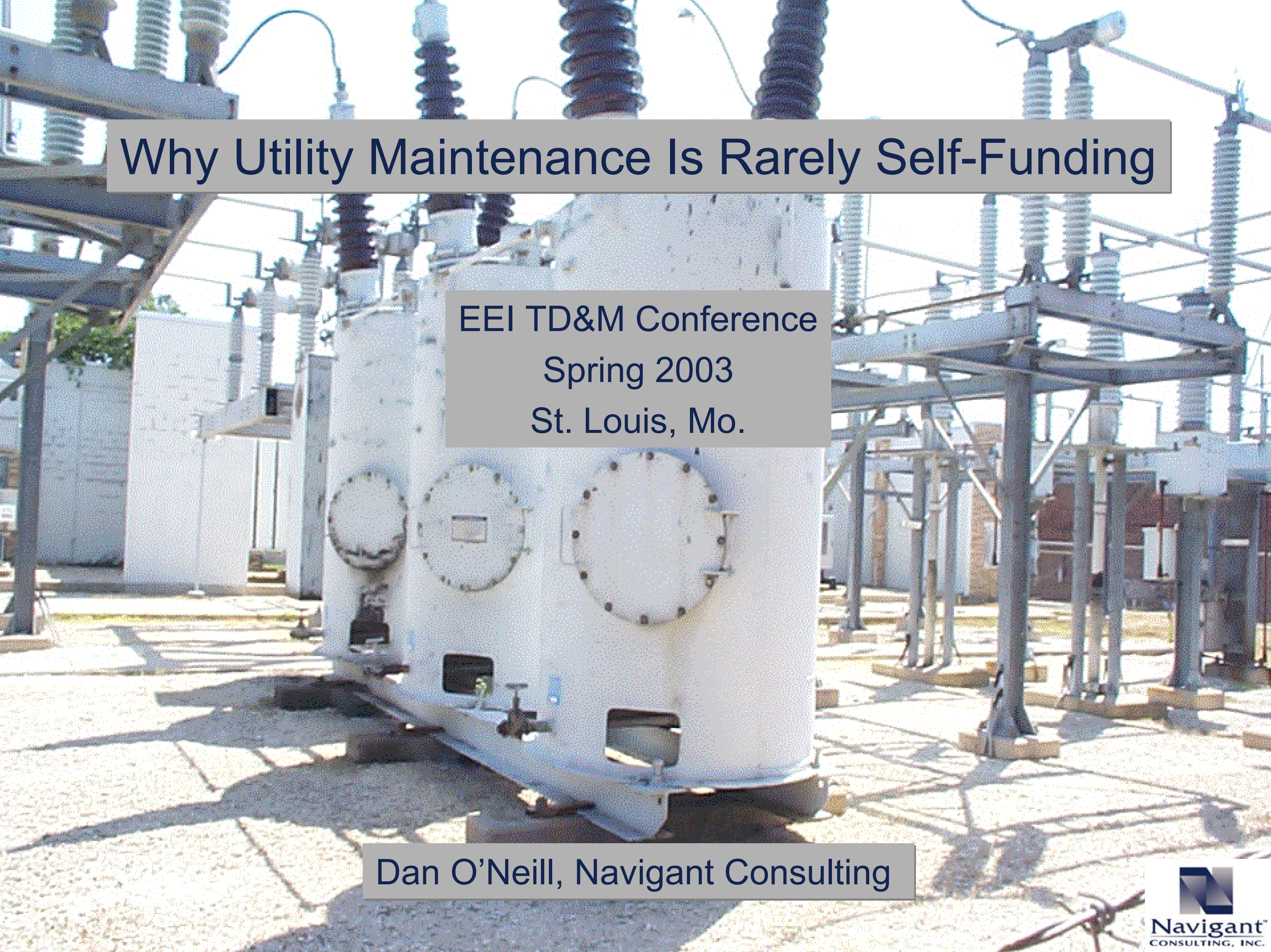

Why Utility Maintenance Is Rarely Self-Funding

EEI TD&M Conference
Spring 2003
St. Louis, Mo.

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Executives often ask, "How can I spend a dollar to save a dollar?

Or, where is the point when a dollar of PM saves a dollar of CM?

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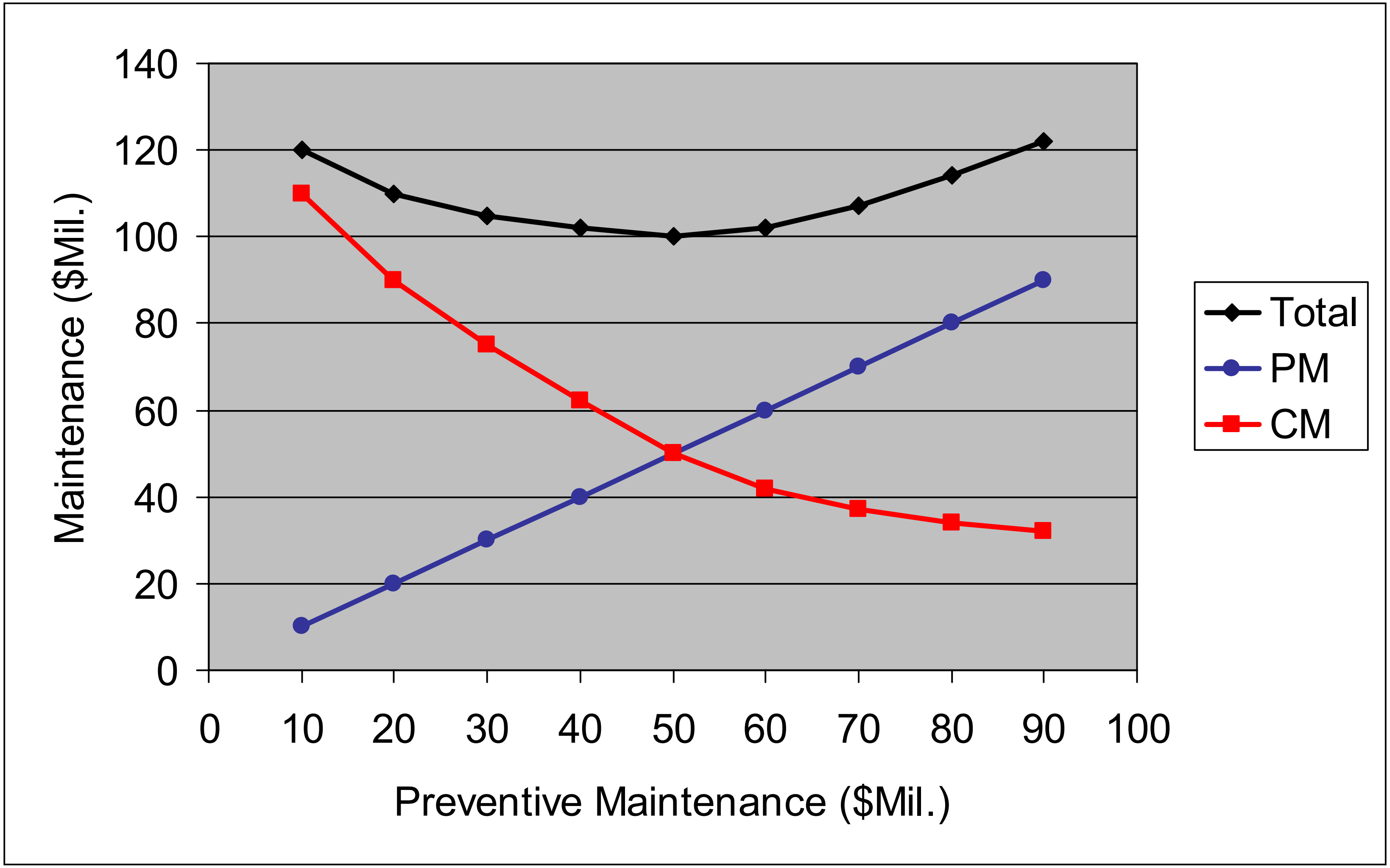

The answer is, "Don't go there. You won't be allowed to stay"

Customers and regulators will demand better reliability than that

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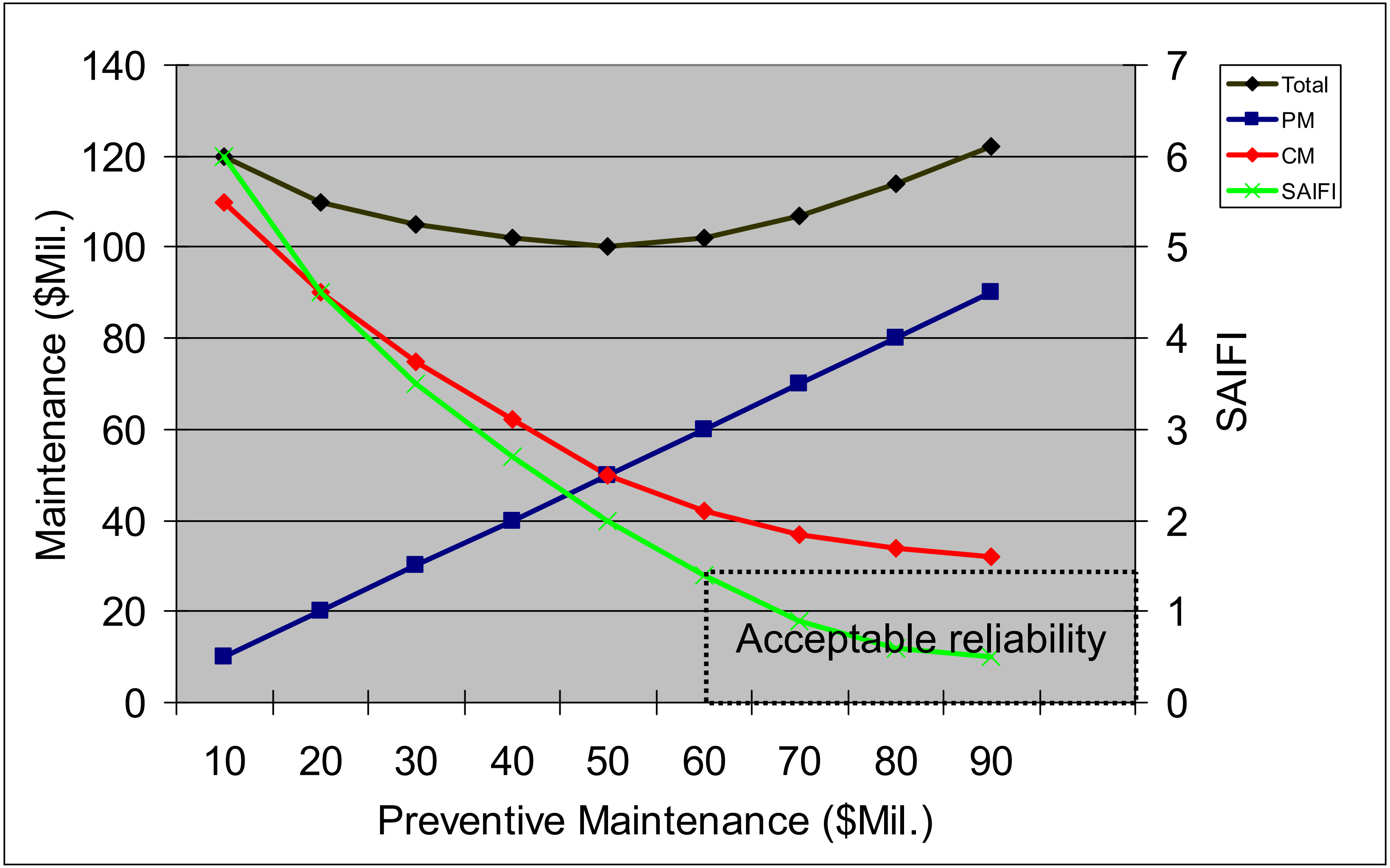

It normally costs $10,000 or more to avoid a tree-caused outage

This figure usually surprises utility executives

Trimming cost per mile	Outage rate per mile	Outage reduction factor	Cost per avoided outage

$2,000 ÷ (.40 x 50%) = $10,000

Or, for comparability to capital projects, take the present value of $2,000 every four years at a 10% discount rate:

$5,700 ÷ (.40 x 50%) = $28,500

Notes:
- Outage rate should be what it would be if not trimmed at the normal end of cycle, e.g., fourth year, which is higher than the average tree-caused outage rate
- Trimming cost is for contact trimming only, not removal
- Effectiveness rate recognizes some skips, fast growth, limited permissions, and non-contact outages like fallen tree/broken limb

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But, it normally costs only about $1000 to restore an outage

So, the PM cost is nowhere near the first-year CM savings

Resource	Resource Units	Per Unit Rate	Need Per Outage	Resource Cost
Trouble responder	1 hour	$100	1.0	$100
Repair crew (2 x)	4 hours	$200	0.4	$320
Call taker	.1 hour	$30	10.0	$30
Additional switching	1 hour	$100	0.2	$20
Additional repair crew	4 hours	$200	0.1	$80
Sub-total average labor				$550
Material – fuse	1	$50	1	$50
Material – pole, X-arm, etc.	1	$2000	.2	$400
Sub-total average material				$450
Total cost				$1000

Notes:
- Time for supervisor, dispatcher, etc., included in loaded labor rate
- Although some outages are more severe, often they are not very preventable, either

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Taking credit for all future outages still doesn't get you there

It puts the break-even point within sight, but still just out of reach

Annual avoided cost of outages		Discount rate		Present value of all future avoided CM		Present value of current and future PM
$1,000	÷	.10	=	$10,000		$28,500

Implies a 10-year 'payback'

Notes:
- The discount rate reflects the weighted average cost of capital (plus risk premium, if any)
- Higher costs of capital in the past, e.g., 15%, were associated with higher rates of inflation
- Dividing by the discount rate is a shorthand way of getting the present value of a stream of income. It assumes a 'perpetual annuity.' For 30 years instead, divide by .106 = 1/9.43
- If you assume 10% includes 3% inflation for the annual outage costs, then the discount rate would be .07, and the PV would be almost $15,000, but not if offset it with a 3% 'risk premium'
- Many executives are not comfortable with a 10-year payback even though the financial analysis says that it is appropriate for a 10% cost of capital

For URD cable replacement, the situation is just as bad

Even if the repair cost is assumed to be twice as high (unless you only replace one section at a time when its failure rate is bad enough)

Replacement cost per 200' section	Outage rate per section	Outage reduction factor	Cost per avoided outage

$6,000 ÷ (.40 x 100%) = $15,000

Or, for entire loops or subdivisions:

$6,000 ÷ (.10 x 100%) = $60,000

Notes:
- Outage rate is based on the typical rule of replacing a segment if it fails 3 times in the last ten years, adjusted to 33% worse for increasing deterioration
- Replacement cost is based on $30 per foot on a 200' segment, replacing direct buried cable with direct buried cable, plus lawn restoration. Replacing with conduit and cable would be more expensive. Injecting with silicon would be about half as expensive where it is feasible, but usually requires multiple sections, not all of which may be failing at a high rate.
- Each time one section of URD cable in a half-loop fails, all customers in that half-loop see an outage (and all in the other half see one during switching), so the outage rate of the loop is often much worse than that of any section

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Likewise for lightning mitigation, etc.

And remediation of other low-incidence pole-top causes

Mitigation cost per pole	Outage rate per pole	Outage reduction factor	Cost per avoided outage

$1,500 ÷ (.05 x 50%) = $60,000

$1,500 ÷ (.10 x 50%) = $30,000

Notes:
- Outage rate is based on 2 lightning-caused outages per mile and 40 poles per mile
- Mitigation cost is based on a three-arrester bank and/or improved grounding
- Effectiveness rate is based on reported field experience, some of which is even lower, because lightning will tend to find the weakest link in mitigation
- In order for the PV of the avoided CM cost to equal the PV of the PM investment, the outage rate per pole would have to be .3, or about every 3rd pole, or 12 per mile for that cause of outage alone, e.g., lightning

Part of the problem is that utilities do not really have a 'sharp pencil'

Typical failure rates on remediation programs are too low

5% failure rate of replaced equipment	Replace 20 units to avoid one failure
.2 avoided outages per mile remediated	Remediate 5 miles of line to avoid one outage
5% reject rate on pole inspection	Inspect 20 poles to find one to replace

"If we knew more precisely which unit or mile to replace or remediate, we could make preventive maintenance more cost-effective"

Notes:
- Outage rates per mile for worst-circuit programs sometimes reach high levels, but if that were all you did, overall reliability would probably keep getting worse
- Replacing failure-prone equipment on a system wide basis is rarely cost-effective. You have to target the highest failure rate (worst first)
- Information is usually lacking to discriminate more finely among classes of equipment to find the one that is most likely to fail next

One solution is to recognize the business value of reliability

At a value to the utility of about $25 per customer interruption per year

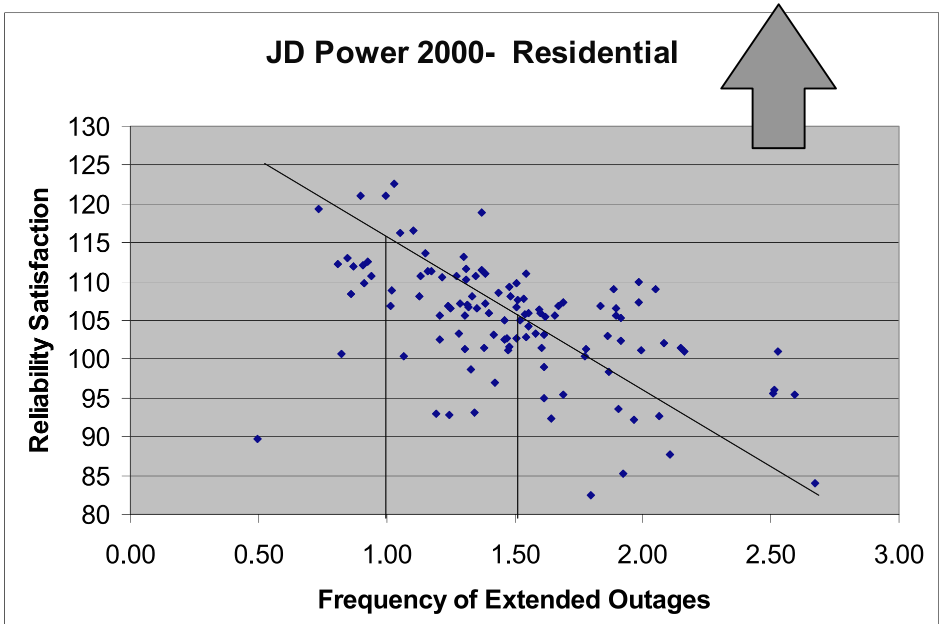
Customer Interruptions -100,000 → SAIFI -.14 → PQ & Rel. Cust. Sat. +2.8 → Overall Cust. Sat. +.64 → Reactive Response Cost +2.5 Mil./yr.

-100,000 CI / 700,000 Cust. = -.14 SAIFI

+10 Points PQ & Rel. Cust. Sat. per .5 SAIFI

PQ & Rel. Cust. Sat. = 23% of Overall Cust. Sat.

Reactive Response = $4 Mil./yr. per Cust. Sat. Pt.



I.e., a 10-point drop in utility's customer satisfaction would require a $40 million response by utility

Source: JD Power & Associates, with Navigant Consulting

Many utilities are already seeing such "reactive response" costs

Penalties/refunds of $25 to $100 per customer interruption are appearing

Customer refund programs (In addition to reliability improvement programs)

ComEd "Commitment"	$60-$100 per customer interruption over 8 hours
IPL refund	$100 per customer interrupted over 24 hours
PacifiCorp guarantee	Up to $100 per customer for missed service levels
Entergy-TX refund	$33 per customer per year (for 120,000 customers)

PBR Programs (Each of these companies agreed to penalties for SAIDI/SAIFI)

All NY State Utilities (ConEd, National Grid, Central Hudson, Energy East, etc.)
All MA Utilities (NSTAR, National Grid, NU (WMECO)
All CA Utilities (PG&E, SCE, SDG&E)
Xcel (in NSP/New Century merger agreement)
Western Resources (in WR/KCP&L proposed merger agreement)
Pepco (in proposed Pepco/Conectiv merger agreement in MD)
Etc.

With such costs included, PM can be cost-effective

And utilities can go where a dollar of PM can save a dollar of cost

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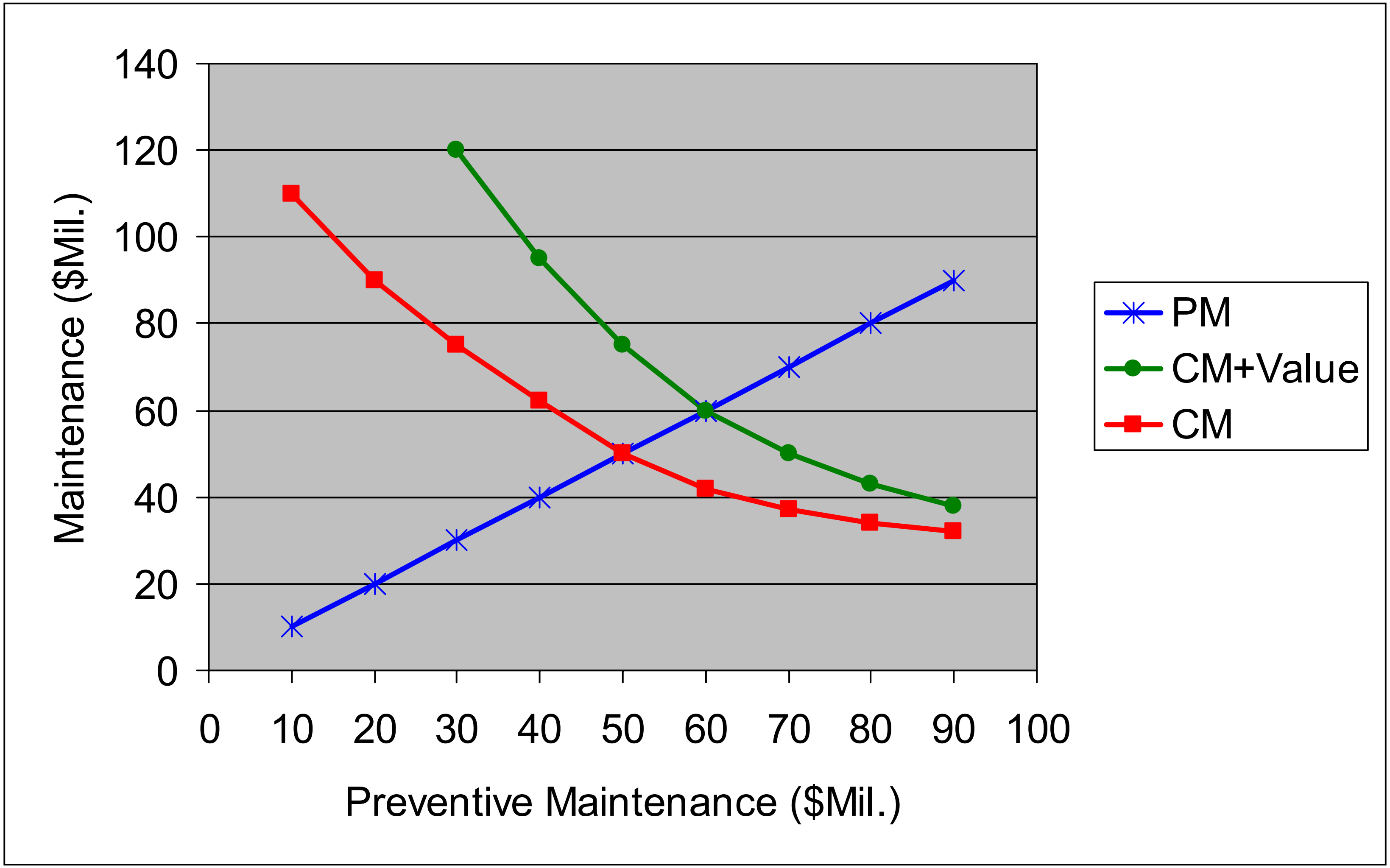

Note: At $25 per customer interruption, the value per outage would be $2,500 - $25,000 per outage, depending on whether the outages were on 100-customer taps or 1000-customer feeder backbones. And the PV of all future avoided outages would be ten times that.

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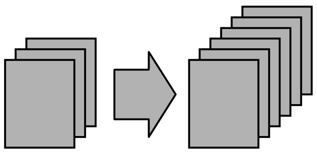
Such values can be built into a ‘funding curve’ methodology

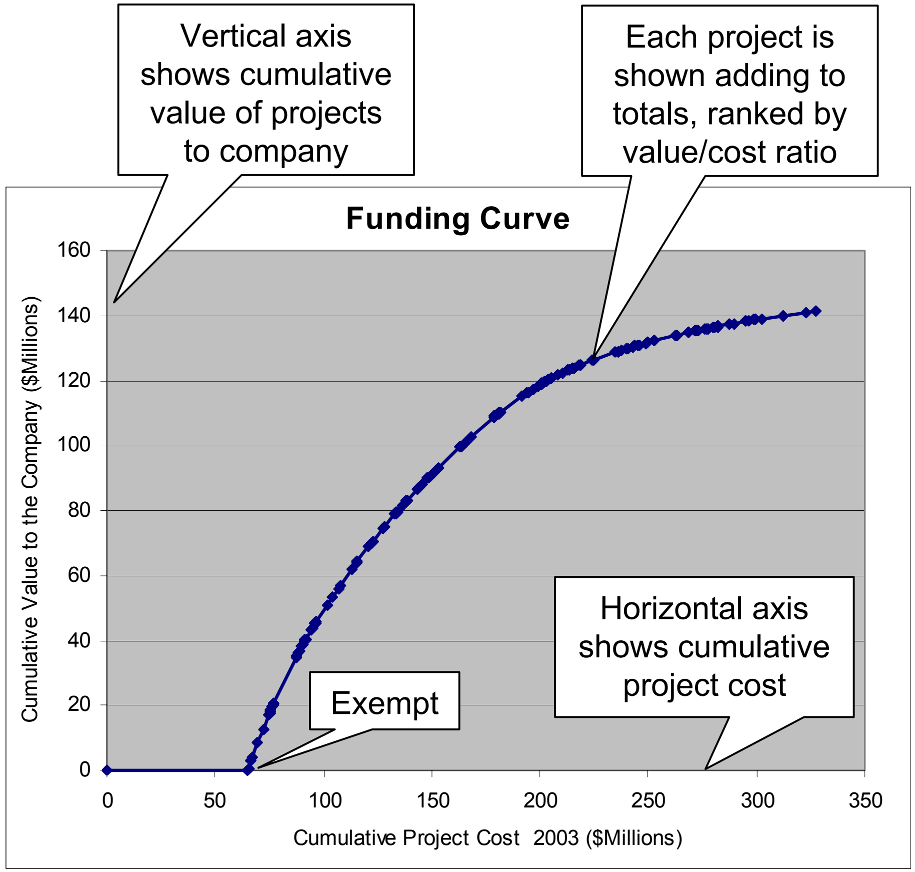
Navigant Consulting’s methodology incorporates this concept

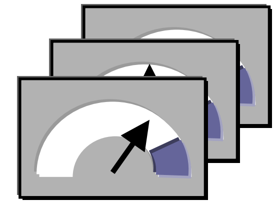


Option Development

Developing cost-effective alternatives for possible funding

- Additions
- Upgrades
- Replacement
- Maintenance
- Standards
- Systems





Results Monitoring

Measuring & managing the drivers of the funded projects and processes

- Benchmarking
- Unit costs
- Failure rates
- Event impacts
- Value added

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Any questions?

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