

Alternative Cooling System Analysis: California's Coastal Power Plants

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*Once-through Cooling:
Results Symposium*

*University of California
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El Segundo



Outline

- 1. Study Purpose**
- 2. Feasibility**
- 3. Methods / Assumptions**
- 4. Cost**
- 5. Maulbetsch Consulting Study**



Purpose & Parameters

- **2006 OPC Resolution on Once-through Cooling:**

“implement the most protective controls to achieve a 90-95 percent reduction in impacts [from impingement and entrainment]”

- **Scope of Work:**

“report will not analyze impingement and entrainment levels at each plant nor...the specific decrease in impingement and entrainment achieved by...each alternative cooling technology”

- **Repower vs. Retrofits**



Some Feasibility Issues

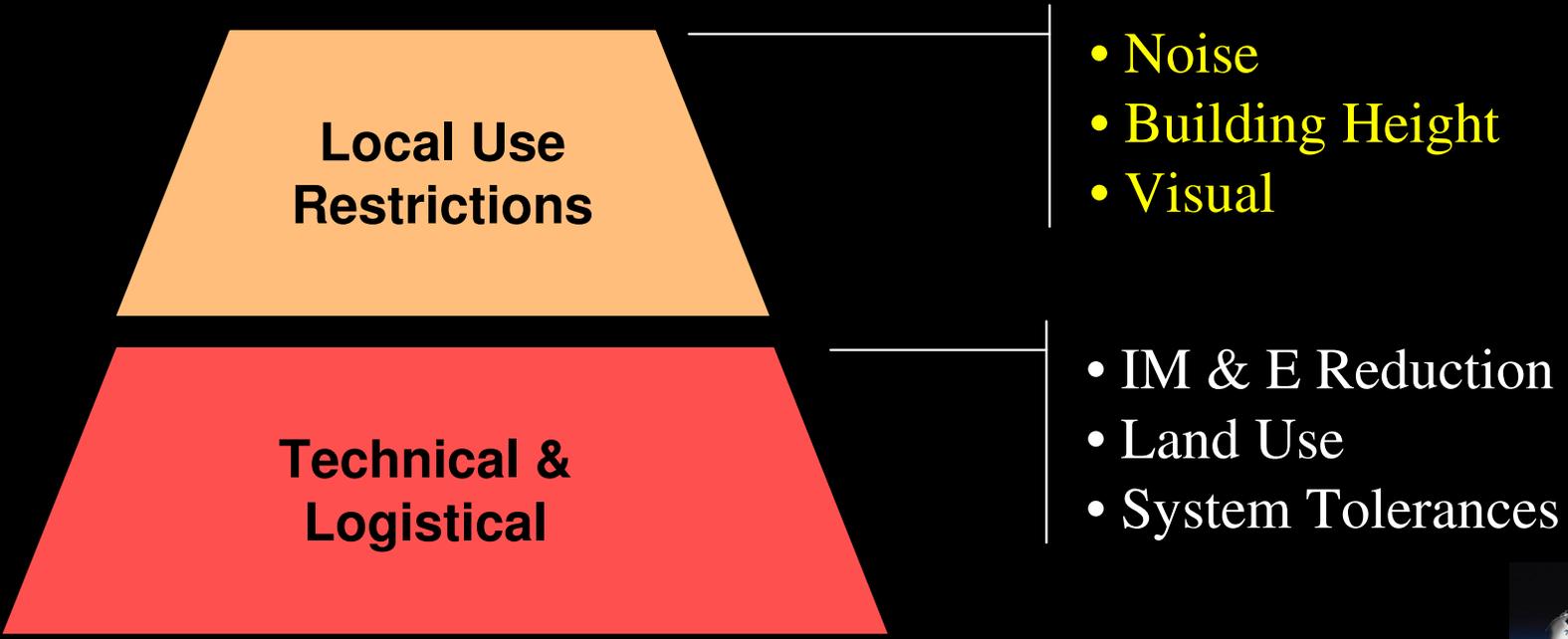


**Technical &
Logistical**

- IM & E Reduction
- Land Use
- System Tolerances



Some Feasibility Issues



**Local Use
Restrictions**

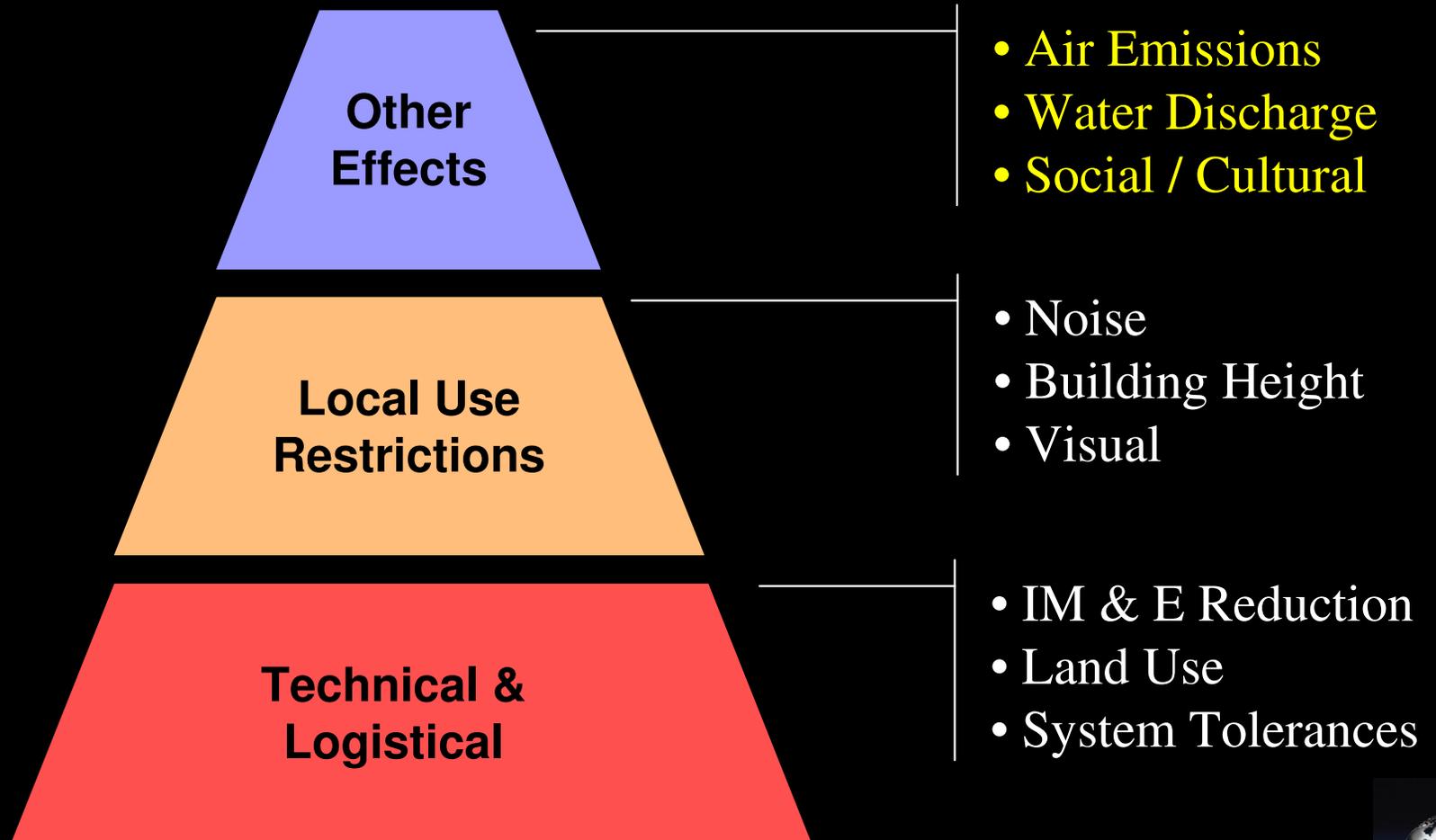
- **Noise**
- **Building Height**
- **Visual**

**Technical &
Logistical**

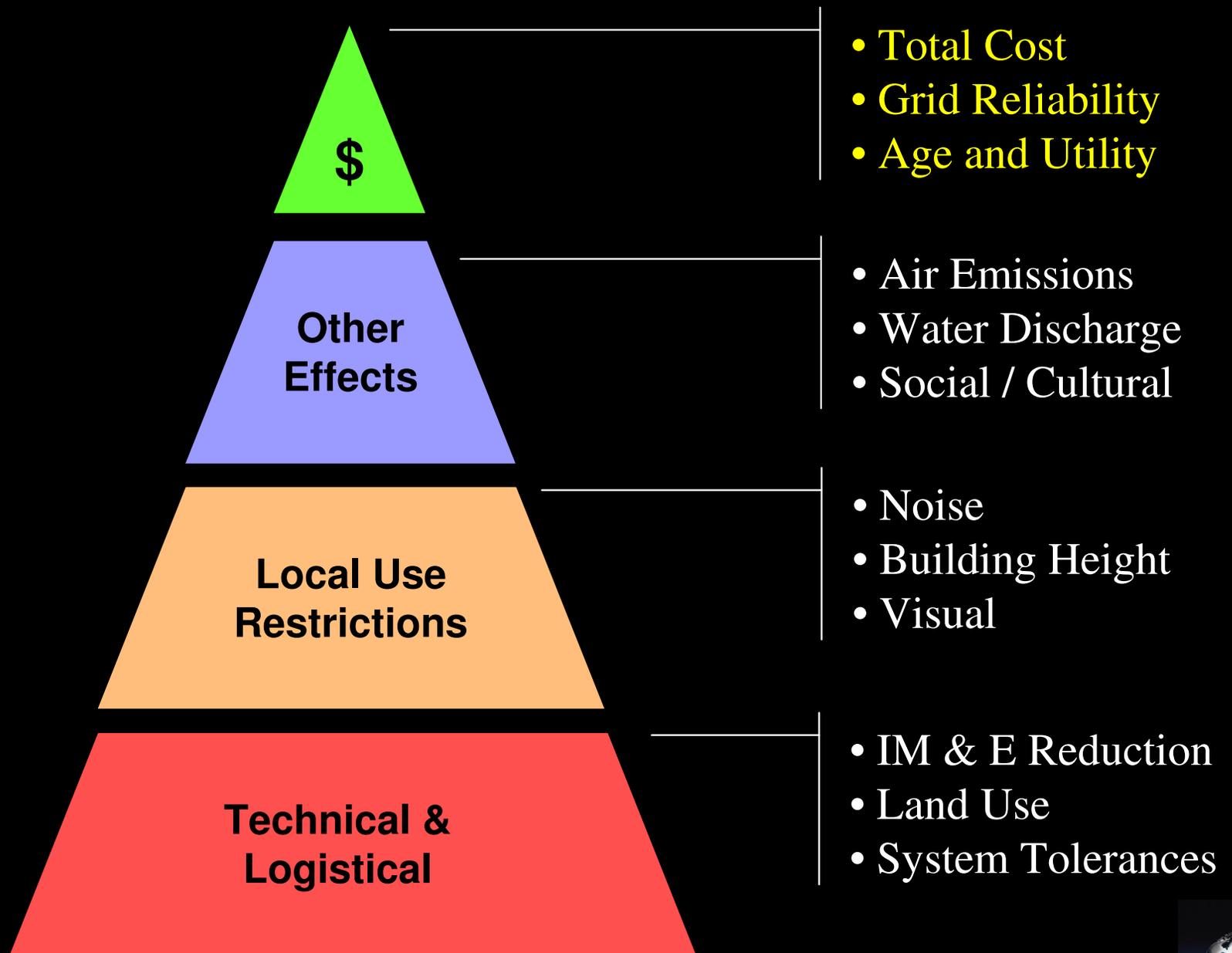
- **IM & E Reduction**
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- **System Tolerances**



Some Feasibility Issues



Some Feasibility Issues



Methods / Assumptions

General Assumptions:

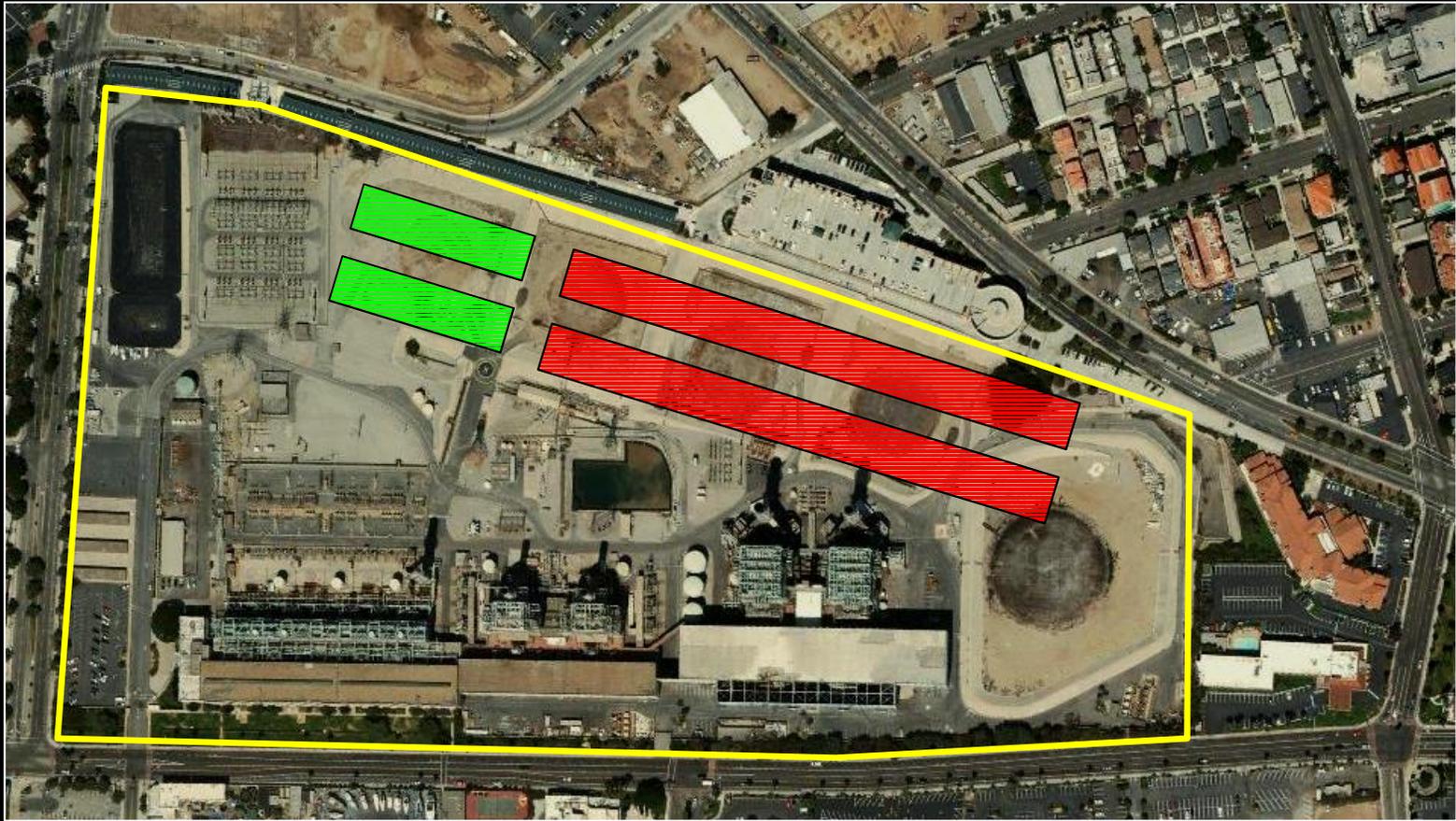
- Provide sufficient cooling for active capacity
- Salt water use for makeup water
- Condenser reinforcement; no re-optimization

Engineering Profile:

- Facility-specific data & local zoning
- Develop conceptual design
- Design-and-build estimate from CT vendors (GEA and SPX/Marley)
- Professional estimators for mechanical, electrical, civil works



Technical / Logistical Feasibility

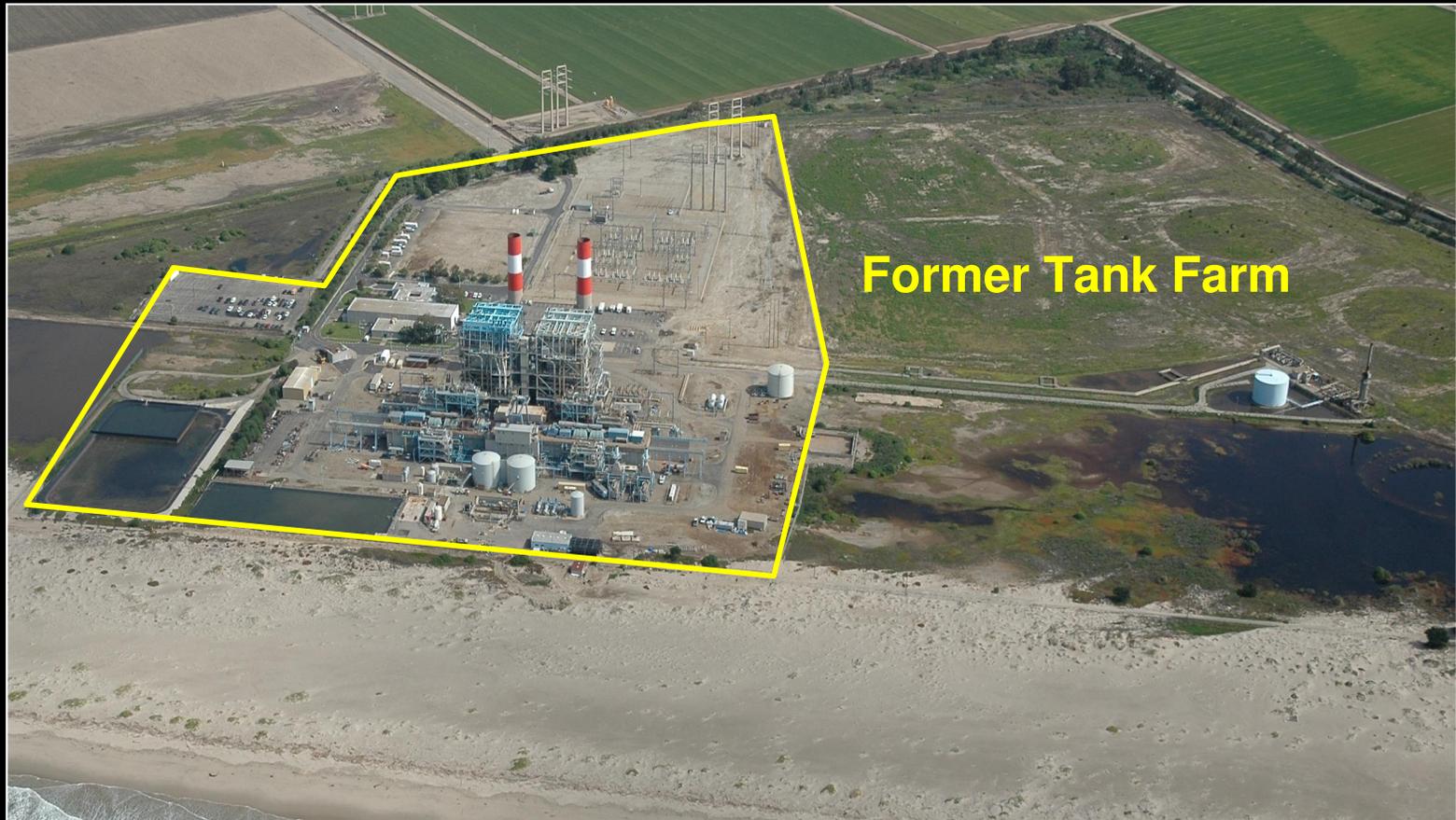


REDONDO BEACH

- 4 active units / 1,300 MW
- Noise limit: 55 dBA
- 612,000 gpm
- Nearest building < 80 feet



Technical / Logistical Feasibility



ORMOND BEACH

- 2 active units / 1,500 MW
- 476,000 gpm
- Pt. Mugu NAS ~ 2.5 miles SE
- Conservation areas



Technical / Logistical Feasibility



- **El Segundo**
- **Ormond Beach**
- **Redondo Beach**



- **Alamitos**
- **Diablo Canyon**
- **Mandalay**
- **Moss Landing**
- **Morro Bay**
- **San Onofre**
- **Contra Costa**
- **Harbor**
- **Haynes**
- **Huntington**
- **Pittsburg**
- **Scattergood**



Cost Estimate

Direct:

- All civil, mechanical and electrical; including cooling tower design-and-build

Indirect:

- 30% of all direct costs (35% for Diablo and SONGS)

Contingency:

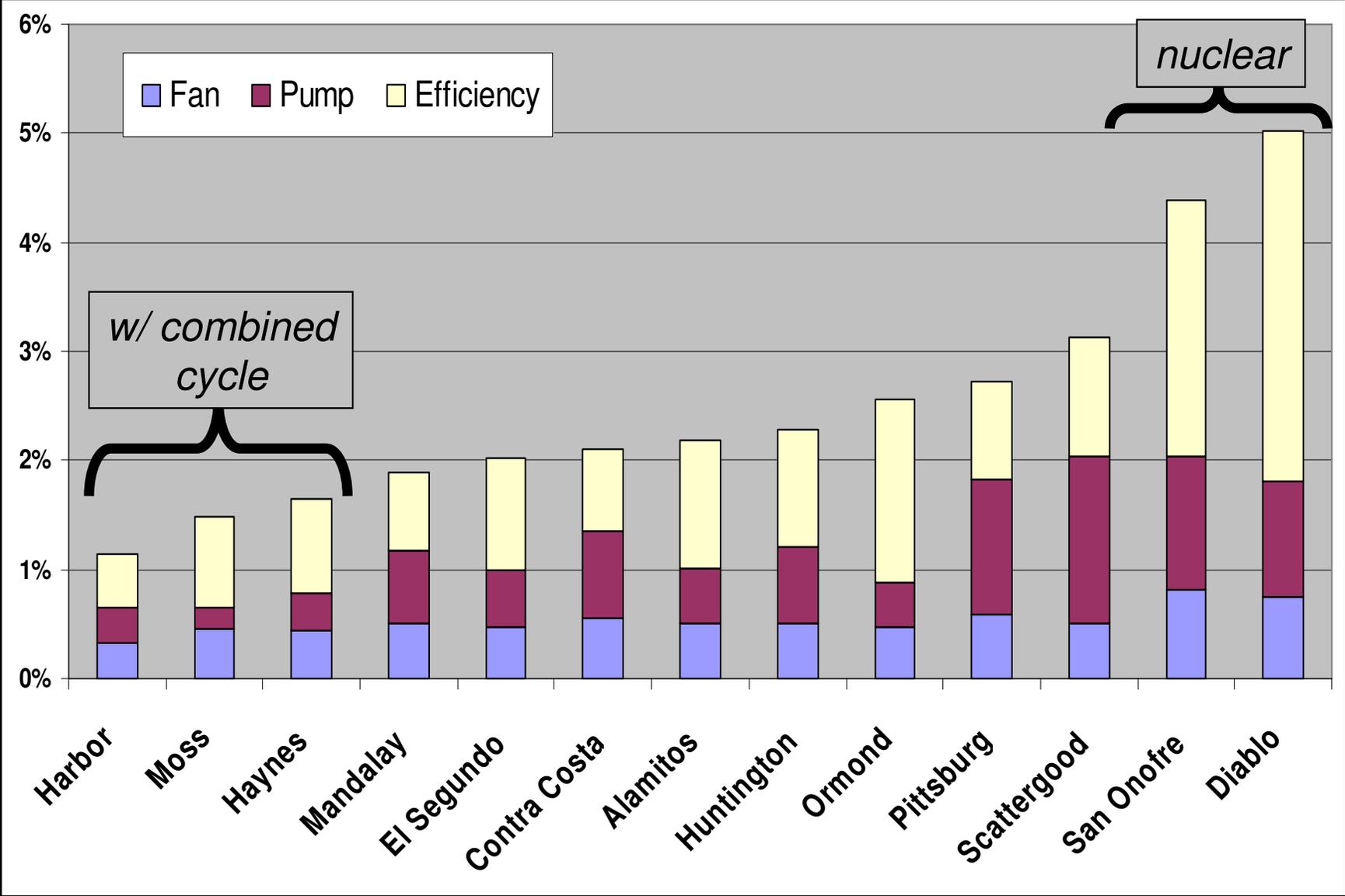
- 25% of all direct costs (30% for Diablo and SONGS)

Energy Penalty:

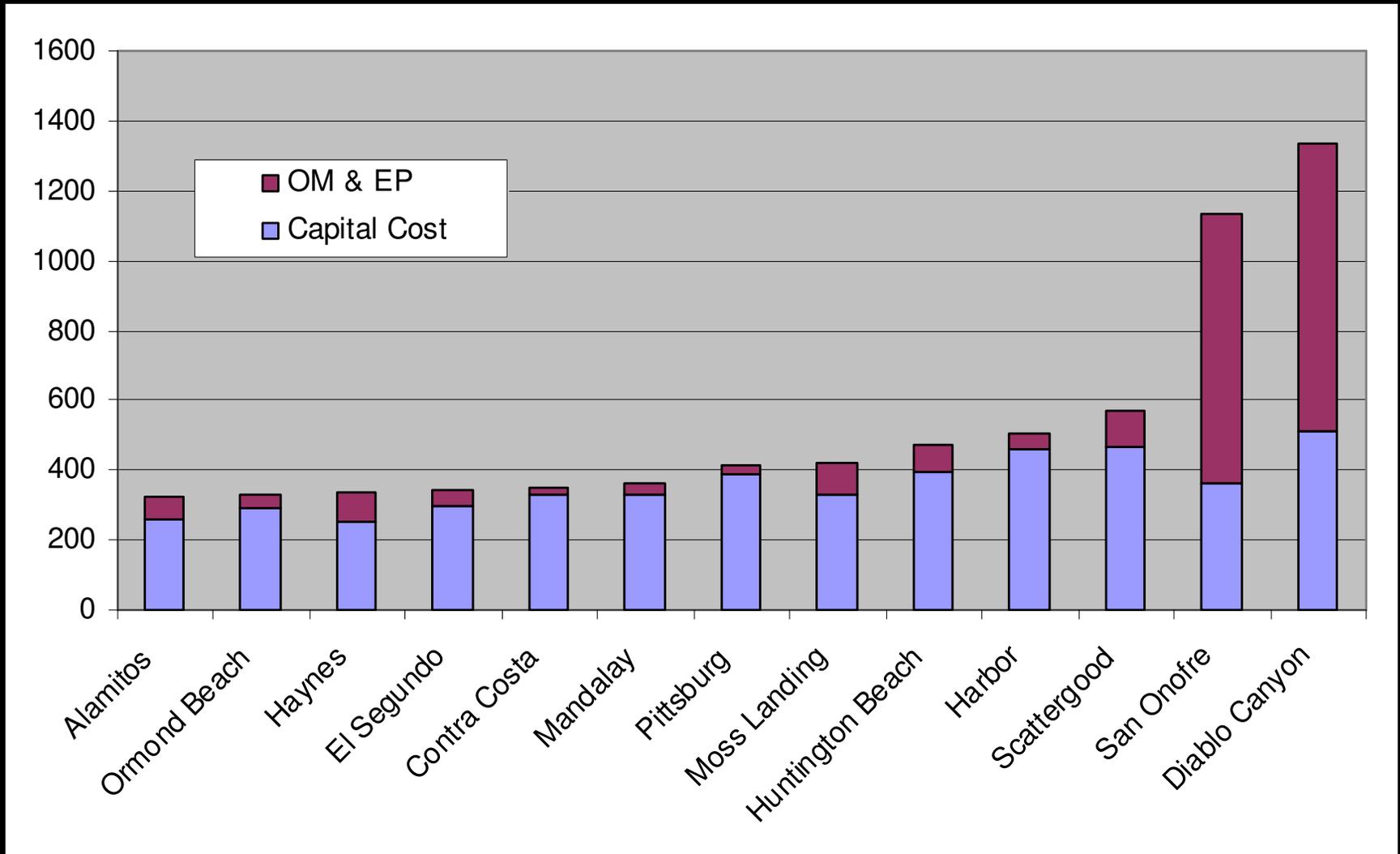
- Parasitic load and efficiency change



Annual Energy Penalty Estimate (%)



Capital and Net Present Cost (\$/gpm)



OM & EP based on 2006 output rate



Maulbetsch Consulting / Tetra Tech

MC
“top down”

10,000

2,500

~1,000

~40

200

Cell Flow
(gpm)

Cell Footprint
(ft²)

Piping
(ft / tower)

Pump Head
(ft)

Fan Power
(hp / cell)

TT
“bottom up”

11,000 – 16,500

2,300 – 3,900

500 – 4,000

~50 – 190

200 – 270



Maulbetsch Consulting / Tetra Tech

	Parasitic Load Increase		Number of Cells		Tower Footprint (1,000 ft ²)	
	TT	MC	TT	MC	TT	MC
Alamitos	1.02%	1.35%	50	84	145	210
Contra Costa	1.35%	1.25%	24	30	62	75
<i>El Segundo*</i>	<i>1.00%</i>	<i>1.00%</i>	<i>20</i>	<i>26</i>	<i>58</i>	<i>65</i>
Harbor	0.66%	0.64%	5	6	11	15
Haynes	0.78%	1.20%	41	61	119	153
Huntington	1.12%	1.00%	28	32	72	80
Mandalay	1.17%	1.04%	14	18	36	45
Moss	0.65%	0.90%	72	82	186	205
<i>Ormond*</i>	<i>0.87%</i>	<i>1.00%</i>	<i>36</i>	<i>46</i>	<i>104</i>	<i>115</i>
Pittsburg	0.90%	1.30%	24	32	62	80
San Onofre	2.04%	3.00%	96	162	380	405
Scattergood	2.03%	1.10%	26	35	71	88

**TT: Unable to design preferred option; represents conventional design*



Summary

- Wet cooling retrofits reduce impingement and entrainment impacts by ~95%, plus thermal discharge reductions
- 12 of 15 facilities considered “technically feasible” in this study
- “Feasible” facilities still face hurdles
- Capital cost: 255 to 524 \$/gpm
- NPC: 324 to 1,334 \$/gpm

