Drawing a Line in the Sand – A ‘Get No Worse’ Program For Asset Replacement

Presented by Dan O’Neill at

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Agenda

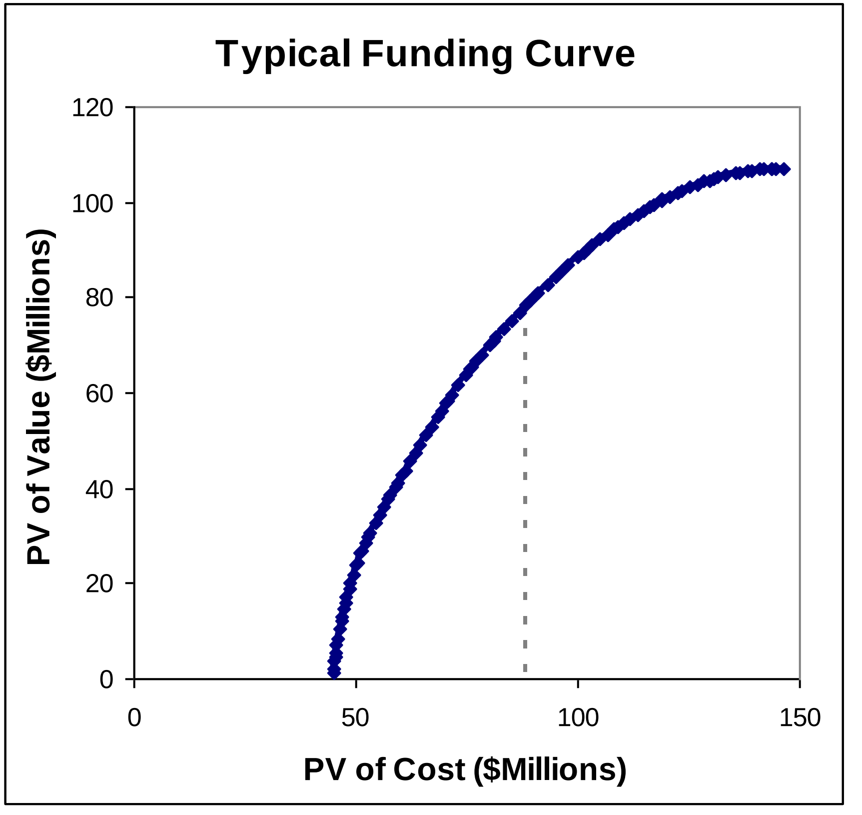
- Why a line in the sand is needed
- Comparison with other utilities
- The simple math of asset replacement
- Observations and Key Questions

Even in good times, utilities struggle to fund asset replacement…

Typical spending prioritization:

- ‘Must Do’ – value not assigned
  - New connections
  - Public Improvement (road moves)
  - Outage restoration
  - Safety programs
- Capacity reinforcement (driven by growth)
- Reliability
  - Imminent failure, worst performers
  - First, second-tier maintenance
  - First- tier replacement
- Renewal/modernization
  - Second-tier replacement
- Efficiency

Illustrative, for a million-customer utility



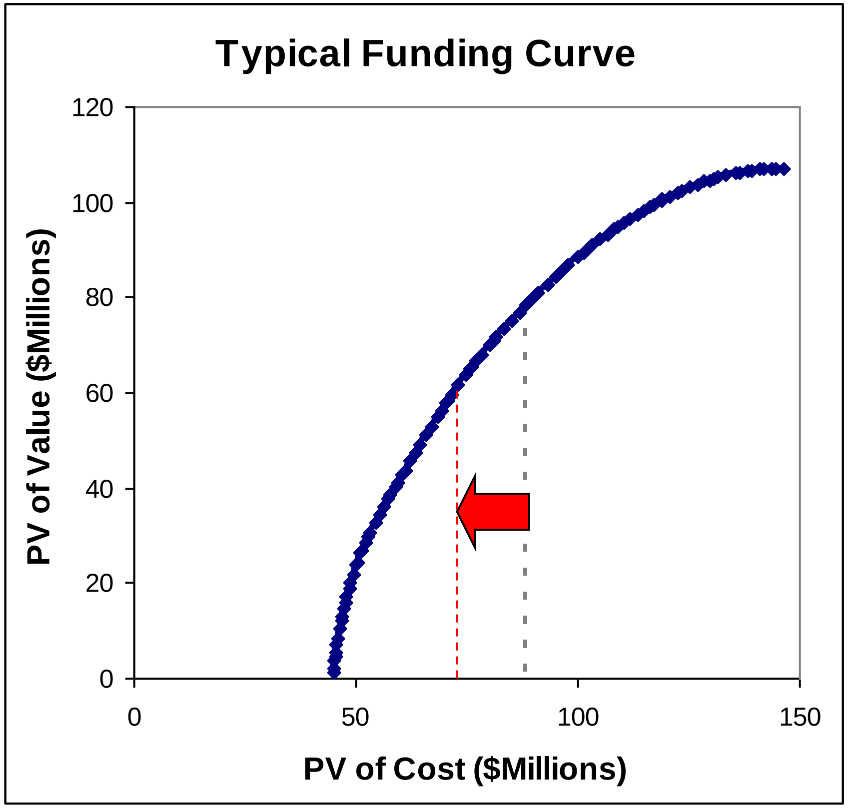
With the typical priorities for spending, asset replacement programs are often almost the <u>last</u> to be funded, and may miss the cut entirely, or get only the most needed ‘tiers’ funded, <u>even in relatively good times</u>

…So, in a financial crisis, it is even harder to fund replacement

Reduced spending prioritization:

- 'Must Do' – value not assigned
  - New connections
  - Public Improvement (road moves)
  - Outage restoration
  - Safety programs
- Capacity reinforcement (driven by growth)
- Reliability
  - Imminent failure, worst performers
  - First, second-tier maintenance
  - ~~First- tier replacement~~ ***deferred***
- ~~Renewal/modernization~~ ***deferred***
  - ~~Second-tier replacement~~ ***deferred***
- ~~Efficiency~~ ***deferred***

Illustrative, for a million-customer utility



All the more reason why utilities will have to 'sharpen the pencil' and do good prioritization to ensure the right projects are funded and also to know the impact of deferring some this year and maybe next

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Most utilities have at least minimum asset replacement programs

Illustrative, for a million-customer utility (distribution only)

Program	Asset Population	Annual Replacement	Annual Cost
Wood Poles	1,000,000 poles	0.5% (10-yr inspection with 5% reject)	$7.5 M
Line transformers	200,000 Xfmrs	1.0% (RTF)	$2.0 M
OH/UG conductor	10,000 miles	0.5% (RTF)	$7.5M
Pole-top equipment - crossarms, insulators, arresters, cutouts, etc.	1,000,000 pole-tops	0.5% (RTF)	$5.0 M
Circuit breakers & reclosers	1500 units	0.6% (~RTF)	$0.5 M
Relays and communication	10,000 units	4.0 % (un-repairable)	$2.0 M
Power transformers	500 Xfmrs	0.5% (fail test)	$3.0 M
Other equipment, vehicles, etc.			$2.5 M
Total			$30.0 M

A certain amount of replacement takes place at a minimum because of restoration after failure, or replacement before imminent failure or hazard

Beyond the minimum, there are reasons for additional replacement

All utilities face similar issues:

- For all utilities, preventive replacement is usually considered ‘discretionary’
  - Behind customer growth, public improvement, failure restoration, safety, and load relief
  - NERC/RTO-mandated programs, considered mandatory, are mainly load relief
- All utilities have ‘aging infrastructure’ issues
  - Average age of most station equipment is at or over its planned 30-year ‘useful life’
- Failure rates are low (0.5% per year), even for targeted assets (1-5%), so first-year impact of deferral is minimal, but becomes significant over 5 to 10 years
- All utilities have ‘legacy’ issues
  - Some may have more than most, due to cost-saving standards changes in 1980-90s, e.g., ground switch with MOAB instead of circuit switchers or breakers

All utilities recognize the need for preventive replacement. And all recognize that it is deferrable, with effects that ultimately accumulate

Some examples are worth investigating further

Various examples can be cited

- **PSE&G** has had a program since 2000 to maintain a <u>constant asset age</u>
  - Has been cut back or eliminated in some of the years since then
- **SoCal Edison** proposed a 5-year plan in its 2006 General Rate Case (filed in Dec 2004)
  - SCE has 4.6M customers, 20k MW of load, 900 subs, 2,000 Xfmrs, 11,000 CBs
  - Substation replacement alone (above failures) is to be $160M per year
    - 1% for Transformers, 2% for Circuit Breakers, 3% for Relays
  - Distribution replacement (above failures) is an additional $255M per year

- **Your utility** - ???

Comparison to other utilities is useful, but ultimately the decision must be based on a utility's own situation with regard to asset condition, historical decisions, customer/regulator expectations, etc.

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The main options for preventive replacement can be categorized

Typical replacement options for the aging infrastructure components are:

- Run To Failure – Replace only upon ‘failure’, using spares that are then replaced
- Historical Depreciation – But due to inflation, this is often less than 1% of replacement cost
- Worst 1% - Allows for replacement of worst assets
- Constant Age – Maintains existing average age, i.e. ‘get no worse’ as to age
- Constant Failure Rate – Maintains existing failure rate (‘get no worse’ in performance)
- Replacement Cost Depreciation – Should be about 3% replacement for 30-year assets
- Target Age, e.g., if age>useful life – Reduce average age to a lower number, like useful life
- Target Condition – Achieve a level of asset performance consistent with expectations

In addition, certain programs may address legacy issues or reliability/operational problems that need addressing apart from the general aging infrastructure requirement

‘Run to failure’ is not really a sustainable option. A reasonable middle ground might be to maintain a constant rate of failure (‘get no worse’). With aging infrastructure, this requires higher funding each year. And with increasing expectations, ‘get no worse’ may not be good enough

Why 'run to failure' is not a sustainable option

'Run to failure' for a system means 'increasing failures over time'

- With no preventive replacement of the 'worst first', normal deterioration implies increasing failures for each asset class and for the system as a whole
- While 'run to failure' can be a workable policy for some assets, e.g., those for which impact is low and/or changeouts occur for other reasons like load growth, public improvement, etc., yet 'run to failure' fails as a system replacement policy because it ensures that the overall system will suffer increasing rates of failure and customer impact
- 'Run to failure' allows no prioritization for assets that are critical to customer service – failure may occur where you can least afford it
- 'Run to failure' as a system policy may be seen as imprudent. Experts may argue about the appropriate rate of replacement, but zero preventive replacement sends a clear message
- A relatively small rate of preventive replacement, perhaps only 1 percent per year, may be enough to maintain constant failure rates (see next pages)
- Replacement upon failure is usually more expensive than a planned replacement

'Run to failure' as a system replacement policy implies a conscious choice to let the failure rate of key assets increase indefinitely. While the increase may be gradual, it will be cumulative and probably noticeable within three to five years, with failures doubling in 10-15 years

The arithmetic of average age is simple

- Say you have 5 assets of various ages. Add the ages and divide by the count:

  10 + 35 + 45 + 50 + 60 = 200 years. So, average age = 200 / 5 = 40 years
- Now say you have 1,000 of each age. The average is still 200,000 / 5,000 = 40 years

- And if you <u>add</u> 1%, or 50, new assets, it reduces the average age by about 1%:

  200,000 / 5050 = 39.604, or approximately 0.4 years less

  Note: New assets have a starting age of zero, so total is still 200,000 years
- Or if you <u>replace</u> 1% of assets that are 60 years old, it reduces average age by 0.6%:

  (200,000 – 3,000) / 5,000 = 39.4 years

  Note: <u>replace</u>, not just <u>retire</u>, so count stays 5,000

- So, with 1% growth <u>and</u> 1% replacement (of 60-year old assets), average age is reduced by about 1 year (0.4 + 0.6), or just enough to offset one year of aging

"Do the math" – A 1% replacement program may keep average age constant, when targeted at the oldest assets and combined with 1% asset growth

A 1% replacement program is an important benchmark

Under the right conditions, a program of 1% replacement could maintain a constant average age, but:

- The more asset growth, the better
- If the 1% replacement includes those replaced upon failure, which are often about 0.5%, the *preventive replacement* program would be only 0.5%,
- Then, for the math to work, the average age of the replaced assets would still have to be 60 years,
- Which would mean, if the failed assets averaged only 40 years, the targeted assets would have to average 80 years

How a 1% replacement program might maintain a constant average age:

Each year assets age 1 year	+1.0 yrs
Add 1% of new assets (old avg. age = 40 yrs) (new avg. age = 40 / 1.01 = 39.6)	-0.4 yrs
Replace 1% of old assets (avg. age replaced: 60 yrs)	-0.6 yrs
Resultant change in average age:	0.0 yrs

Even though 1% replacement seems like a 100-year program for 30-year assets, if properly targeted at the 'worst first', it is often sufficient to maintain a high constant age (e.g. 40 years), so that the system can be characterized as 'getting no worse' in average age, a relevant and often-watched indicator

A 1% replacement program may also maintain the failure rate

Under certain circumstances, 1% replacement maintains a constant average failure rate:

- The average failure rate of many utility assets is about 0.5% per year
- Each year, the assets deteriorate, with their failure rate increasing by perhaps 5% of the failure rate, or .025%
- If there is 1% growth of new assets, that growth will reduce the average failure rate by 1% of the failure rate, or .005%
- If the assets replaced have an average failure rate of 2%, 1% replacement would reduce the average failure rate by .020%

How a 1% replacement program might maintain a constant average failure rate:

Annual increase in failure rate due to deterioration	+0.025%
Add 1% of new assets	-0.005%
Replace 1% of old assets	-0.020%
Resultant change in failure rate:	0.000%

As the failure rate deterioration increases, replacement will have to increase as well in order to keep up. The key to effective replacement is targeting the right assets for replacement – those with high failure rates

Some assets may require more than 1% replacement

Assets that may require higher than 1% replacement are those with:

- High consequences of failure, e.g., EHV equipment, radial large customers, etc.
- High deterioration rate, e.g., RTUs (shorter life), GIS (bad design), etc.
- Operational challenges, such as
  - Parts unavailable or with long lead times
  - Difficult to schedule outages
  - Requires special expertise from workforce that is diminishing with age
  - No longer meets standard
  - Non-critical failures take valuable time, e.g. leaking gas or air
  - Achieving work efficiency by replacing other assets in the same station while there

In most cases, these factors would simply lead to higher prioritization of these assets in the overall replacement program. If there are too many of these factors, or they affect a whole class of assets, e.g., RTUs, then the overall program should exceed the 1% requirement to 'get no worse'

Each utility should calculate its ‘get no worse’ scenario for planning

A long-run optimal asset replacement strategy can be built around a ‘get no worse’ scenario:

- Historical levels of funding may be close to a ‘Run To Failure’ plan and would very probably lead to worsening performance within five years
  - At today’s costs, even the spending equal to depreciation is not enough to ‘get no worse’
- Other comparable utilities have aspired to at least a ‘get no worse’ plan, if not better
  - SoCal Edison’s plan is five years
  - PSEG targets constant age, implying ‘get no worse’
- A typical desired replacement program is 1% for most assets, 2% for RTU’s and CB’s
  - Some of the worst CB’s and RTU’s are causing high O&M cost
- ‘Legacy remediation’ funding often takes ten years to phase out problems known today
  - Many other utilities have already eliminated one or more of these problems
  - Many utilities ‘bought’ many of these problems via cost saving options in the past

If, in the current financial crisis, some utilities choose to defer all but the minimum amount of asset replacement, they can expect to see failures rise at a modest rate, but one that could accumulate significantly (even double) if the deferral lasts too long. Eventually, they should target improvement by funding at more than the ‘get no worse’ rate

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Observations and Key Questions

<u>Observations</u>

- <u>Run to failure is not a sustainable system option</u> – It will cause failures to double over decades (or sooner), while a program targeted at replacing the worst 1% or so could stabilize them
- <u>Systems with low asset growth will suffer more</u> – Adding new assets each year re-invigorates the system naturally and eases the rate of replacement needed to stabilize asset failures
- Asset replacement is <u>deferrable, but the effects will accumulate</u>, becoming noticeable in just a few years and causing failures to double in decades or less (if 'deterioration' is 5-10% per year)

<u>Key Questions</u>

- Has your utility <u>calculated</u> the 'get no worse' level of replacement for each category of assets?
- Does your management know the <u>rate</u> at which asset failures will <u>accumulate</u> as asset replacement is deferred?
- Do you have <u>models</u> that can simulate what is required to achieve different scenarios of asset failure in the future?

<u>Questions?</u>

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Utilities should learn what level of asset replacement will get them to a 'get no worse' scenario, so they can target where to go from there