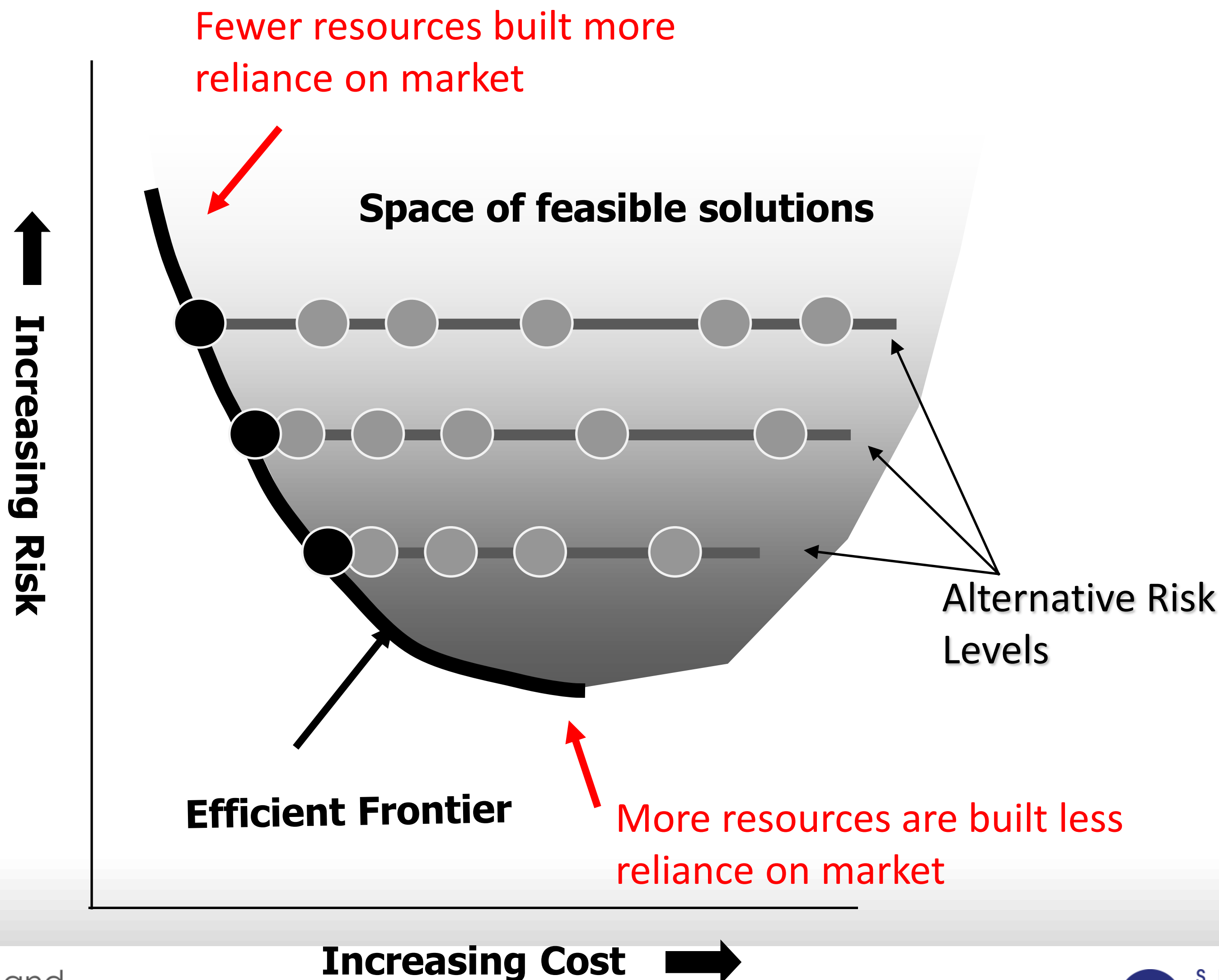
PV Cost for each of 800 futures (for each resource plan) Plan #1



Plan #2
Higher Average Cost but Lower Risk



Efficient Frontier



Incorporating Adequacy

- Associated System Capacity Contribution (similar to ELCC)
- Adequacy Reserve Margin (similar to PRM)
- Verification of adequacy

Associated System Capacity Contribution (ASCC)

- The ASCC represents the effective capacity contribution of a resource when added to the existing PNW supply
- Because of hydro storage, some resources can effectively provide more capacity than their nameplate
- To calculate ASCC:
  - Start with an inadequate power supply (i.e. LOLP > 5%)
  - <u>Needed Capacity</u> = Capacity required (based on curtailment record) to get to 5% LOLP
  - <u>Nameplate Capacity</u> = Resource capacity needed (from GENESYS runs) to get to 5% LOLP
  - ASCC = Needed capacity/Nameplate capacity
  - *ELCC = Incremental load/Resource nameplate capacity needed to serve incremental load (without affecting adequacy)*

Examples of ASCC

- Start with an inadequate supply
  LOLP = 50%
- Capacity needed for adequacy
  5,850 MW
- Amount of CCCT nameplate for a 5% LOLP
  4,400 MW

- ASCC (CCCT) = 5,850/4,400 = 1.3

- Same process for EE:
- ASCC (EE) = 5,850/4,900 = 1.2

Associated System Capacity Contribution for Various Types of Resources

	Q1	Q2	Q3	Q4
Solar PV	0.26	*	0.80	0.42
Wind	0.03	*	0.11	0.08
Geothermal	1.28	*	1.02	1.20
Energy Efficiency	1.24	*	1.14	1.16
Natural Gas	1.28	*	1.02	1.20

*The lack of adequacy issues in Q2 makes the system capacity contribution essentially zero. The numbers used here are from Q3 to avoid computational difficulties.

Adequacy Reserve Margin (ARM)

- ARM = Min resource reserve requirement for both energy and capacity needs

- Use a power supply that just meets the Council's quarterly adequacy standard (see below)
- Sum up the total rate-based generation
- Use weather-normalized load

- ARM = (Resources – Load)/Load
  Calculate quarterly ARMs for both peak and energy needs
- *PRM = Peak-hour surplus capacity to cover contingency and other reserves, load variations due to temp and additional resource outages*

	Q1 Jan-Mar	Q2 Apr-Jun	Q3 Jul-Sep	Q4 Oct-Dec
LOLP	1.9%	0%	0.5%	2.3%

Sample ARM Calculations

Capacity		Oct-Dec	Jan-Mar	Apr-Jun	Jul-Aug
Resource Type	**Description**	**Q4**	**Q1**	**Q2**	**Q3**
Thermal	Winter Capacity * (1 - FOR)	15344	16013	13993	15251
Wind	5%	227	227	227	227
Hydro	10-hr 95th Percentile	16715	17790	16792	15404
Firm contracts	1-Hour Peak	-225	-167	-493	-631
Total Resource		**32060**	**33863**	**30518**	**30250**
Load	**1-Hour Peak (expected)**	32494	33521	26299	28142
L/R Balance	Resource - Load	-434	342	4219	2109
ARM capacity	**(Resource - Load)/Load**	**-1.3%**	**1.0%**	**16.0%**	**7.5%**

Energy		Oct-Dec	Jan-Mar	Apr-Jun	Jul-Aug
Resource Type	**Description**	**Q4**	**Q1**	**Q2**	**Q3**
Thermal	Winter Capacity * (1 - FOR) * (1 - Maint)	10992	10990	10988	11012
Wind	30%	1360	1360	1360	1360
Hydro	Critical (driest) Year Hydro	11827	10642	13794	10569
Firm contracts	Period Average	-325	-200	-729	-802
Total Resource		**23853**	**22790**	**25411**	**22138**
Load	**Peirod Average (weather normalized)**	23319	23536	21208	22262
L/R Balance	Resource - Load	534	-745	4203	-124
ARM energy	**(Resource - Load)/Load**	**2.3%**	**-3.2%**	**19.8%**	**-0.6%**

Verification of ARM and ASCC

- Using only the ARMs in the RPM
- Using game 781 resource build out in GENESYS yields an LOLP of 0.3%
- Result = Overbuilding

- Use ARMs and ASCC in RPM
- Game 781 LOLP is 4.4%
- Within the acceptable range (3-5%)

PNW Adequacy Assessment for 2021

(Adequacy Standard: LOLP ≤ 5%)

	LOLP (%)	Imports 3400	Imports 2500	Imports 1700
Loads	High	22	24	26
Loads	Med	8	10	12
Loads	Low	2	4	6

PNW Capacity Needs for 2021

- NOT adequate except in low growth case
  - High load — LOLP = 24%
  - Medium load — LOLP = 10%
  - Low load — LOLP = 4%

- New capacity need
  - High load need — 2,230 MW
  - Medium load need — 1,040 MW
  - Low load need — 0 MW

7th Power Plan Key Findings

- Energy efficiency & demand response offset most new load growth
- Targeted EE by 2021
  - 1,400 average megawatts (annual average)
  - 2,660 megawatts (winter peak)
- Targeted DR by 2021
  - None
  - Prepare to develop as much as 700 MW
- 7th plan additional capacity needs by 2021 for adequacy
  - Low load case 0 MW
  - High load case 3,000 MW (RPM high load can be > adequacy high)
  - *Consistent with adequacy analysis (range of 0 to 2,230 MW)*

EUE (MW-hours)

(Lining up these results to the LOLP heat map
implies about a 1,000 MW-hour EUE threshold for a 5% LOLP)

Imports → / ↓Loads	3,400	2,500	1,700
High Load	6,400	8,700	11,800
Med Load	1,200	2,500	3,000
Low Load	200	700	1,600

LOLH (hours)

(Lining up these results to the LOLP heat map implies a 1-event-in-10-year threshold of 1.1 based on average event duration of 11 hours)

Imports ➡ ⬇ Loads	3,400	2,500	1,700
High Load	8.2	9.4	10.7
Med Load	1.6	2.4	3.1
Low Load	0.3	0.7	1.3