

**Final Report -
Avista Corporation Wind Integration Study**

Prepared for:
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A Parametric Evaluation of Wind/Hydro Integration in the Avista System in the Pacific Northwest

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March 21, 2007

EnerNex/Avista Study Relationship

- **EnerNex Role**

- Study oversight/review/guidance
- Provision of certain datasets
 - Incremental reg. & load following required
 - Day-ahead wind forecast
- Final Report

- **Avista Role**

- Provide wind data
- Develop remaining datasets
- Develop and run System LP Model
- Summarize results



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Methodology Overview

- **Develop Hourly LP Model Of Avista System**
 - Model of both Real-Time and Pre-Schedule timeframes
 - Pre-Schedule commitment and market transactions “honored” in Real-Time
 - Represent inherent flexibility and constraints
 - Hydro storage and minimum flow
 - Minimum up/down requirements
 - Reserve capabilities and ramping rates
 - Transmission paths
 - Hydro spill and wind “feathering”
 - Access to energy market for balancing and optimization
 - Pre-Schedule and Real-Time markets

Methodology Overview (Cont.)

- **Run Model With and Without Wind Variability**

- Over same historical timeframe (2002-04)
 - Using actual loads
 - Wind is priced in each hour at market
 - Eliminates potential for wind shape to bias result
 - Carry additional reserves in “With Wind” case

- **Compare System Values**

- Change is spread over wind deliveries to arrive at an integration cost
 - Per MWh (absolute or % of market price)
 - Per kW-month (absolute or % of market price)

Pre-Schedule Wind Model Delivery Schematic

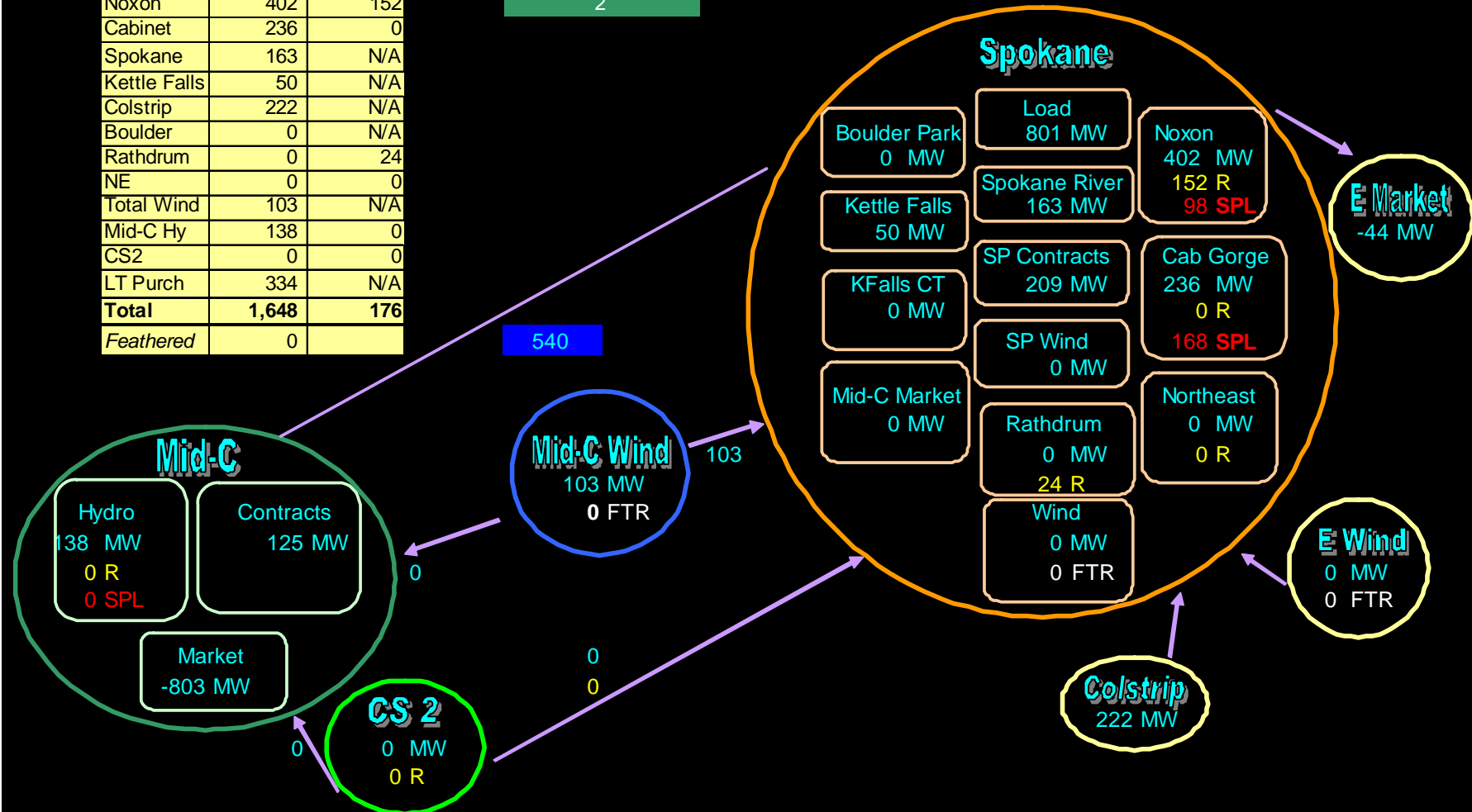
Generation Summary

Resource	Power	Res
Noxon	402	152
Cabinet	236	0
Spokane	163	N/A
Kettle Falls	50	N/A
Colstrip	222	N/A
Boulder	0	N/A
Rathdrum	0	24
NE	0	0
Total Wind	103	N/A
Mid-C Hy	138	0
CS2	0	0
LT Purch	334	N/A
Total	1,648	176
Feathered	0	

Modeled Hour

2

Spokane



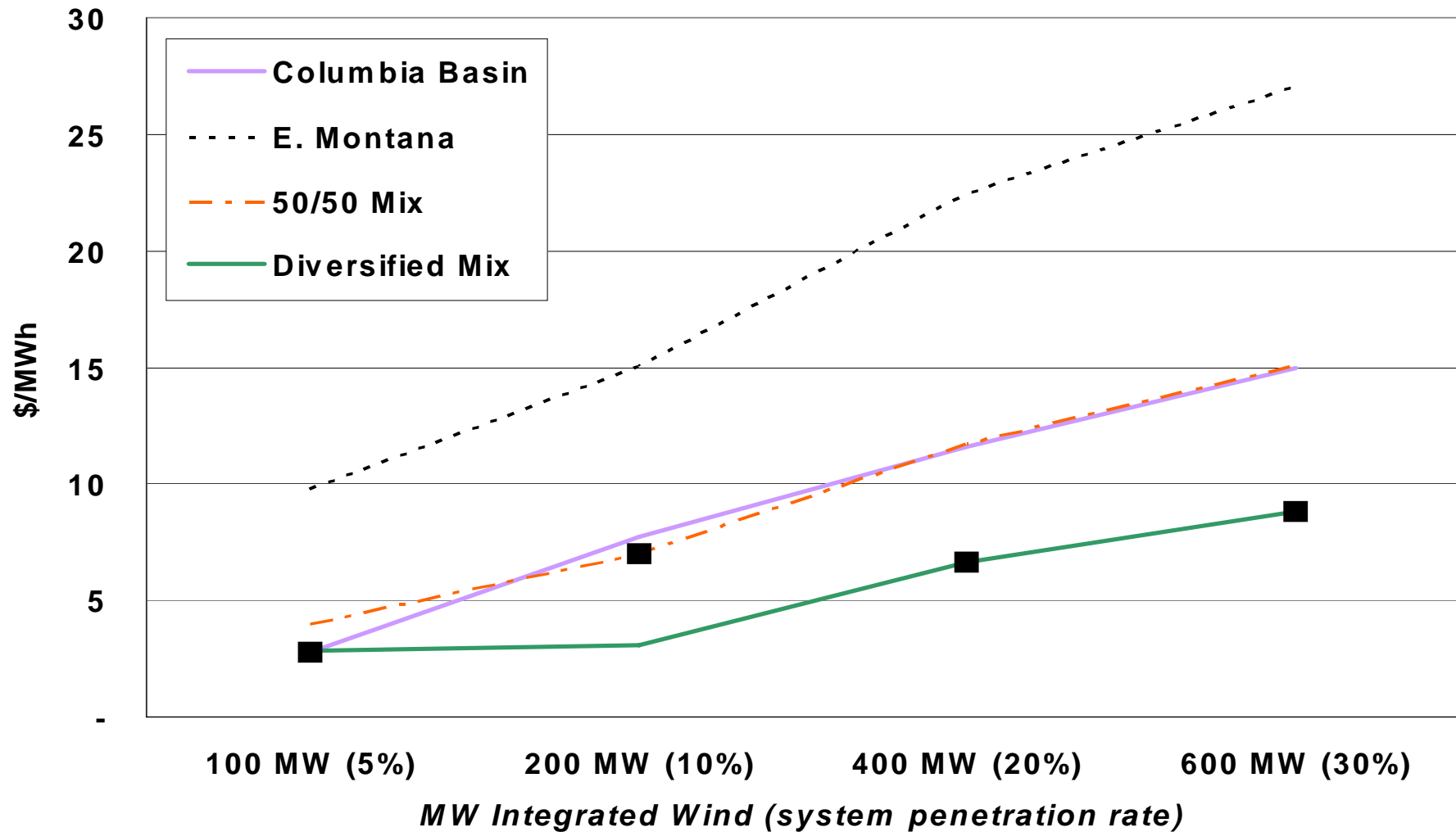
Overview of Avista's System (2005)

- 2,200 MW Control Area Peak
- 875 MW Minimum Load
- 1,200 MW Hydro
 - Very flexible with generous short-term storage
 - Provides majority of reserves for wind
 - Regulation, spinning, supplemental
- 550 MW Gas Turbines
 - 280 MW CCCT with 100 MW of spinning and supplemental reserves
 - 210 MW (4 units) provide only supplemental reserves
 - Remaining 7 (small) units cannot provide reserves

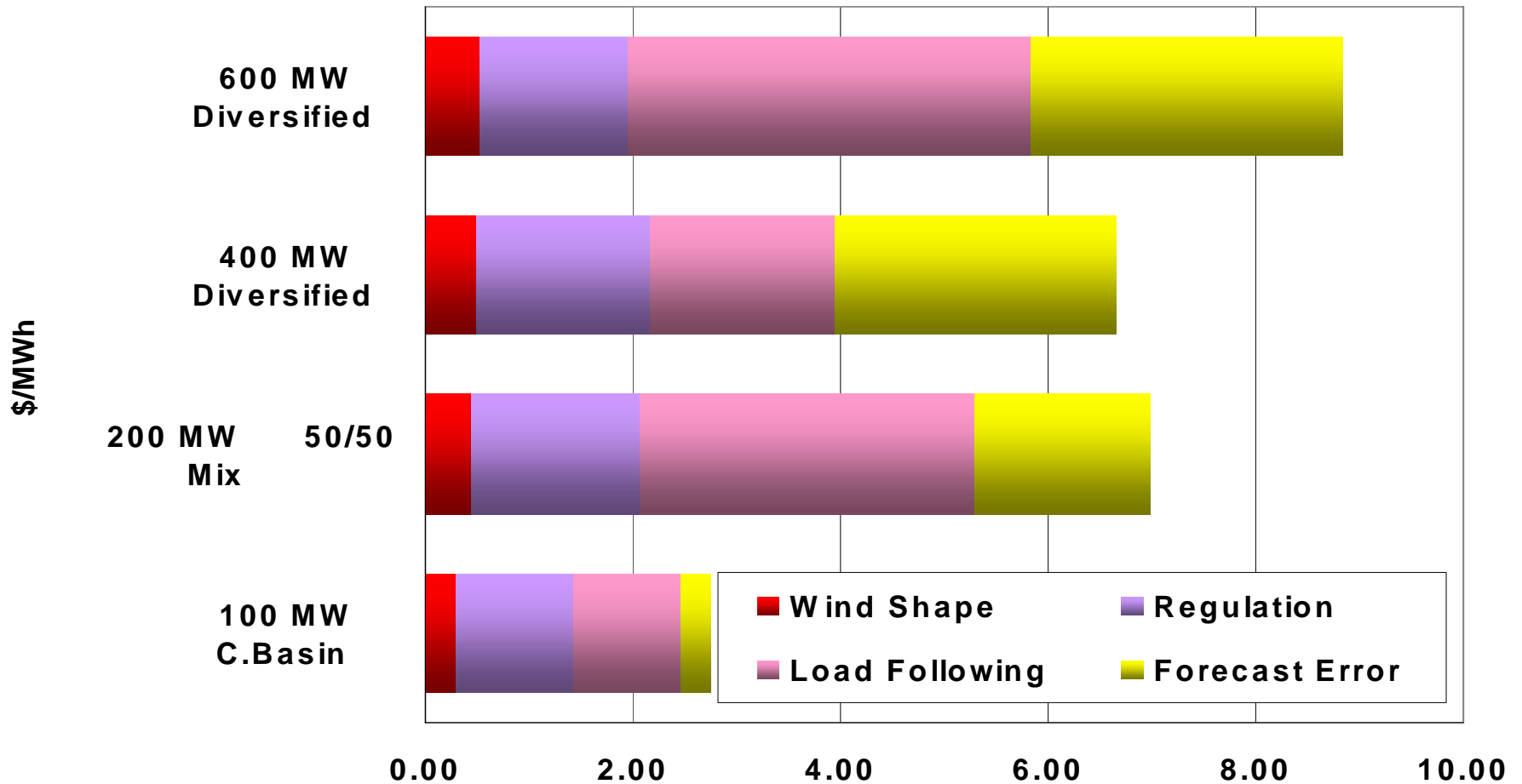
Overview of Avista's System (Cont.)

- 230 MW Coal and 50 MW Biomass
 - Do not provide reserves
- 35 MW of Stateline Wind
- ~750 MW Contracts Rights
 - 350 MW for “native load”
 - 400 MW third-party resources to serve 3rd-party loads in control area
 - No reserve capabilities
- ~200 MW Capacity Contract Obligations
 - Sales of AGC and spinning reserves for third-party load and wind

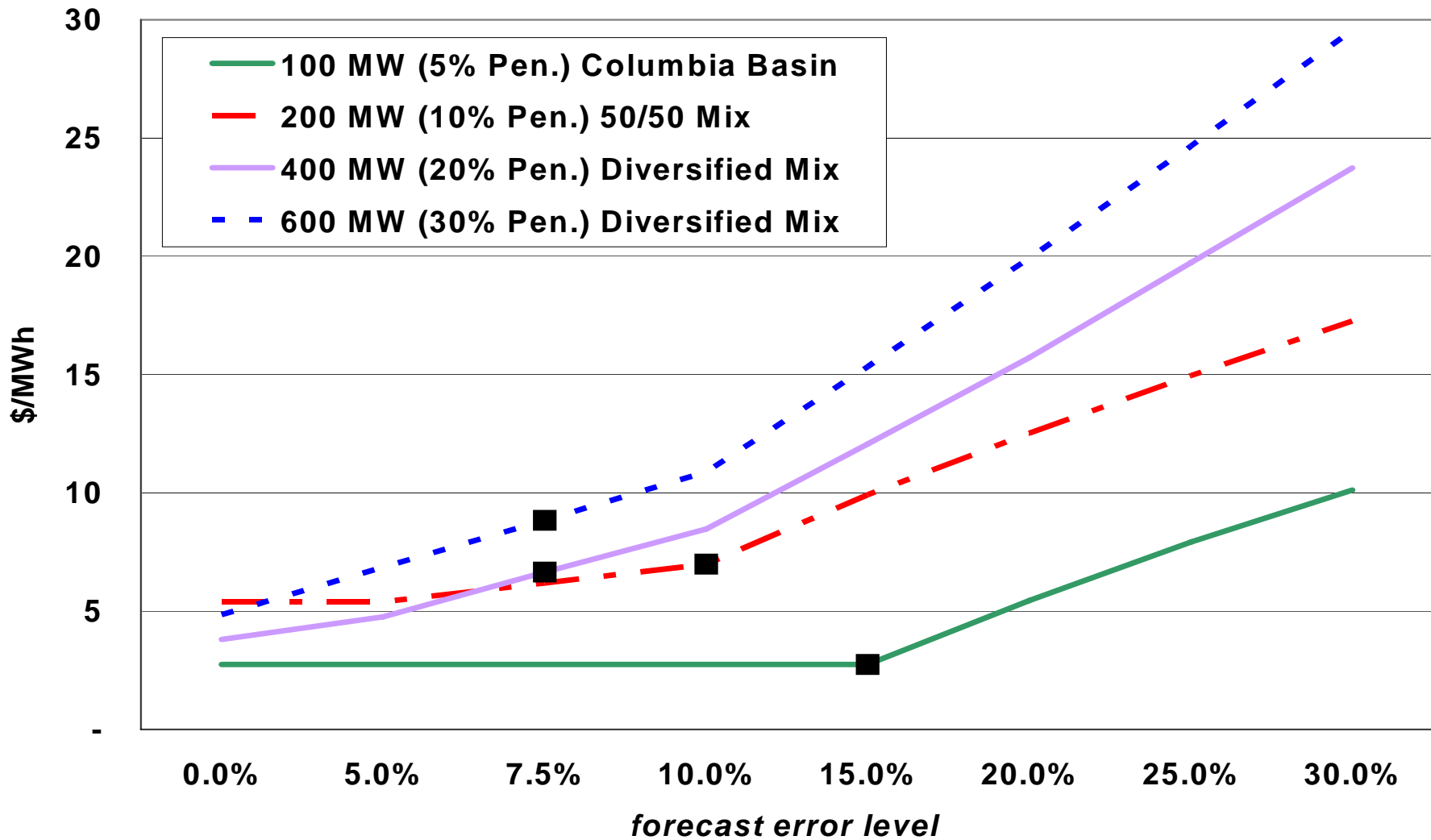
Wind Integration Costs by Basin



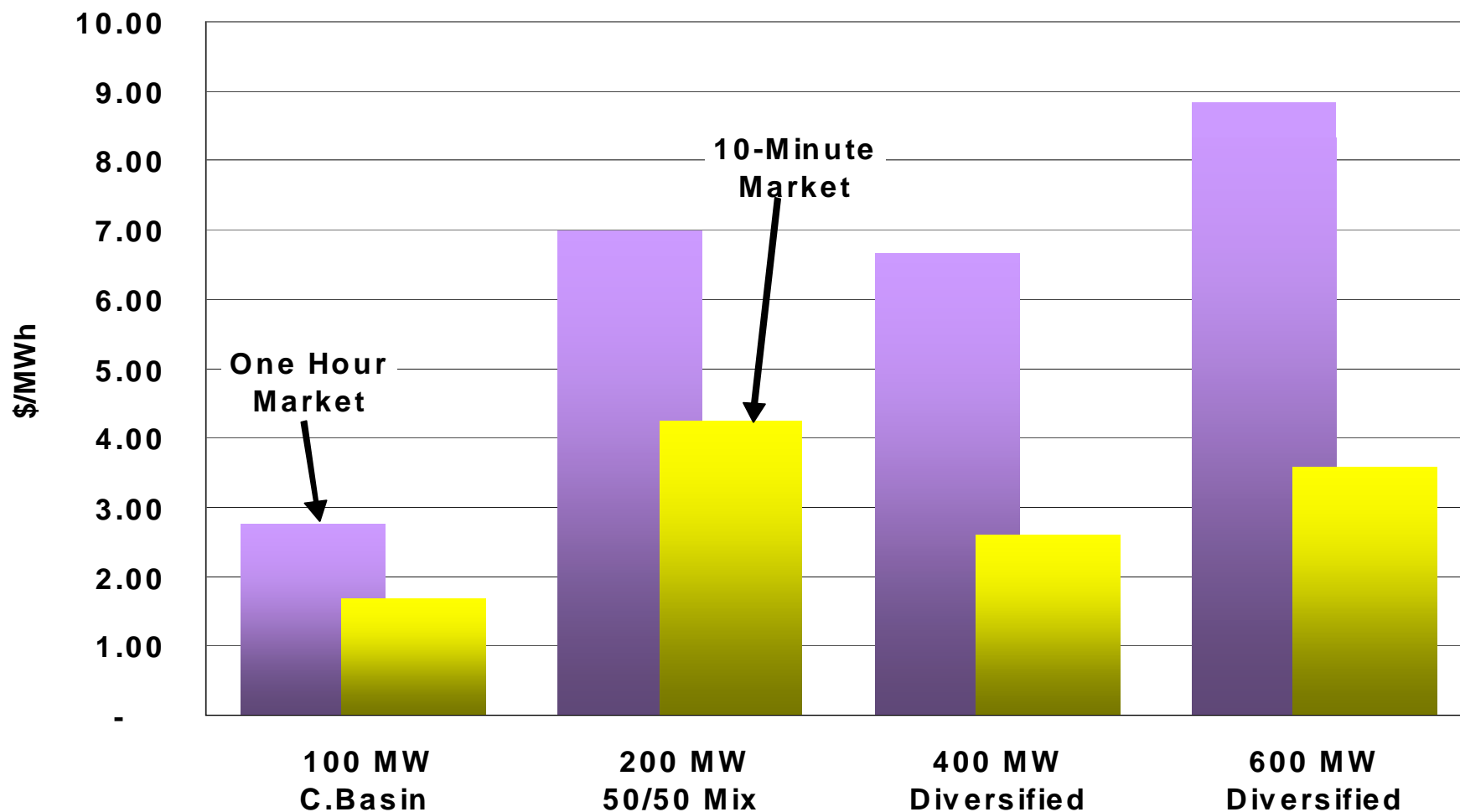
Wind Integration Cost Components



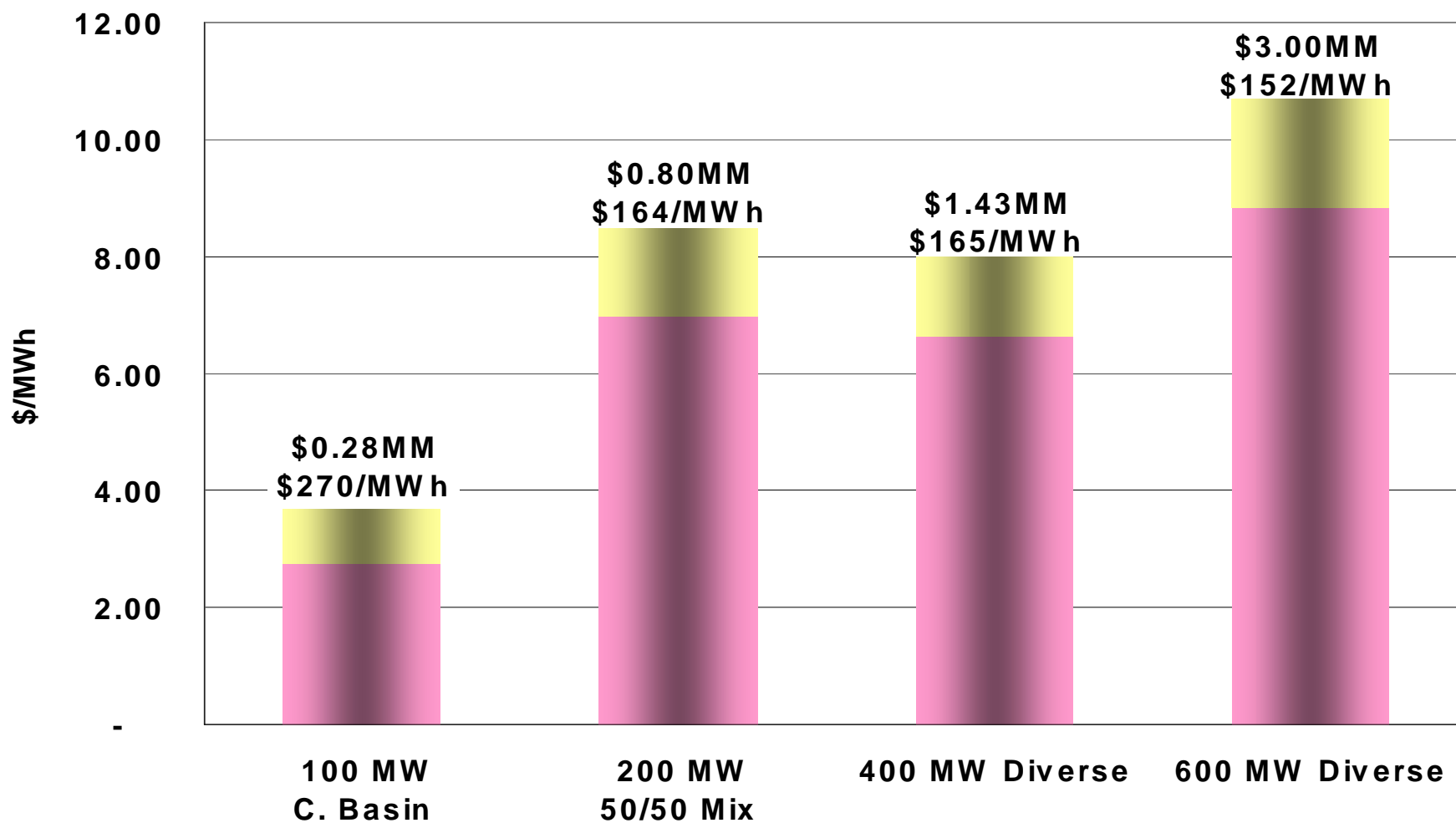
Impact of Forecast Error



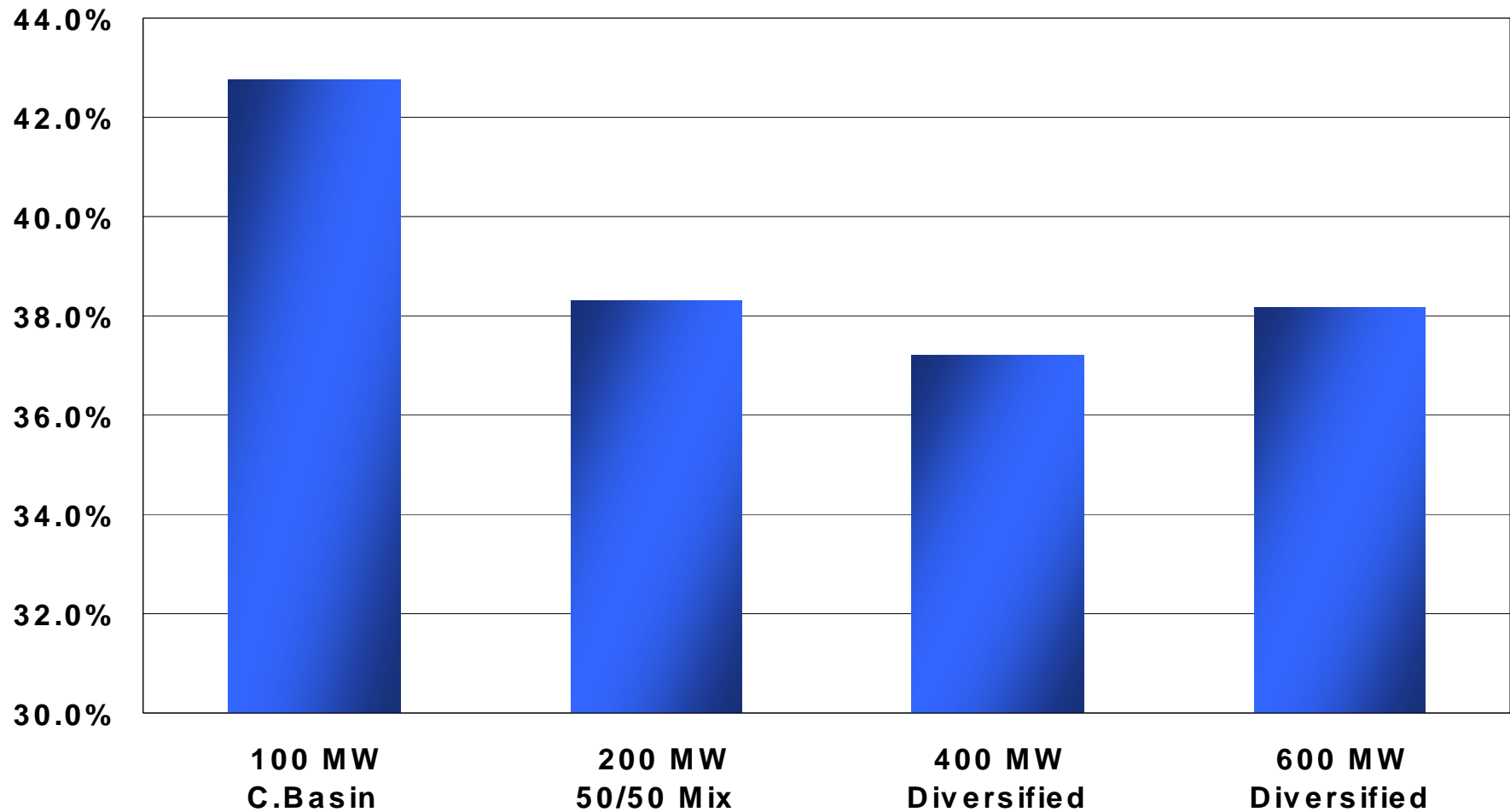
Impact of Shorter Market Time Step



Benefit of Wind Feathering



Hydro Re-Dispatch Costs (% of total integration)



Study Results

Wind Capacity	System Penetration	Wind Mix	Forecast Error	Incremental Integration Reserves					Integration Cost		
				Reg-ulation	Load Following	Forecast Error	Total	% of Nameplate	(\$/MWh)	(%Mkt)	(\$/kW-mo)
100 MW	5%	C.Basin	15.0%	2.1	1.3	-	3.3	3.3%	2.75	5.0%	0.61
200 MW	10%	50/50 Mix	10.0%	4.1	5.5	5.0	14.5	7.3%	6.99	12.7%	1.55
400 MW	20%	Diversified	7.5%	7.9	15.8	15.0	38.7	9.7%	6.65	12.1%	1.47
600 MW	30%	Diversified	7.5%	11.0	27.7	30.0	68.7	11.5%	8.84	16.1%	1.95

Wind Capacity	System Penetration	Wind Location	Average 3 Years	Low Hydro	Average Hydro	High Hydro
100 MW	5%	C.Basin	2.75	2.07	2.72	3.49
200 MW	10%	50/50 Mix	6.99	8.76	6.32	6.02
400 MW	20%	Diversified	6.65	9.85	5.79	4.39
600 MW	30%	Diversified	8.84	12.14	7.80	6.75
Average Market Price			54.85	62.58	56.52	45.45

Valuing a Wind Resource

- Components of Wind Resource Cost
 - Busbar price of power
 - Account for green tags
 - Transmission from site to system
 - Integration
- Comparing to Traditional Resources
 - Mark-to-market valuation of wind energy
 - Based on expected hourly shape of output
 - Less wind resource costs
 - Adjust for capacity contribution