The Economics of Custom Power

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PQ Problems have Costs

$50 billion per year in the USA is lost as a result of power quality breakdown.

SOURCE: Bank of America Report

A manufacturing company lost more than $3 million one day last summer in Silicon Valley when the “lights went out.”

SOURCE: New York Times, January, 2000

“A voltage sag in a paper mill can waste a whole day of production — $250,000 loss.”

SOURCE: Busines Week, June 17, 1996

Half of all computer problems and one-third of all data loss can be traced back to the power line.

SOURCE: Contingency Planning Research, LAN Times

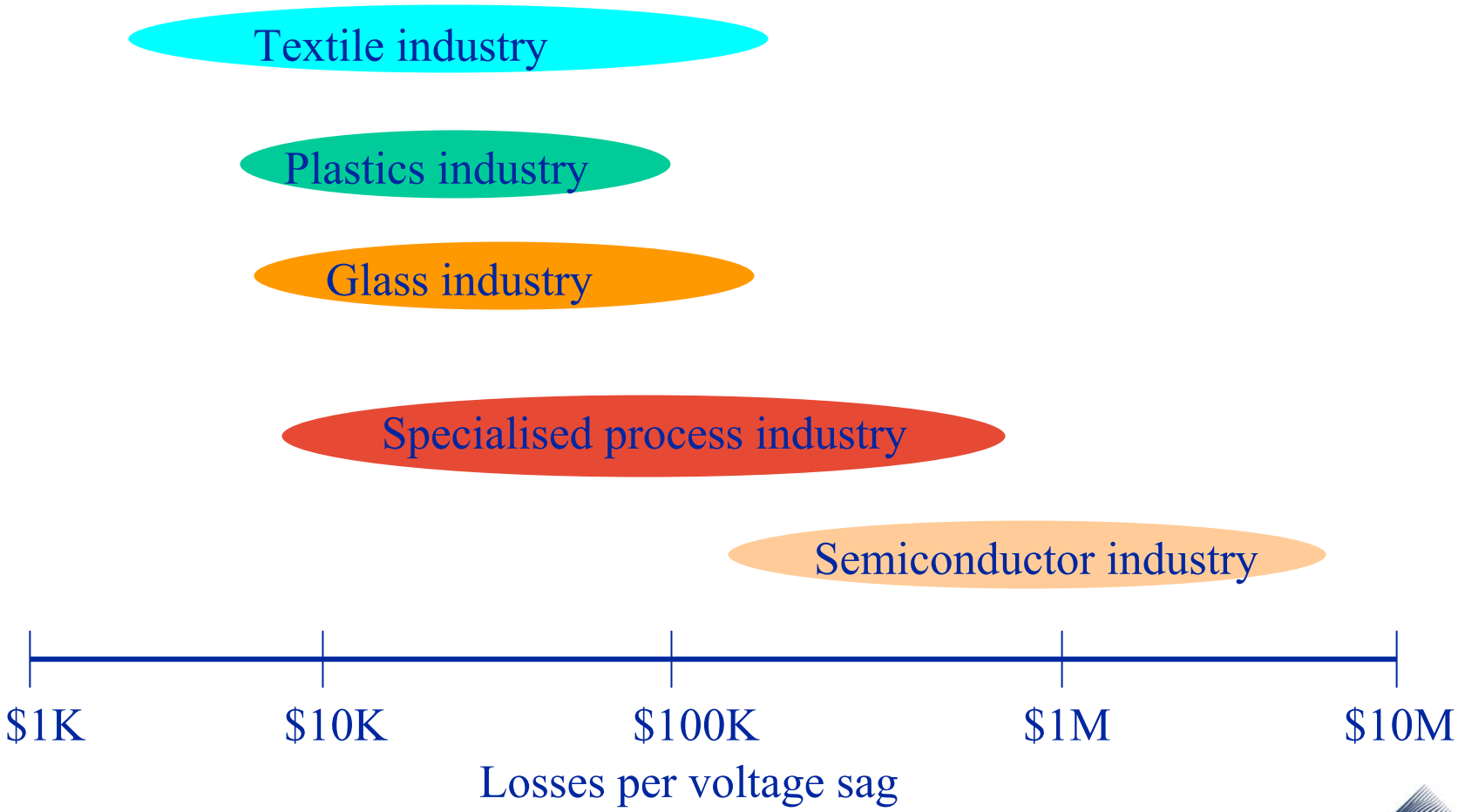
Factors affecting PQ Costs

- Lost production
- Scrap
- Costs to restart
- Labor costs
- Equipment damage and repair
- Other costs

Categories of Interruption Costs

- High cost facilities
  - Semiconductor plants
  - Pharmaceuticals
  - Data centers
- Medium Cost Facilities
  - Automotive manufacturing
  - Glass Plants
  - Plastics and chemicals
  - Textiles

Example costs

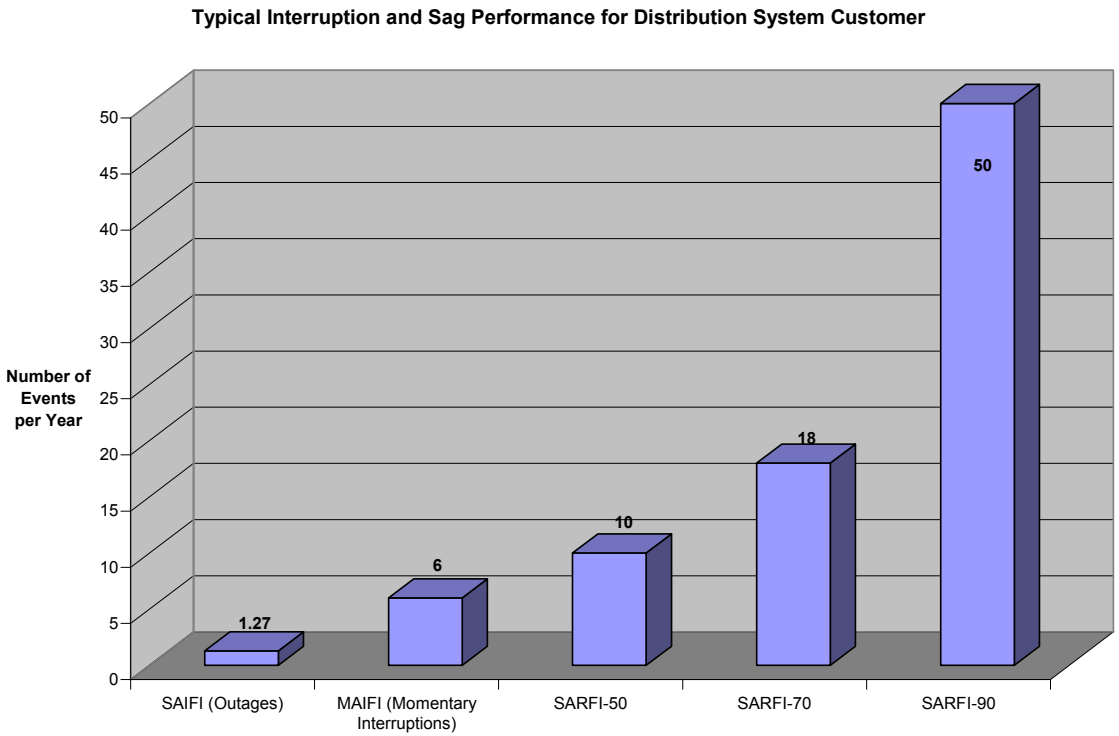


Costs of Momentary Interruptions

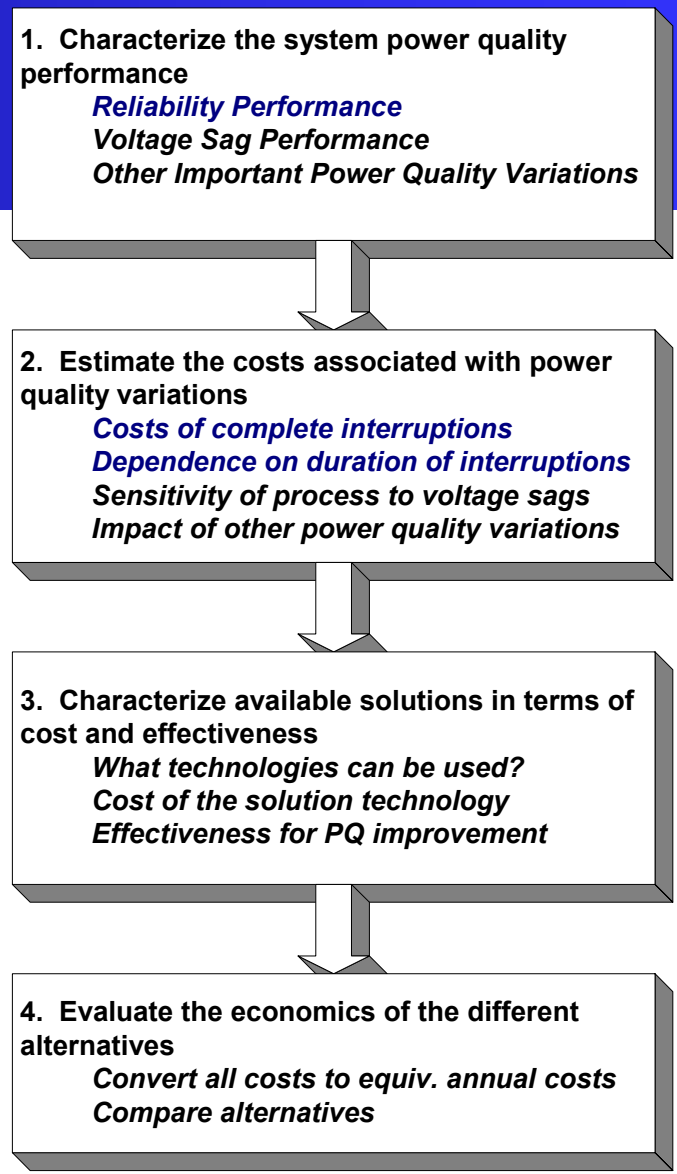
Category	Cost of Momentary Interruption ($/kW Demand)	
	Minimum	Maximum
INDUSTRIAL		
Automobile Manufacturing	$5.0	$7.5
Rubber and Plastics	$3.0	$4.5
Textile	$2.0	$4.0
Paper	$1.5	$2.5
Printing (newspapers)	$1.0	$2.0
Petrochemical	$3.0	$5.0
Metal Fabrication	$2.0	$4.0
Glass	$4.0	$6.0
Mining	$2.0	$4.0
Food Processing	$3.0	$5.0
Pharmaceutical	$5.0	$50.0
Electronics	$8.0	$12.0
Semiconductor Manufacturing	$20.0	$60.0
COMMERCIAL		
Communications, information processing	$1.0	$10.0
Hospitals, banks, civil services	$2.0	$3.0
Restaurants, bars, hotels	$0.5	$1.0
Commercial shops	$0.1	$0.5

What about voltage sags?

- Facilities experience many more voltage sags than interruptions

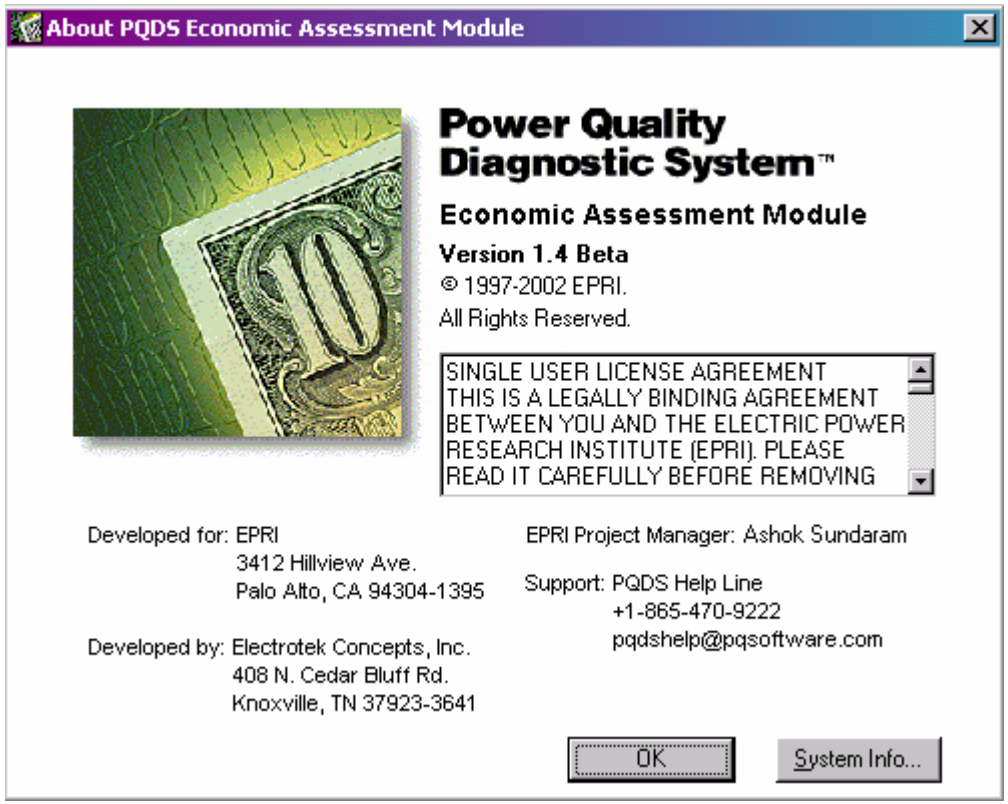


Evaluating the economics



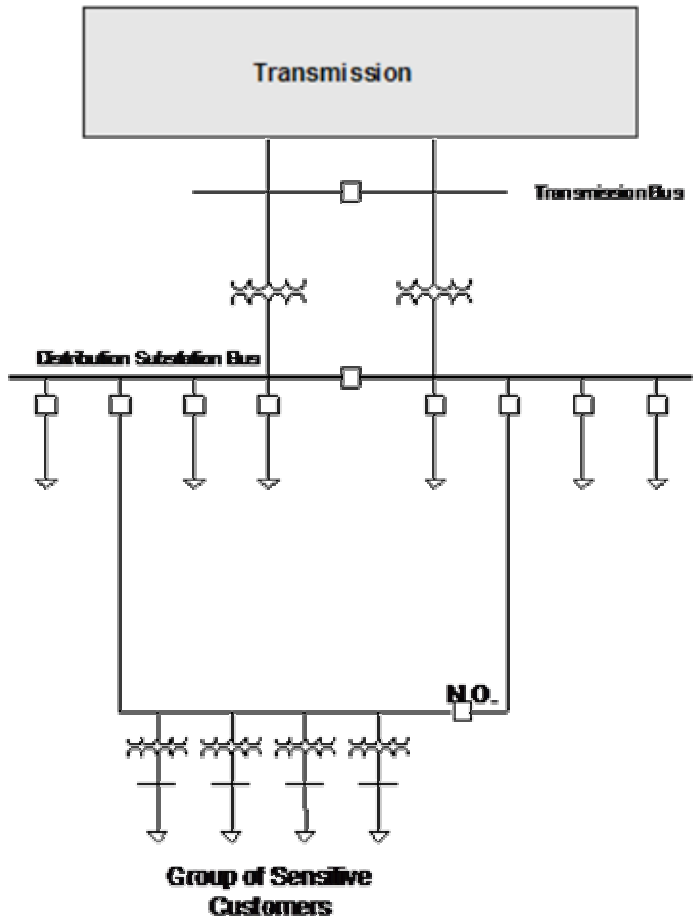
Evaluating the Economics

- Economic Assessment Module (EAM).

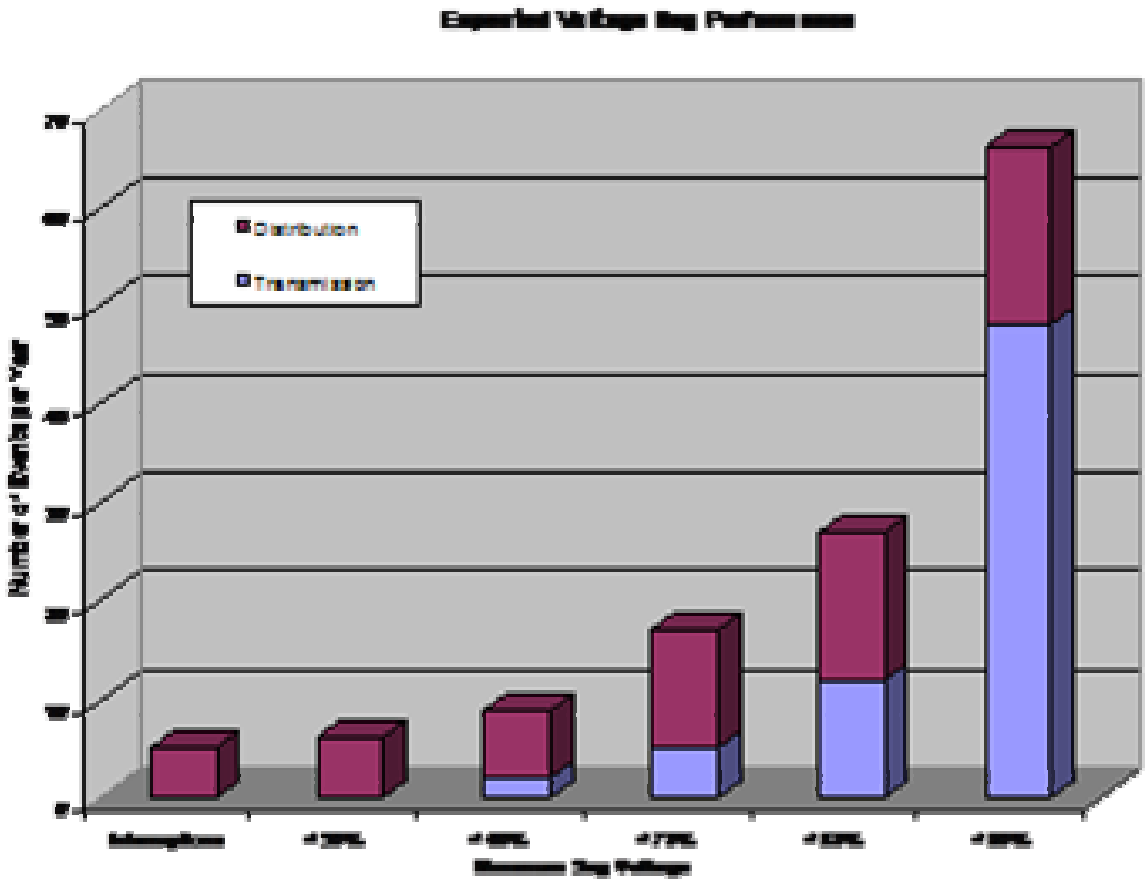


Example System

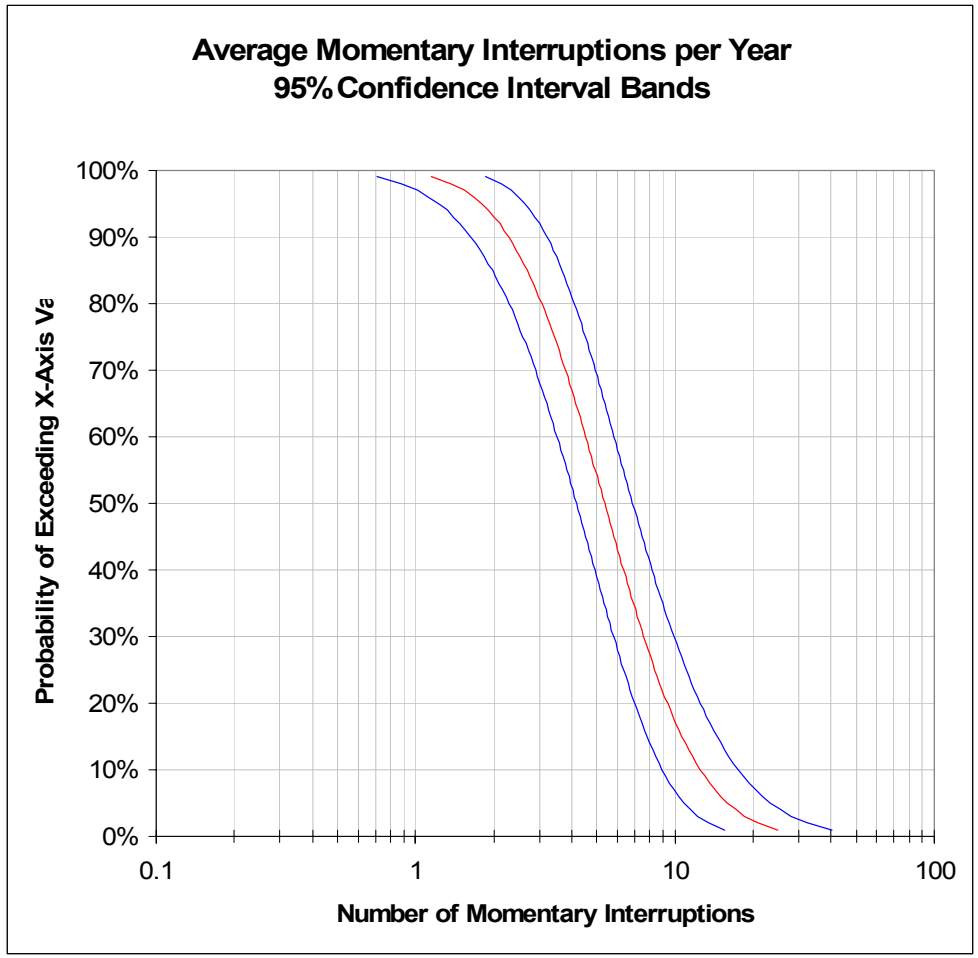
- Economics of improving power quality to a group of customers
- Focus on voltage sags because this is typically the most important (costly) PQ variation



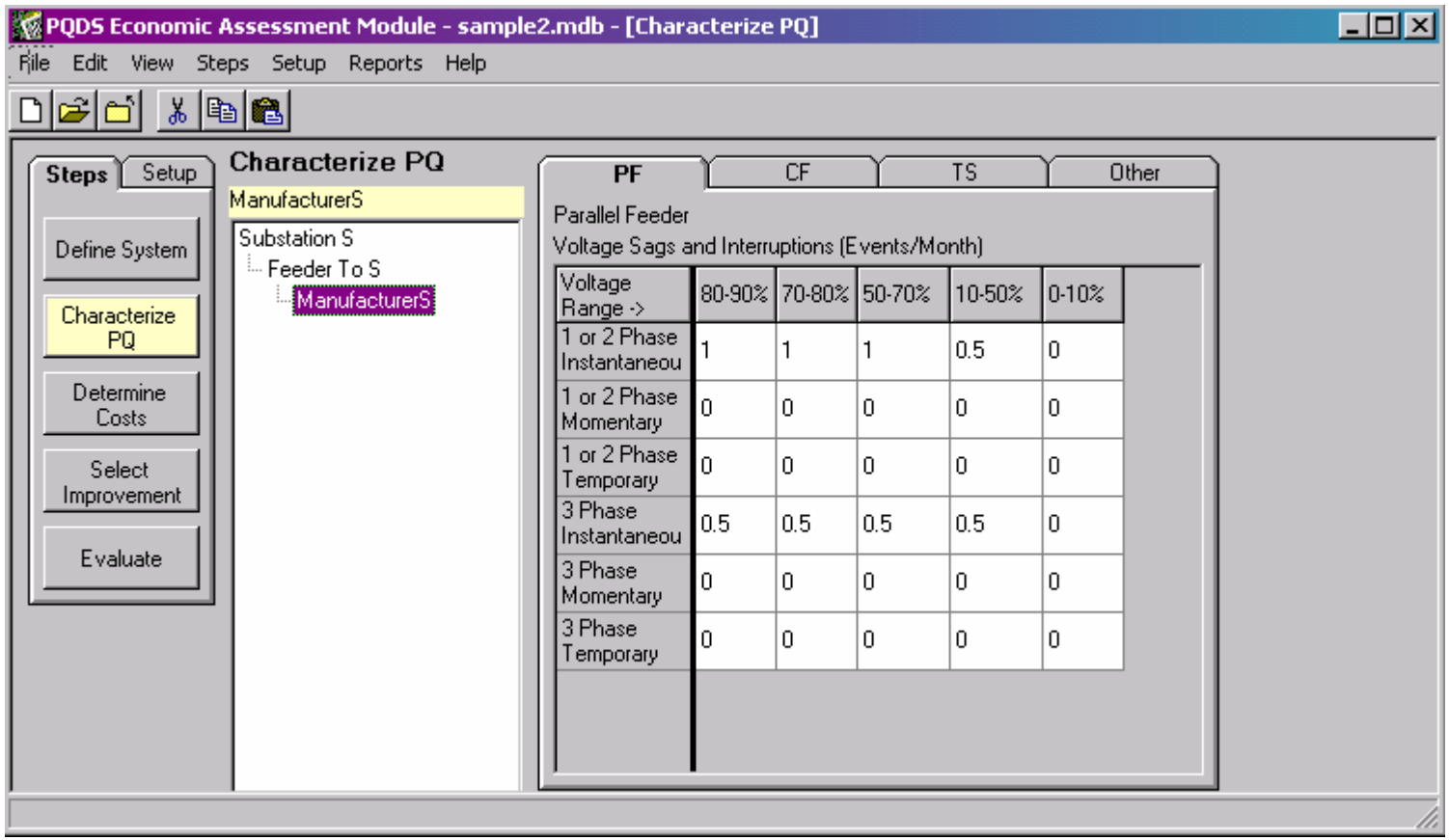
Characterizing System Performance



Remember that the performance is not deterministic – it VARIES



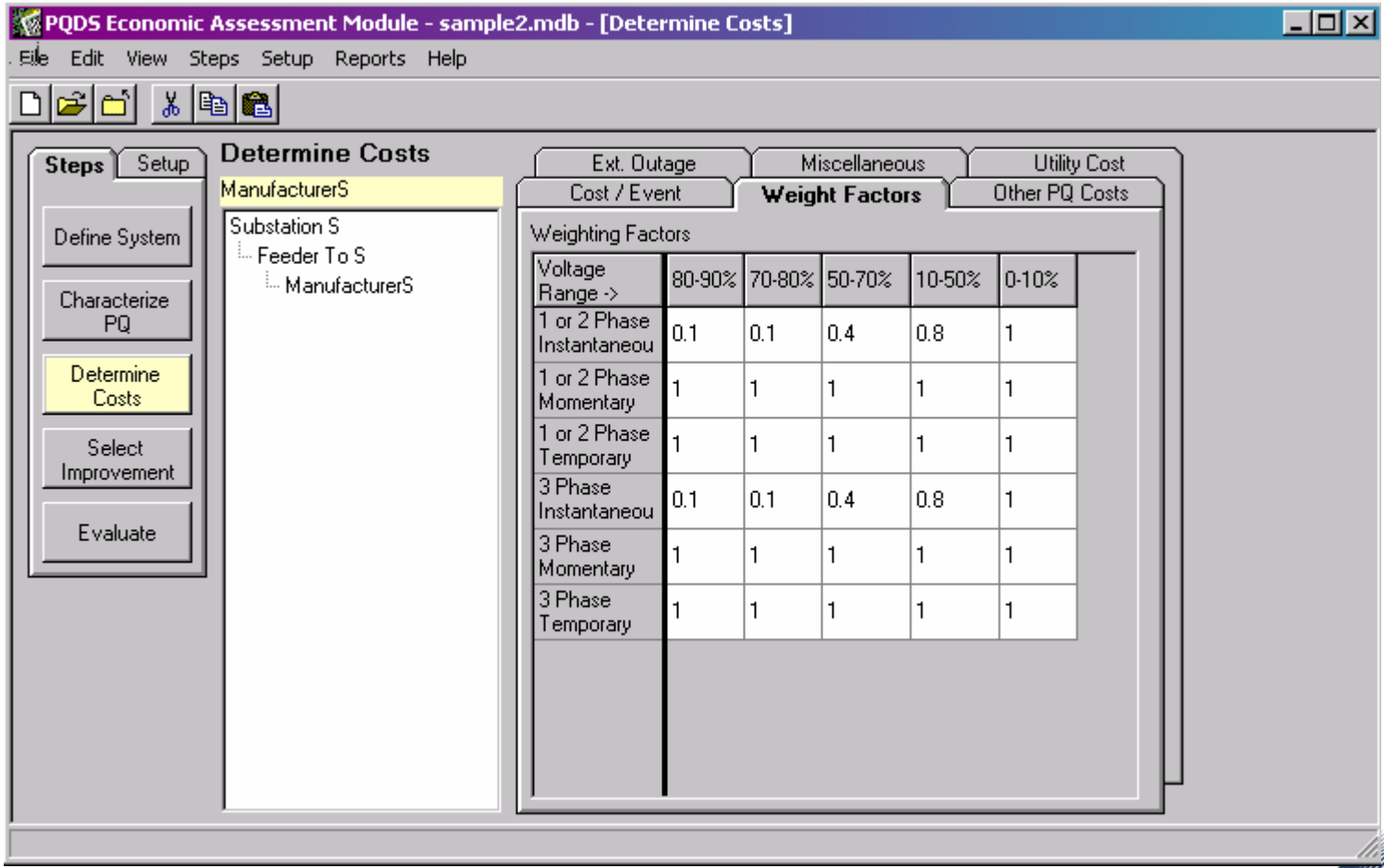
EAM
Characterize PQ Levels



Characterizing costs – concept of Weighting Factors

Category of Event	Weighting for Economic Analysis	Expected Number per Year	Equivalent Interruptions per Year
Interruption	100%	5	5.0
Sag below 50%	100%	1	1.0
Sag between 50% and 70%	70%	13	9.1
Sag between 70% and 80%	40%	10	4.0
Sag between 80% and 90%	10%	39	3.9
TOTAL		68	23.0

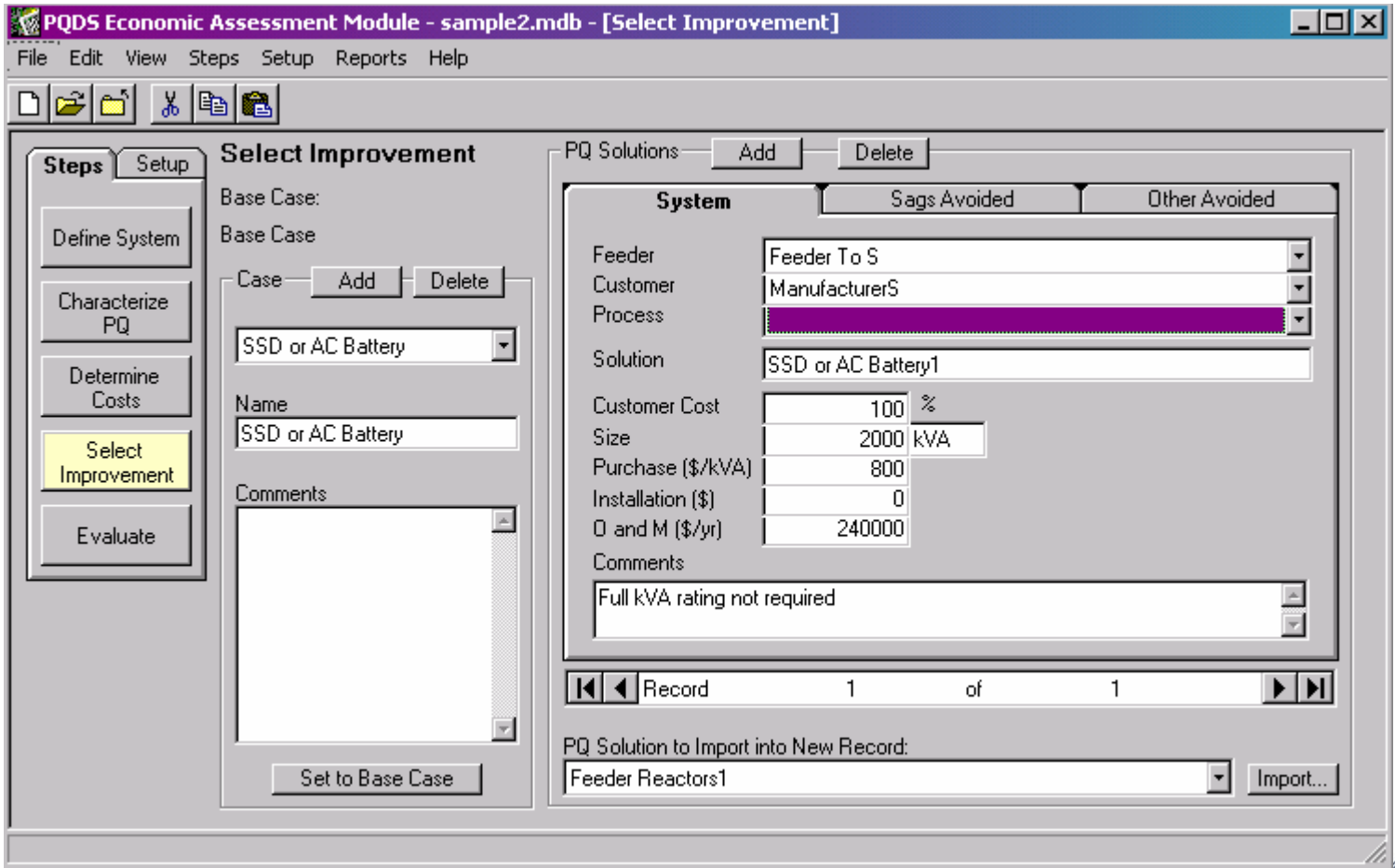
EAM
Determine costs of pq problems



Develop Solution Options

- Equipment Protection
  - CVT
  - Local DVR technologies
  - UPS
- Facility Service Entrance Protection
  - DVR
  - Standby Power Supply (batteries, flywheels, superconducting magnets, supercapacitors)
- Custom Power Options on Supply System
  - DVR
  - Static Switch or Fast Transfer Switch
  - Combination

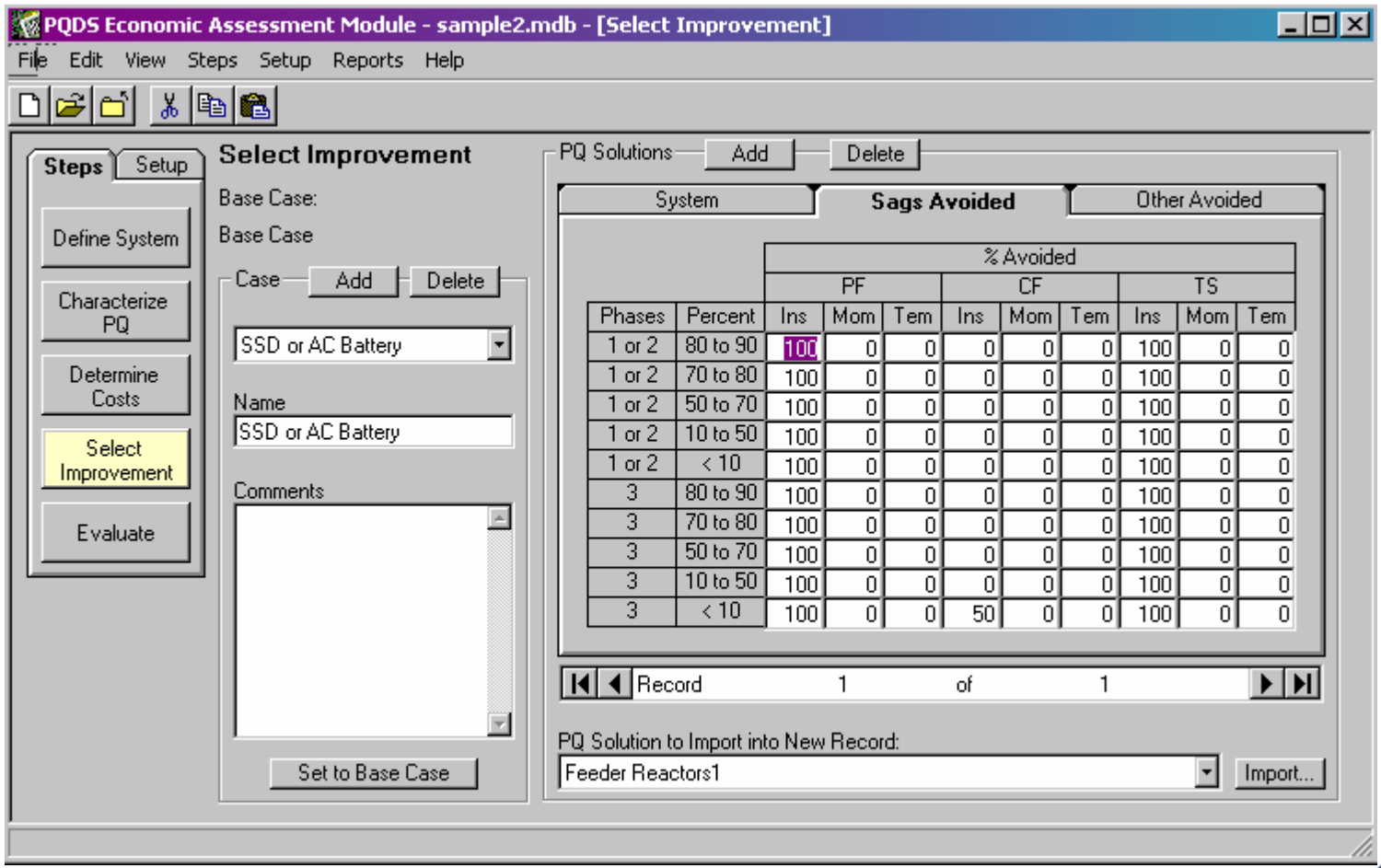
EAM
Costs of Solution Options



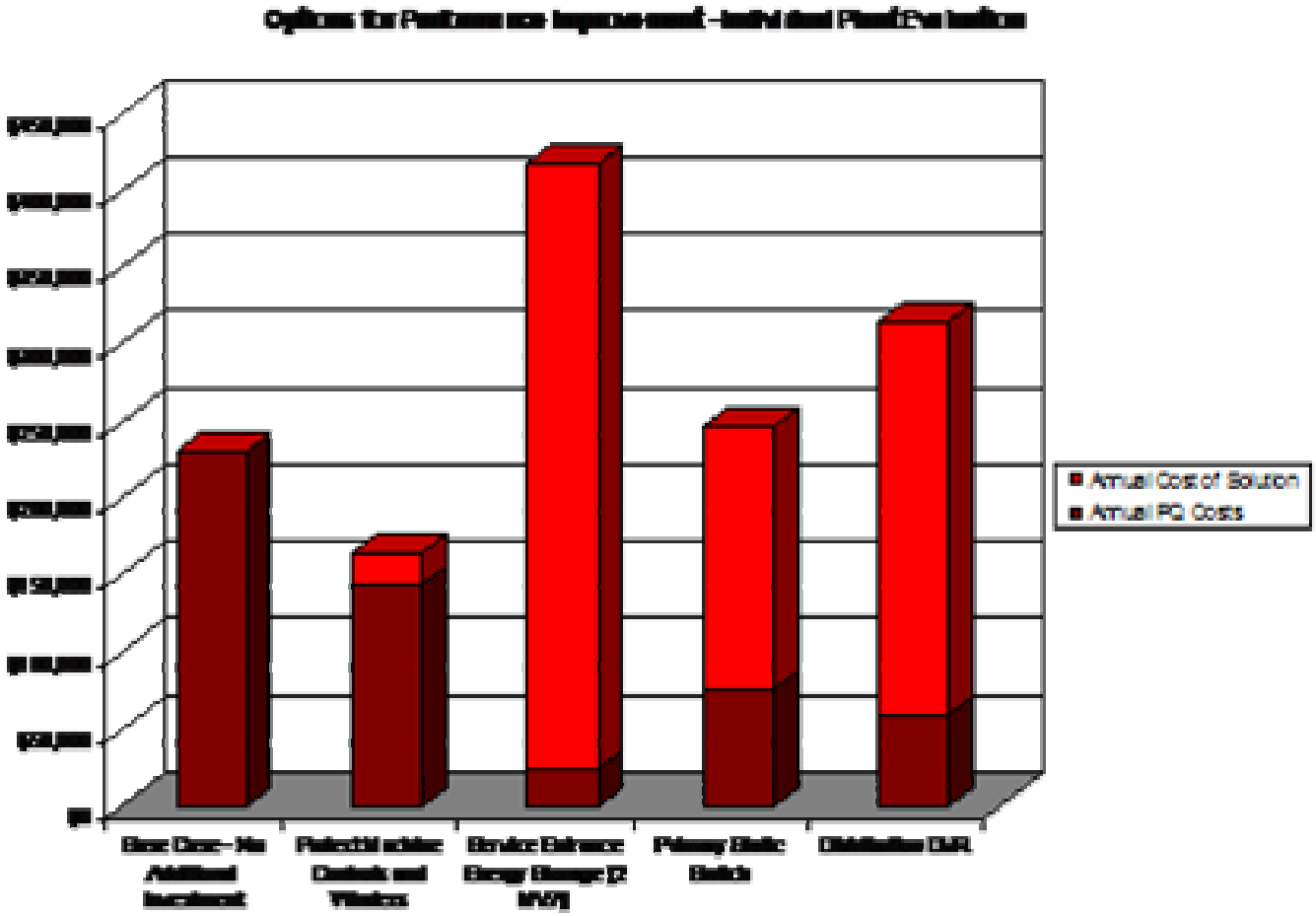
Performance of the Solution Options

Type of Condition Affecting Customer	Weighting	Base Performance (events/year)	Reduction with Controls Protection	Reduction with Service Entrance Energy Storage	Reduction with Primary Static Switch	Reduction with DVR
Interruptions	1	5.0	0%	80%	100%	0%
Sags below 50%	1	1.0	0%	100%	100%	20%
Sags 50-70%	0.7	13.0	30%	90%	87%	100%
Sags 70-80%	0.4	10.0	60%	95%	30%	100%
Sags 80-90%	0.1	39.0	90%	95%	8%	100%
TOTAL EVENTS AFFECTING PLANT		68.0	23.0	4.8	44.7	5.8
Total Events Weighted for Severity		23.0	14.4	2.3	7.6	5.8

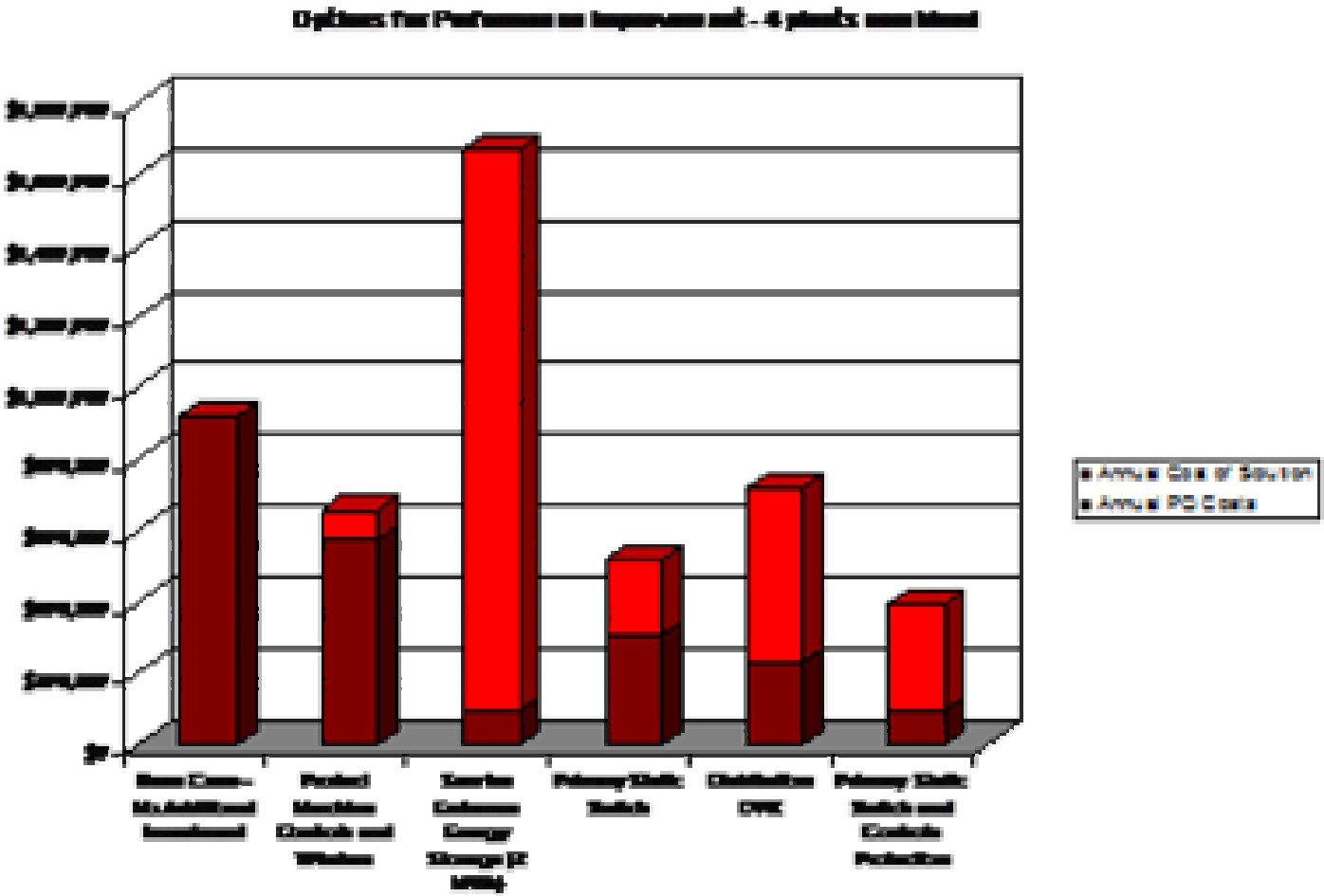
EAM
Performance of solution



Cost Comparison for a Single Customer



Cost Comparison for Multiple Customers



Economic evaluation - Summary

- Convert everything to equivalent annual costs
- Calculate a base cost using existing conditions
- Look at the reduction in costs associated with each alternative
- Find the minimum TOTAL costs