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Economics of Downtime - Cost/Payback of Implementing Low Cost Solutions

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Payback Considerations

- Customers respond more positively to business cases based entirely on solving known business or manufacturing problems
- Decision makers aren't interested in the technical details, but rather in the business effect of the interruptions caused by the PQ event and how the proposed solution will improve bottom line profitability
- Acceptable payback requirements vary. Typical ranges are from 12 months to 36 months with anything over 18 months being increasingly harder to cost justify

Calculating Payback

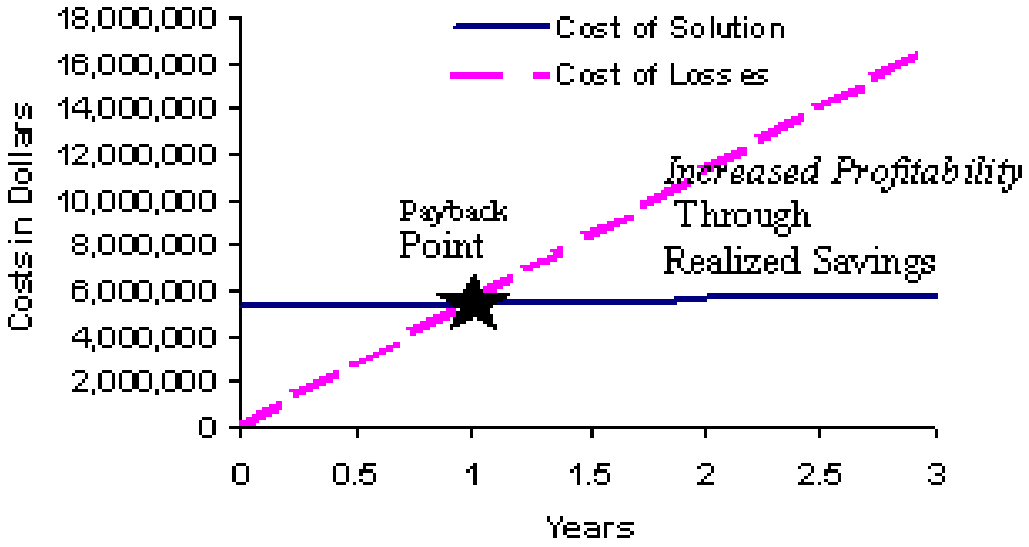
- To Calculate Payback you need to know
  - One Time Capital Outlay
  - Cost of installation
  - Annual Benefit
  - Ongoing Annual Expense

Payback Analysis

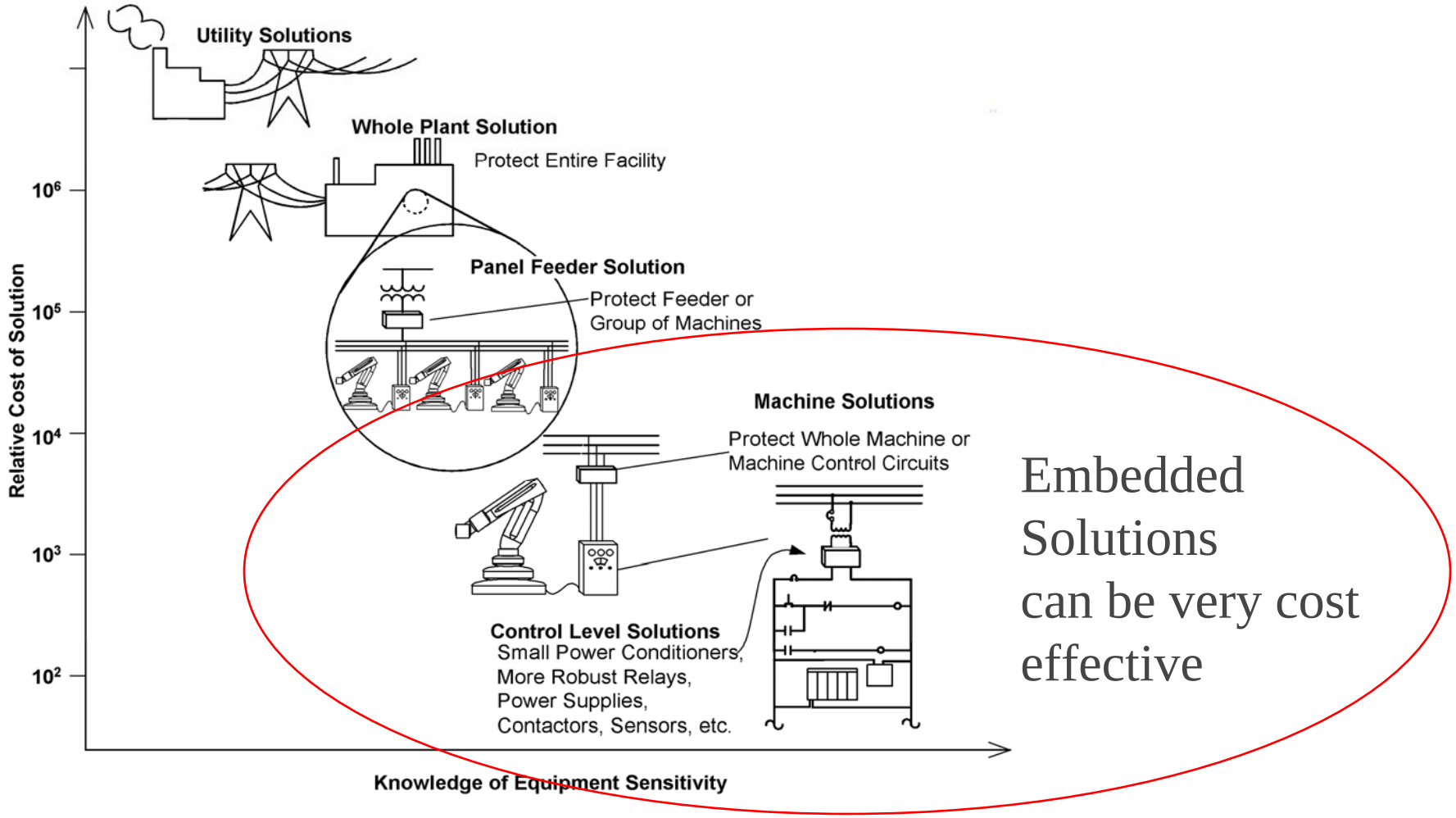
Compatibility Financial Analysis from IEEE 1346

Investment	*Examples*	**Return**	*Examples*
One-time capital outlay	*Enhanced equip,* Custom Power	Annual benefit	*Cost of reduced downtime*
+		-	
Installation	*Installation cost*	Ongoing annual expense	UPS maintenance, Premium utility service
Net Investment		Net annual return	

Pay back (months) = (net investment/net annual return) * 12

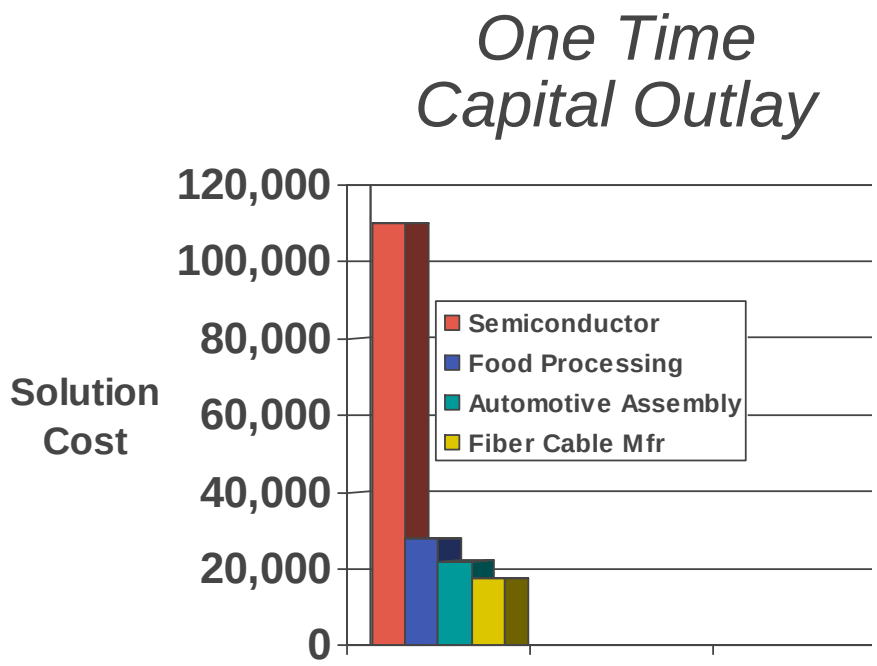


Cost of Solution Varies Based on Knowledge of Problem



Example Embedded Solution Costs

- Costs shown for four different plants based on separate power quality audits where embedded approaches are recommended
- Price based on fixing most critical equipment issues in each plant
- For Semiconductor:
  - Many Production Tools and Support Equipment
- For Food Processing:
  - Boiler, Labeling, Cooking
- For Automotive:
  - Paint Shop and Body Shop Controls
- For Fiber Cable:
  - Multiple Lines (most expensive losses are from cable jacketing section)



Cost of Installation

- For an embedded solution implementation, the cost of installing each device must be considered
- Items to consider:
  - Engineering Labor
  - Procurement Labor
  - Electrician Labor
  - Line Downtime Costs to install solution
  - Installation Fixtures
- For some low cost embedded solutions, the cost of installation is as much as the cost of the hardware!

Calculating the Cost of A Power Quality Disturbance

- IEEE 1346 provides a good resource for calculating the cost of power quality events.
- In some industries the actual cost for each event can be difficult to measure
- In other industries the cost can be more directly calculated

Downtime Related
- Increased buffer inventories (value of incremental inventories * WACC) ____
- *Lost work*
  - *Idled labor*
    - Disrupted process (man-hrs * unloaded labor rate) ____
    - Starved process (man-hrs * unloaded labor rate) ____
  - *Lost production*
    - Lost profits (unbuilt product * profit margin) ____
    - *Makeup production*
      - Overtime labor + premium ____
      - Overtime operating cost ____
      - Expedited shipping premiums ____
      - Late delivery fees ____
  - *Cost to repair damaged equipment*
    - Repair labor ____
    - Repair supplies ____
    - Repair parts ____
    - *Cost of replacement part availability*
      - Expedited shipping of parts ____
      - *or*
      - Carrying cost of parts ____
  - *Cost of recovery*
    - Secondary equipment failures (treat as repairs) ____
    - Recovery labor inefficiency ____

Product quality
- Replacement value of scrap (BOM value + labor value) ____
- Blemished product lost profit margin ____
- *Rework cost*
  - Labor ____
  - Manufacturing supplies ____
  - Replacement parts ____

Miscellaneous
- *Customer dissatisfaction*
  - Lost business ____
  - Avoided customers due to longer lead time ____
- Fines and Penalties ____
- Other ____

TOTAL ____

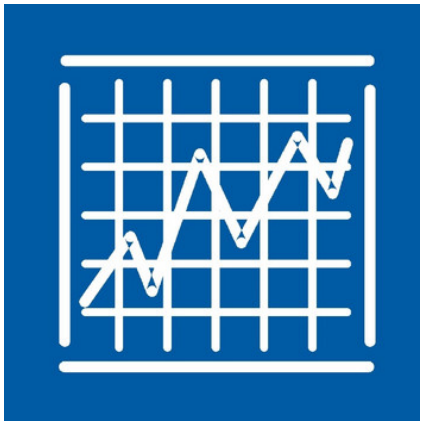
Typical Reported Per Event Cost of PQ Disturbance

No.	Process	Reported Cost	Service Voltage	Load
1	Semiconductor	$1,500,000	69 kV	25 MW
2	Semiconductor	$1,400,000	161 kV	30 MW
3	Semiconductor	$ 700,000	12.5 kV	10 MW
4	Metal Casting	$ 200,000	13.8 kV	16 MW
5	Chemical Plant	$ 160,000	12.5 kV	5 MW
6	Pulp and Paper Mill	$ 110,000	161kV	100 MW
7	Aerospace Engine Machining	$ 100,000	13.8kV	10 MW
8	Food and Beverage	$ 87,000	12.5 kV	5 MW
9	Chemical Plant	$ 75,000	66kV	3 MW
10	Chemical Plant	$ 75,000	66kV	5 MW
11	Electronic Components	$ 75,000	12.5 kV	5 MW
12	Crystal Growth	$ 60,000	12.5 kV	1 MW
13	Chemical Plant	$ 46,175	66kV	30 MW
14	Wiring Manufacturing	$ 34,000	12.5 kV	2 MW
15	Chemical Plant	$ 18,000	12.5 kV	2 MW
16	Fibers Plant	$ 15,000	12.5 kV	1 MW
17	Paper and Packaging	$ 10,000	12.5 kV	4 MW
18	Plastic Bag Manufacturing	$ 10,000	480V	4 MW
19	Plastics	$ 7,500	12.5 kV	4 MW
20	Stainless Steel Manufacturing	$ 5,500	12.5 kV	2 MW

Automotive Reported as high as $700,000.

Annual Benefit

- The annual benefit is best calculated based on a yearly average of past PQ related losses.
- Can also be projected based on PQ data (number of events, magnitude and duration), known susceptibility of equipment and an estimated cost per event
- May also include production line utilization rate in calculation.



Ongoing Annual Expense

- For small Embedded Solution Power Conditioners, the cost of this is minimal since there are no batteries to maintain
- An occasional checkup of power conditioner output, status indicators, and dust accumulation is all that is required

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Cable Manufacturer Payback Example

Example Cable Manufacturer Payback Estimation

- Assume fiber optic cable manufacturer looses $30,000 per each event when a cable jacketing line is running and is shutdown due to PQ.
- Seven (7) events below threshold for line equipment to shutdown last year (based on PQ Data)
- Utilization rate of line is 40%
- Embedded Solution hardware costs is $3,997
- Installation Costs are estimated at $3,000
- Ongoing Annual Expense is estimated at $1,000

Example Payback Time Calculation

- The estimated payback time for implementing a power quality solution is calculated by:

Pay back (months) = (net investment/net annual return) * 12

Net Investment = Power Conditioner costs + Installation Costs

Power Conditioner Costs (including payoff) = $3,997

Installation Costs = $3,000

Net Annual Return = Annual Benefit – Ongoing Expenses

Annual Benefit = (number of events expected below voltage sag threshold next year multiplied by the utilization rate of the line multiplied by cost of each shutdown) = 7 x 0.4 x $30,000 = $84,000

Ongoing Expenses = $1,000

Payback Period = [($3997+$3000)/(($84,000-1000)]x 12=($6997/$83,000) x 12

Payback Period = 1.0 Month !

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Semiconductor Plant Payback Example

Example of Semiconductor Plant Payback Estimation

- Assume 200mm Semiconductor manufacturer looses an average of $566,000 per each event when process is upset due to power quality disturbances.
- 10 Events per year average that cause losses.
- Embedded Solution hardware costs is $350,000
  - Includes 75 most sensitive tools, associated pumps, and facility system equipment. Installation of over 100 embedded solutions.
- Installation Costs are estimated at $350,000
  - Procurement Labor
  - Engineering Labor
  - Electrician Labor
  - Verification Testing for proper operation
  - Machine Downtime Costs (Estimated at $100k)
  - Fittings, etc.
- Ongoing Annual Expense is estimated at $20,000

Example Payback Time Calculation

- The estimated payback time for implementing a power quality solution is calculated by:

Pay back (months) = (net investment/net annual return) * 12

Net Investment = Power Conditioner costs + Installation Costs

Power Conditioner Costs = $350,000

Installation Costs = $350,000

Net Annual Return = Annual Benefit – Ongoing Expenses

Annual Benefit = (number of events expected below voltage sag threshold next year multiplied by cost of each shutdown) = 10 x $566,000 = $5,660,000

Ongoing Expenses = $30,000

Payback Period = [($700,0000)/(($5,630,000)]x 12

Payback Period = 1.5 Months

Conclusions

- Embedded Solutions Typically Range from $500 to $5,000 for an OEM machine or Production Line Equipment.
- Payback times of less than a year are common for these solutions
- These costs are relatively small in comparison to the cost of associated losses

The Price of the Solution is small compared to Costs associated with Lost Production and Downtime