

Markets Instead of Penalties

Creating a Common Market for Wind
and Energy Storage Systems

Imbalances

System
Shortage

System
Surplus

Generator
Shortage

Generator
Surplus

Pricing Color Key



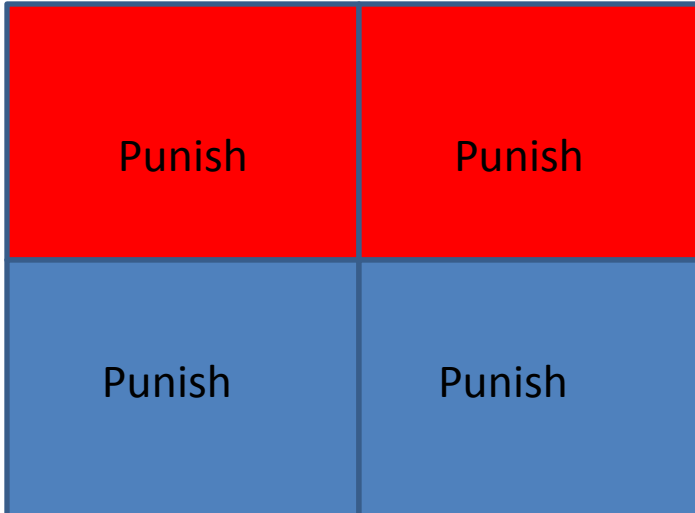
RED—High Price



BLUE—Low Price

Imbalance Penalty Mechanism

	System Shortage	System Surplus
Generator Shortage	Punish	Punish
Generator Surplus	Punish	Punish

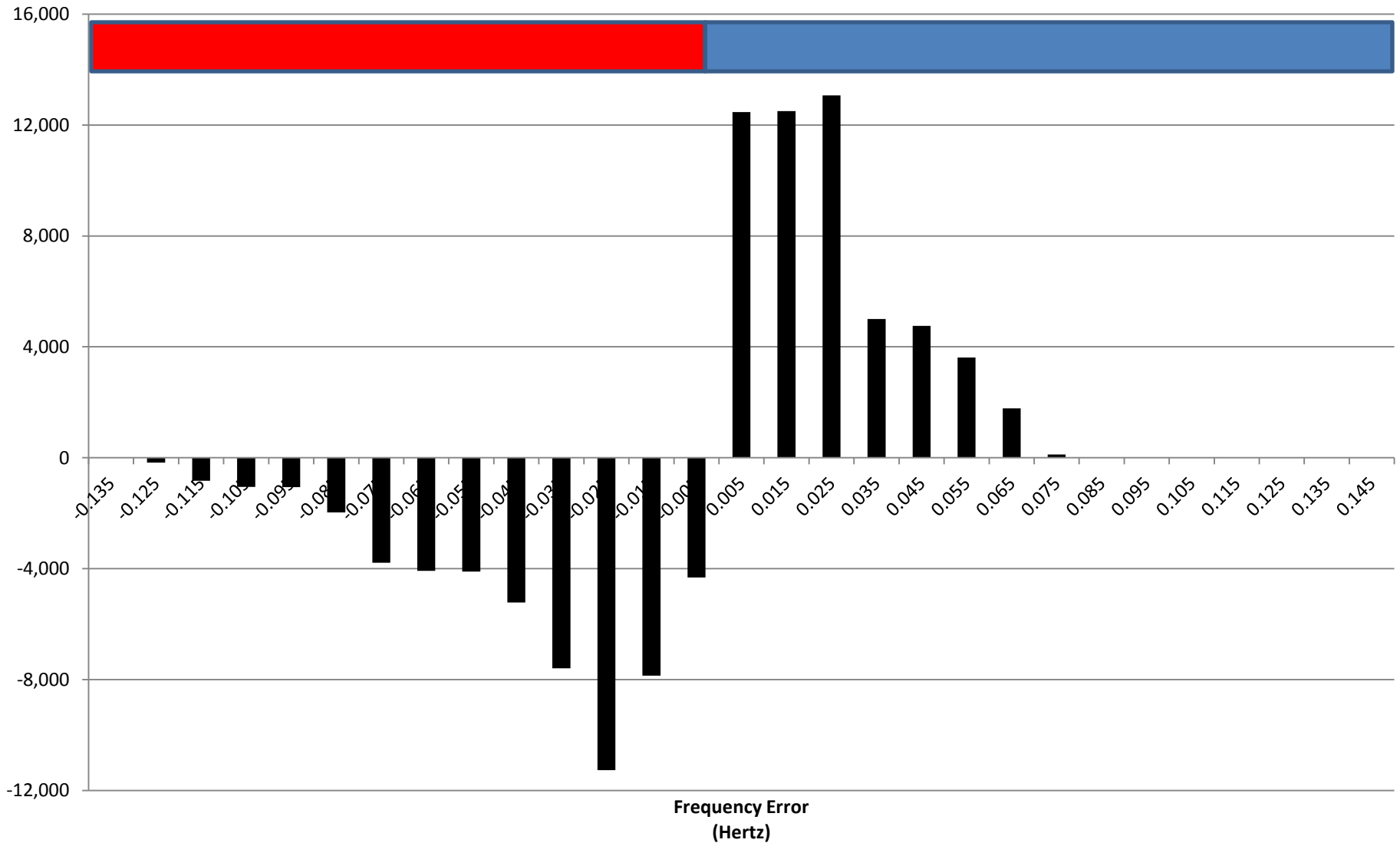


Imbalance Market Mechanism

	System Shortage	System Surplus
Generator Shortage	Punish	Reward
Generator Surplus	Reward	Punish

The diagram illustrates the imbalance market mechanism through a 2x2 matrix. The columns represent the system's overall state: 'System Shortage' and 'System Surplus'. The rows represent the generator's own state: 'Generator Shortage' and 'Generator Surplus'. The matrix is divided into four quadrants by a horizontal and a vertical line. The top-left quadrant (Generator Shortage, System Shortage) is red and labeled 'Punish'. The top-right quadrant (Generator Shortage, System Surplus) is blue and labeled 'Reward'. The bottom-left quadrant (Generator Surplus, System Shortage) is red and labeled 'Reward'. The bottom-right quadrant (Generator Surplus, System Surplus) is blue and labeled 'Punish'.

Simulated Kodiak Wind Error Against Simulated Kodiak Frequency Error (MW-sec)

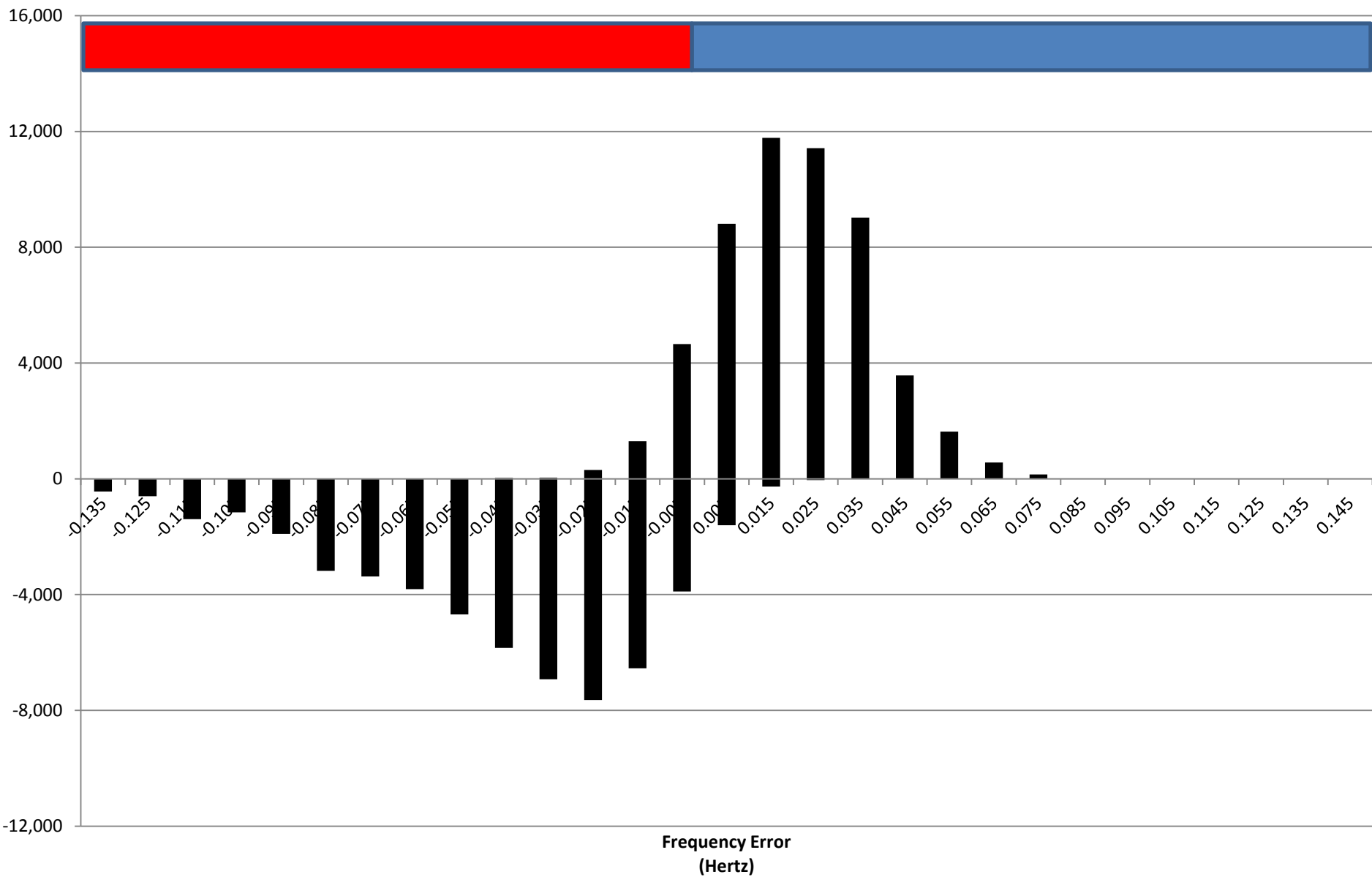


Organizing Data

Penalty Approach

	MW-Sec	Factor	Billed
Left	-53,296.20	125%	-66,620.25
Right	53,296.20	75%	39,972.15
Sum	0.00		-26,648.10

Simulated Kodiak Wind Error Against Simulated Joint Frequency Error (MW-sec)



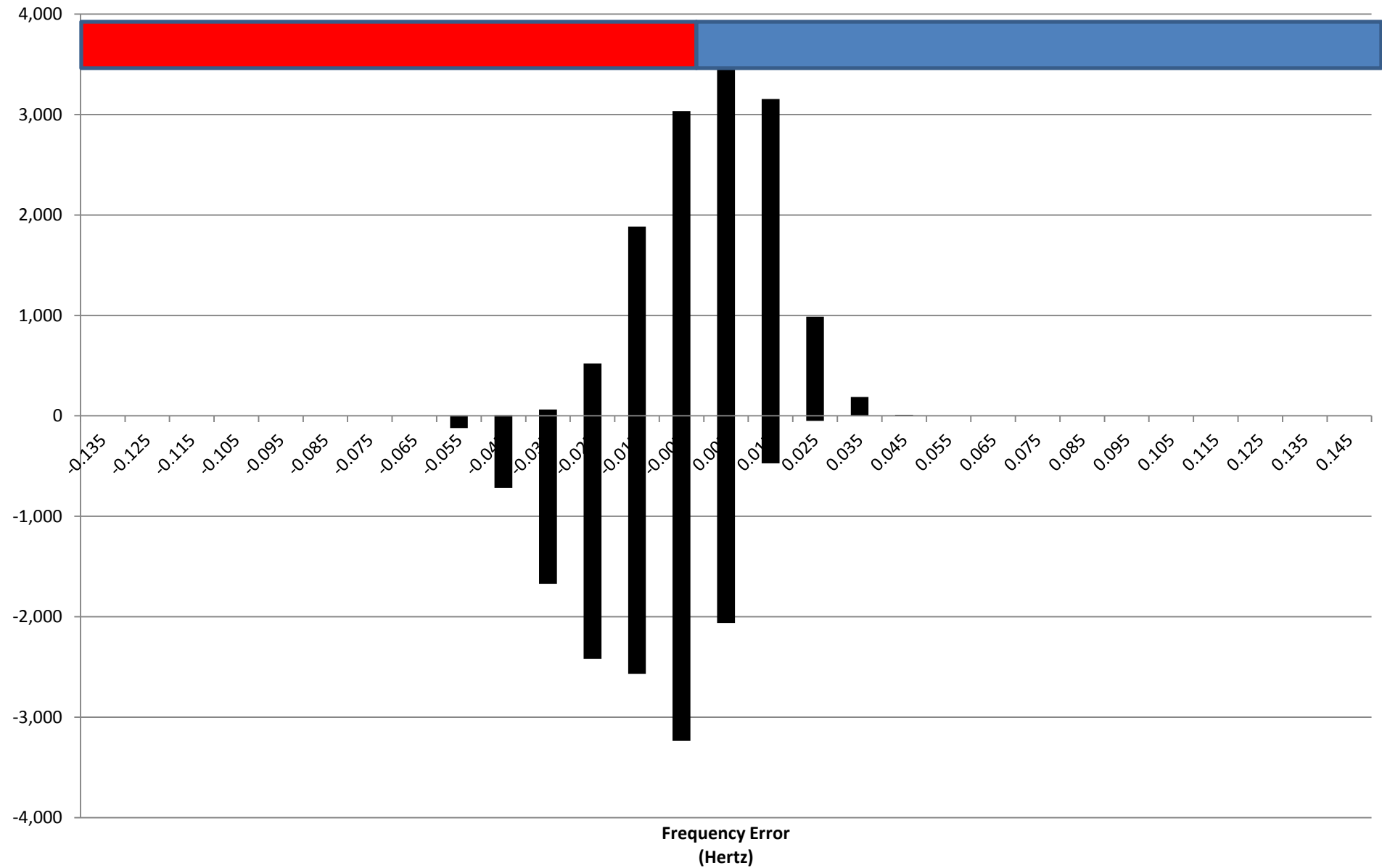
Organizing Data

Market Approach

(53,296.20 MW-Sec)

	MW-Sec	Factor	Billed
Left	-51,377.09	125%	-64,221.37
	6,339.86	125%	7,924.82
Right	-1,919.11	75%	-1,439.33
	46,956.34	75%	35,217.26
Sum	0.00		-22,518.62

Simulated Kodiak Wind Error (Small System) Against Simulated Joint Frequency Error (MW-sec)



Organizing Data (Small System)

Market Approach

(13,324.05 MW-Sec)

	MW-Sec	Factor	Billed
Left	-10,736.08	125%	-13,420.09
	5,514.34	125%	6,892.93
Right	-2,587.98	75%	-1,940.98
	7,809.71	75%	5,857.28
Sum	0.00		-2,610.87