Security Risks and Technology Obsolescence Reduce Smart Meter Expected Lifetimes

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Key Article Points:

- Meter manufacturers and most utility companies attempting to justify large-scale smart meter deployments claim useful life values in the range of 15 to 20 years.

- Those individuals and groups who acknowledge that electronic equipment lifetimes are heavily influenced by security issues and technology obsolescence typically forecast much shorter useful lifetimes for smart meters, anywhere from 5 to 15 years with 10 years being a good median value.

- Smart meter useful life values (as used by most utility companies) are based solely on classical reliability analysis that models mechanical failure rates induced by accelerated life testing. These tests are normally conducted by the meter manufacturers themselves.

- Classical mortality factors ***and*** technology obsolescence determine the ***actual*** useful life of a smart meter, and they do so simultaneously. Therefore, both should be taken into account. Ignoring technology obsolescence and only considering classical failure rates will result in a gross overstatement of the useful life of a smart meter.

- On balance, the information presented in this article supports the conclusion that the useful life of a utility smart electric meter should not be considered to exceed 10 years. Utility companies planning to deploy smart meters in the future should adjust their project plans and cost benefit analyses accordingly.

Introduction

When utility companies or their consultants conduct business case analyses for smart meter deployments, they typically assign an expected “useful life” [1] for the asset. For example, one utility [2] in its cost benefit analysis (CBA) stated the following:

> “With respect to meter depreciation, Ameren Illinois has reviewed some of the largest AMI deployment plans in the United States, such as those by

> Duke Energy, Southern California Edison, DTE, and PG&E to base its AMI deployment on a **useful life** of 20 years for the AMI meter."
>
> "The timeframe of the primary business case is 20 years for both benefits and costs, which aligns with the estimated **useful life** for the AMI-related investments."
>
> General Assumption: "Meter depreciation time (**useful life**) period used in the model is 20 years" [2]

Based upon my own analysis, most electric utilities have assigned smart meter useful lifetimes in the range of 15 to 20 years. [3]

Traditional electromechanical (analog) meters have expected useful lifetimes from 20 to 30 years as used as part of cost benefit analyses, but in fact such meters have a proven track record of lasting over 40 years in the field, and analog meters are not prone to catastrophic failures. [4] [5] [6]

In October 2015, I published an article indicating that the true useful life of utility digital smart meters is probably in the range of 5 to 10 years based upon the evidence provided in the article, including the Congressional testimony of one utility executive stating that "these devices have a life of between 5 to 7 years." [7]

This current article updates and supplements information presented in the article from October 2015. **On balance, the information presented in this updated article supports the conclusion that the useful life of a utility smart meter should not be considered to exceed 10 years**. Those utilities planning to deploy smart meters in the future should adjust their project plans and CBAs accordingly.

Evidence for Smart Meter Useful Lifetimes Being Less than 15 to 20 Years

Contrary to the large number of utilities assigning smart meter lifetimes in the range of 15 to 20 years [3], there is a considerable amount of evidence that those numbers are overly optimistic. Here is a sampling of that information with appropriate references:

1. In Canada, the Ontario Auditor General's report from 2014 stated: "The estimated useful life for a typical smart meter is 15 years, compared to 40 years for an analog meter. **The distribution companies we consulted said the 15-year estimate is overly optimistic** because smart meters … will likely be **obsolete** by the time they are re-verified as required by the federal agency Measurement Canada **every six to 10 years**." [8]

2. Based upon a comprehensive article at *Smart Energy International* in 2008 on "The AMI Investment Decision":

> "Considering both the realities of technological **obsolescence** in solid state electronics and telecommunications, and the need to offer incentives for investment in AMI, it would be sensible for utilities and regulatory bodies to **adopt 10 years as the useful life** for AMI."

> "A **useful life of 10 years for the combined technologies** – metering, telemetry, and data management – would mitigate the risks of technological **obsolescence** and shortfalls in realising expected benefits." [4]

3. As reported at this website in 2015, a senior vice president of FirstEnergy provided testimony at a Congressional hearing on **cybersecurity** for power systems. At this hearing the corporate officer stated that: "These devices [referring to smart meters] are now computers, and so they have to be maintained. They don't have the life of an existing meter which is 20 to 30 years. **These devices have a life of between 5 to 7 years**." [7]

4. From Nick Hunn, a long-time critic of the Great Britain smart metering project: "Smart meter lifetimes around the world are closer to **10 years** than [the Department for Business, Energy and Industrial Strategy] BEIS' assumption of 25 years, which wipes out the long-term benefits, and means the whole charade will be repeated in **ten years' time**, …" [9]

5. According to BEUC, the European consumer organization:

> "As smart meters have a rather **limited life expectancy** compared to current mechanical meters, CBAs should take into account the replacement of both current and future meters as well as any additional costs that may occur at the later stage translating into higher expenses for consumers. Without proper analyses, BEUC is highly concerned about the costs that consumers will have to pay without benefiting from the new technology. …
>
> While the lifetime of current analogue meters is around 30 years, **it is expected that smart meters will need to be replaced or upgraded after 8 to 15 years**. In order to avoid premature replacements of these meters and ensure they function properly until a possible second deployment wave, modularity of the meters and all the components of systems need to be flexible." [10]

6. According to Dan Lewis, Senior Energy and Infrastructure Adviser at the Institute of Directors in the United Kingdom: "The first thing to say is that this [smart meter] programme is not primarily for consumers. The projected chief beneficiaries, … are the suppliers. They will own the meters and mine the data they produce, while removing a big cost from their balance sheet – manual meter readings and customer billing complaints. Meter manufacturers like the programme too, because the long shelf life of electro-mechanical meters – easily 40 years – would give way to **10 year replacement cycles, interim upgrades and repairs that invariably come with electronic obsolescence**." [11]

7. According to the *New York's Utility Project*, an initiative of the Public Utility Law Project of New York: "Some utilities are now urging faster depreciation (a cost of

service allowed by regulators when setting rates) for the new 'smart' equipment assuming a **useful life that is much shorter, perhaps eight to ten years**, more in line with the shorter lifetimes of computers and communications equipment. Others are urging more immediate recovery of their 'smart meter' costs through surcharges to pay for the meters over shorter periods. The utilities' advocacy of shorter depreciation or cost recovery periods suggests a **lack of faith on their part in reliability of the new systems**." [12]

8. From the Edison Electric Institute (EEI) in 2006: "The costs of installing smart meters are not negligible. There are, for example, the costs of replacing the existing electromechanical meter, the **likely shorter useful lives of smart meters**, and the need to replace meters on a 'one-off' (one at a time, not a general deployment) basis. The useful expected life of electronic meters is expected to be about **10 to 15 years**, due to the pace of technological innovation. The useful life of traditional meters is 25-30 years." [13]

9. According to an Accenture report in 2013:

> "While the concept of smart metering for consumer billing purposes is relatively mature, the technology is still evolving. So too are some of the uses of smart metering, with utilities, consumers and third parties all exploring new solutions to extract further value from their investments. Preferred communications technologies are changing, **meter asset life is uncertain** and some smart metering products are constantly evolving."
>
> The Accenture report contains a table labeled as: "Trends in smart meters and premise-side equipment." In that table it is listed that the smart meter "asset lives [are] considerably shorter than previous meter generation (**five to 15 years**)." [14]

10. According to smart grid workshop sponsored by the Department of Energy and the Vermont Electric Company (VELCO) in 2011: "For a long time, meter technology evolution was relatively slow-moving, and meter device lifecycle problems were not a critical issue. Today, overlapping technology lifecycles is an increasingly important question without an easy answer. Understanding the AMI business case is a case in point: What is the life of the meter now? Typically this was assumed to be 20 years. With the new pace of technological change, **does the assumed lifetime of a meter unit become 10 years**? [15]

11. From the International Electrotechnical Commission (IEC) Strategic Business Plan in 2015: "With traditional electromechanical designs and life spans of several decades, use of hazardous materials and safe disposal of decommissioned meters is not an issue. **Electronic meters may have shorter life cycles due to functional obsolescence**, and some types may contain batteries and other hazardous materials. Therefore, this aspect may be more important in the future." [16]

12. Based upon an energy and finance expert's article at *Engerati* in 2016: "Governments, particularly in the UK, have a poor track record of successfully

delivering large IT projects, and the lack of technological maturity increases the threats to a durable implementation. **There are significant risks that smart meters installed today will need to be replaced or upgraded *ahead* of their 12-15 year lifespan, eroding consumer value**." [17]

13. According to a cleantech industry analyst in 2014 on the subject of "advanced metering infrastructure challenges": "New technology risk/future-proof technology: Technology in this field is changing quickly, and the **fear of technological obsolescence is real** for utilities. Advanced metering infrastructure technologies also often do not have mass-scale proven business cases to demonstrate the benefits of implementing AMI." [18]

14. Regarding smart meter installations by Midstate Electric in Oregon, Tom Weller, Midstate Electric engineering supervisor is quoted in the September 2012 issue of *Rural Electric* that: "We based our decision on the assumption that if you buy something today, you may have to **replace it in 10 years due to technical obsolescence, even though the meter still works just fine**." [19]

15. In a 2011 published paper on smart meter lifetime prediction: "For smart meters … not enough long-term experiences [frequently exists] over its failure behaviour to make conclusive statements to reachable verifications of validity. This difficulty is compounded by the fact, that shorter innovation cycles and product varieties make it more **problematic to find general statements over lifetime prediction of smart meter**." [20]

16. Regarding the smart meters being deployed in Scotland, one training company states: "The Smart Meter Roll-Out will require approximately 12,000-15,000 engineers to replace 53 million meters in 27 million properties by 2020. A relatively **short smart meter life-span of 10-12 years** will ensure sustainable employment for years' to come." [21]

17. Based upon a 2010 article at *EnergyCentral*: "While most smart meters have a possible life of 20 years, and change-out may become appealing for technology reasons after **five to seven years**, most experts believe that **utilities will more than likely replace meters every 10 to 15 years**, taking advantage of new technologies at that time." [22]

18. Here is an early cautionary note from the Ontario Energy Board, Cost Considerations Working Group on its "smart meter initiative" in 2004: "Electronic meters may be less robust and more **vulnerable to technological obsolescence** than mechanical ones presently used. This would imply greater repair/replacement frequency and if failures result in throwaways, as currently happens with many electronic devices, overall costs may be substantially higher." [23]

19. A communication standard called *ZigBee* is many times used by smart meters to enable the use of In-Home Devices (IHDs) by the homeowner. As documented in the 2014 policy report by the Institute of Directors in the UK: "ZigBee chips product lifetimes are unlikely to exceed **four years**. This is much shorter than the duration of the installation stage of the smart meter rollout of 2015-2020. It is

considerably shorter than the 12-15 year lifespan of a smart meter and considerably less than the 40 year lifetime of an analogue meter. **Thus, new smart meter re-installations may be required only a few years** into the programme right across the country." [24]

20. As part of preparing for the roll-out of smart meters in the UK, testimony presented in 2011 by Vincent de Rivaz, Chief Executive Officer, EDF Energy included the following: "The **obsolescence** of the new meters will be to the tune of **10 years**, while today it is 25 to 30 years. … Yes, it is a new technology — it is about the digital world — and it is fair that meters move from old technology to the new one. However, new technology, by definition, is more frequently **obsolete**. I am talking about **10 years**, and maybe it will be a bit longer, but not necessarily a lot longer." [25]

21. In 2008, Frontier Economics studied the costs pertaining to smart meters and included a cautionary note regarding the communications components in the meter: "All the manufacturers indicated smart meter design lives of 20 years. However they placed a **caveat** on this around the life of the **communications components**, which they indicated may **have a shorter life**." [26]

22. According to Howard A. Scott, PhD, an independent industry expert: "The metering industry has changed dramatically over the past 25 years. The expected lifetime of a meter has changed from 25 years to closer to **10 years**." [41]

23. In May of 2018, testimony was provided by the Office of the Attorney General for the state of Kentucky in a rate case for the deployment of Advanced Metering Systems for Louisville Gas and Electric Company & Kentucky Utilities Company:

> "In discovery from the Companies' recent rate case, the Companies reported that of the 1,677 smart meters installed for Pilot, only 376 are still in service as of December 31, 2016. … The Companies explained in discovery … that most smart meters were replaced due to an LCD display failure. While the smart meter manufacturer has likely corrected such an issue by now, the issue is indicative of the more complex and **sensitive nature of electronic meters** compared to the traditional mechanical type, and why a benefit period of longer than 20 years over-estimates smart meter benefits. It is also worth noting that electric cooperative utilities in Kentucky generally depreciate smart meters over a 15-year period."
>
> "[E]quipment failure is just one of many risks to smart meters' useful lives. There are **technology obsolescence** risks to a long life for any smart meter deployment. In Ohio, Duke Energy has asked for permission to replace the entire AMS system it completed installing just 4 years ago, including 546,000 meters, 370,000 gas meter index modules, and the entire communications network at a cost of $169 million, or about $245 per customer. The utility's request cites many forms of **obsolescence** in its

> testimony, from field data collectors' cellular service mode (2G/3G) to inflexible software (which is unable to bill time-varying rates), to lack of meter and communications device manufacturer support (acquisitions and bankruptcy). The evaporation of manufacturer support, particularly for meter communication networks, is apparently all too common. Landis + Gyr, the Companies' proposed smart meter and communications network provider, is no longer supporting the TS2 meter communications solution it obtained in a 2006 acquisition, in which many utilities had continued to invest as recently as 2016." [27]

24. In April 2018, a final order was issued by the New Mexico Public Regulation Commission (NMPRC) regarding a request by the Public Service Company of New Mexico (PNM) to deploy smart meters. The request was denied, i.e, "disapproved." [28] [29] PNM had selected 20 years as the expected useful life for the proposed smart meters. As part of the rationale for the denial, the NMPRC stated:

> "PNM's analysis does not include replacement costs that might arise from the **obsolescence** of the meters over their physical service lives and their potential incompatibility with future applications that might be used with the AMI system. As an example of the potential for such costs, Arizona Public Service Company and Texas New Mexico Power Company ("TNMP") were both forced to replace AMI meters that relied upon 2G cellular service after their telecommunications carriers stopped providing 2G service. … PNM's analysis does not include estimates of cost to remediate a hacking incident, such as costs to restore lost data and other billing information." [29]

As one reviews the entries above where useful lifetime values are mentioned, they vary through the range of 5 to 15 years, specifically: 5 to 7, 10, 6 to 10, 10, 8 to 15, 10, 8 to 10, 10 to 15, 5 to 15, 10, less than 12 to 15, 10, 10 to 12, 10 to 15, a few years, 10 years, and 10 years.

A term I often highlighted above was *obsolescence*. This reference is made regarding devices that because of security concerns, electronic components no longer adequately performing the function for which they were created, and/or the lack of communications services support, the devices may become obsolete prior to failing due to "wear out."

The above references present estimates for smart meter lifetimes in the range of 5 to 15 years (with 10 years being a good median value). The values come from a number of reputable sources, including industry experts, consumer organizations, utility consultants, and even utility managers when speaking outside the realm of large utility companies attempting to justify smart meter deployments as part of CBAs. Notably absent from the quotes above are smart meter manufacturers. Before I proceed further to demonstrate why smart meter useful lifetimes are likely less than 15 to 20 years, let me first attempt to show why many utility companies tend to assign the higher values.

The Apparent Basis for 15 to 20 Year Smart Meter Useful Lifetime Numbers

One can partially deduce the origin of optimistic smart meter useful lifetime values from a recent August 2018 ruling by the Public Service Commission for the Commonwealth of Kentucky where the PSC denied the companys' request to deploy smart meters. The utility companies substantiated a 20-year service life value with a two-word email from the manufacturer stating "20 years." From the Order:

> "[T]he **Commission is not persuaded by the Companies' assertion that the meters have a 20-year service life**. The Companies' only evidence to support a 20-year service life of the Landis+Gyr meters is a **two-word email** from a sales representative that indicates a service life of '20 years'. … The Companies offered no further evidence, explanation, or support for a 20-year service life."
>
> "Last, it appears that the Companies applied an **expanded service life** in order to create a cost-benefit scenario favorable to their proposal. Even assuming all of the Companies' other calculations and assumptions are accurate, the **AMS proposal results in a net cost to customers if the meter service life is less than 20 years**." [30]

As we can see, the utility companies based their estimated smart meter useful life solely upon the word of the selected meter manufacturer Landis+Gyr. There is also an implication by the PSC that the utility companies may have purposely applied a 20 year value because it was the only way to arrive at favorable result as part of a cost benefit analysis.

In general, the basis for the more optimistic assigned values of 15 to 20 years for smart meter useful lifetimes is apparently the following:

- Utility reliance on manufacturer claims that smart meters should have useful lifetimes between 15 to 20 years or more.
- A bias towards wanting to rely on optimistic lifetime values in order to arrive at favorable results as part of cost benefit analyses (CBAs).
- A willful or naïve bias towards ignoring fundamental differences between traditional analog utility meters and solid state metering that introduce additional factors which reduce the *actual* useful lifetimes, namely, security risks and technology obsolescence.
- "Echo chamber" bias where current utility CBAs often reference smart meter lifetime values from past CBAs and represent them as "typical" even though they are unproven. Please note, for example, the reference by Ameren Illinois as mentioned in the Introduction to this article where Ameren references "Duke Energy, Southern California Edison, DTE, and PG&E to base its AMI deployment on a useful life of 20 years for the AMI meter." [2]

Before addressing manufacturer claims on smart meter useful lifetimes, I want to first address one outlier document where two researchers created a catchy title for a paper

presented at a 2001 conference in Asia, entitled, “Exceeding 60-Year Life Expectancy from an Electronic Energy Meter.” [31]

I wouldn’t normally give this paper the time of day, but a vice president for a utility company participating in the recent Kentucky utility rate case (mentioned above) referenced this single study as part of his testimony to help create the impression that smart meters must have useful lifetimes of at least 20 years or more, stating:

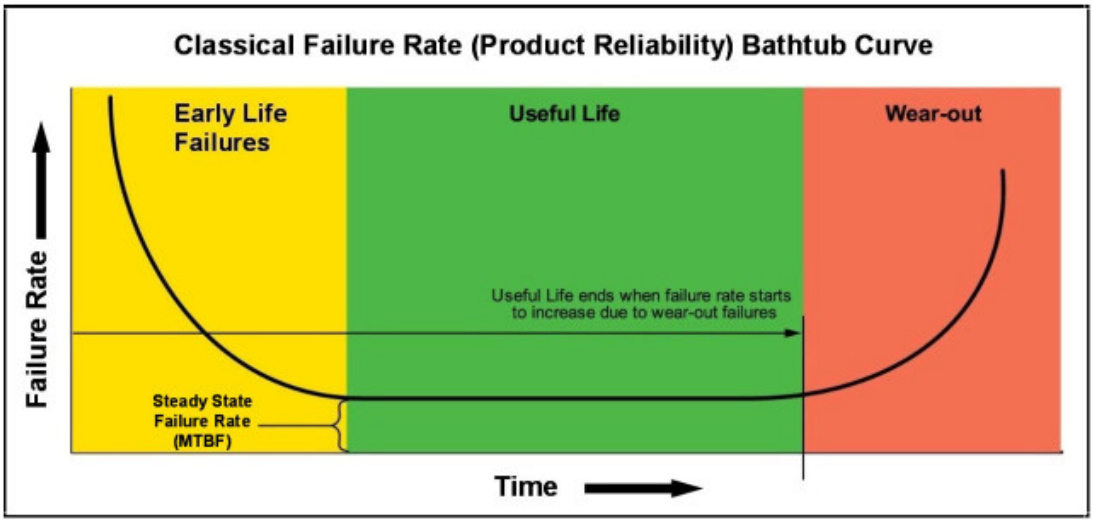
> “In addition, at least one study has suggested than an energy measurement integrated circuit in an AMR meter could have a service life 60 years.” [32]

This “one study” stated that *one component* of an electronic utility meter, “an energy measurement IC” [integrated circuit], had sufficiently passed a “high temperature operational lifetest” to be able to achieve a 60-year life expectancy. Although this finding may be interesting to some, the paper itself recognized that the life expectancy of the meter itself (not one component) is a function of the life expectancy of each component in the meter as well as the overall design. The paper merely hypothesized that the results of testing this one component “brings us another step closer to accepting electronic energy meters as the energy meter of the future.” I find it disingenuous and deceptive that someone would reference this single study in a utility rate proceeding.

Classical Failure Rates and the Bathtub Curve

Now let me proceed to discuss how smart meter manufacturers attempt to justify estimated smart meter lifetimes in the range of 15 to 20 years. As stated above, the utility companies typically rely on the claims of meter manufacturers for estimated useful lifetime values in order to develop their CBAs.

Reliability engineers model equipment failures with a bathtub shaped curve as shown. There are early life failures that may be due to poor installation or quality control issues; there is a steady state region of the curve where you have relatively constant random failures; finally, there is a point where “wear-outs” begin to occur at an ever-increasing rate signaling the end of the useful life of the device.



In the area of the bathtub curve where you have a relatively low rate of failures is where manufacturer testing concentrates its efforts to determine the duration of this period of time. Manufacturers perform accelerated life testing (ALT) and deliberately operate a product at an elevated stress condition so that failures can be induced more quickly as compared to waiting for years to observe how a product performs in the field. Stress conditions normally include high and low temperatures as well as temperature cycling, vibration tests, voltage extremes, etc. [5]

In analyzing the data from accelerated testing, engineers typically calculate a quantity called MTBF, or "Mean Time Between Failures." [33] Such is the case for Itron in responding to a question from Fortis BC in Canada pertaining to its OpenWay CENTRON meters in 2012. Refer to the letter/email from Itron that states the following:

> "In response to your query regarding the expected life of the OpenWay CENTRON meters, the expected life is 20 years.
>
> Also, MTBF, or mean time between failure, is a basic measure of a system's reliability. It is typically calculated as the inverse of the failure rate and is represented in units of hours. The higher the MTBF number is, the higher the reliability of the product. The annual failure rate for the OpenWay CENTRON meter is 0.5% for 20 years. Therefore, the MTBF is calculated as 1/0.005 = 200 years or 1,752,000 hours." [34]

Before we analyze whether this type of claim is representative of the ***actual*** useful life of a smart meter, let us look at one more example. As part of Southern California Edison's cost benefit analysis for smart meters in 2006, it touted having performed its own accelerated testing of ***one*** "simple" solid state meter:

> "SCE recently completed accelerated life testing on one solid state simple kilowatt hour meter. The meter went through thermal shock and thermal cycle (-50c to +100c) for 80 days. This translates to well over 20-year life using generally accepted useful life modeling procedures." [35]

Personally, I am not impressed with test results from ***one*** solid state meter that may not even be a "smart meter" that would contain an embedded communication module. Yet Ameren Illinois used this same information several years later as part of its own CBA:

> "Moreover, Southern California Edison conducted product testing that concluded that the meter useful life would be 20 years or more. … [footnoted] SCE Cost Benefit Analysis, Vol 3., December 21, 2006." [2]

In summary, the smart meter useful life values for most utility companies are based upon classical reliability analysis that models mechanical failure rates induced by accelerated life testing. From my analysis I saw no evidence that these values address security risks and technology obsolescence. In addition, there is some question whether the classical testing process adequately addresses communication chips and other accessory components of a smart meter such as LCD displays, weather seals, etc. Certainly communication-related equipment is not normally assigned a 15 to 20 year useful life in other industries.

Evidence for the expected shortened lifetime for communication components is not hard to find. For example, as previously quoted in this article, Frontier Economics stated:

> "All the manufacturers indicated smart meter design lives of 20 years. However they placed a caveat on this around the life of the **communications components**, which they indicated **may have a shorter life**." [26]

According to the *New York's Utility Project*, an initiative of the Public Utility Law Project of New York:

> "**Our experience of computing and communications equipment makes us very concerned that utilities have expectations for reliability that are unfounded**. Limited data on AMI meters confirms our concerns. … legacy meters need repair rarely – so rarely that managers do not even monitor their reliability. Yet new devices based on digital technology with electronic circuit boards, wireless links and many similarities to consumer electronics are widely assumed to be equally durable. We are already monitoring many similar devices and have data showing very poor levels of reliability relative to meters. There is no compelling evidence to believe that the weatherproof versions of computers and communications equipment are going to be more reliable than their interior counterparts." [12]

Security Risks and Technology Obsolescence

We have seen in this article that utility companies primarily base their estimated useful lifetime values on classical reliability analysis taking into account random equipment failures revealed as a result of accelerated life testing. There is some indication the results of such testing may not fully take into account all relevant components of a smart meter, but the results may still meet industry norms for such testing.

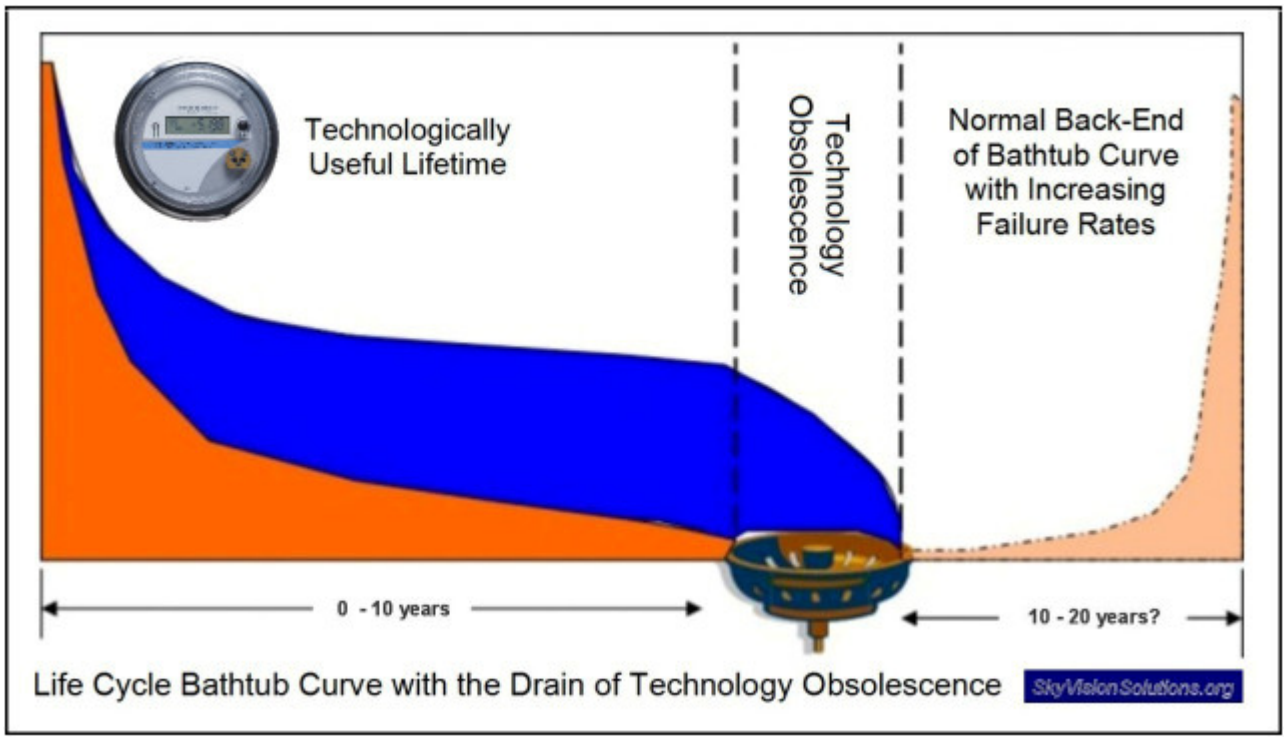
More prominently, however, what utility personnel conveniently ignore is that the *actual* useful life for a smart meter is strongly influenced by other factors such as security risks and technology obsolescence.

Let me now more concisely define "technology obsolescence." *Technology obsolescence* is the loss of value for an asset to perform its function based on the need to substitute one technology for a newer technology. [4]

In some cases the transition to a newer technology may result from a *desire* for more functionality, but the transition may also be *required* due to the lack of technical or logistical support for the older technology. A recent example for smart meters was that some AMI meters deployed within the last few years were dependent on 2G cellular technology. With the phase-out of that technology, the utility is forced to replace the meters with a different technology that is still supported. [29] Such an issue did not arise with traditional analog meters due to the simplicity of design that was not dependent on communications support.

Technology obsolescence and classical mortality factors determine the *actual* useful life of a smart meter, and they do so simultaneously. Therefore, both should be taken into account. Ignoring technology obsolescence and only considering classical failure rates will result in a gross overstatement of the useful life of a smart meter. [36]

In order to better illustrate the influence of technology obsolescence on the useful life of a smart meter as compared to the classical bathtub curve used by meter manufacturers and reliability engineers, refer to the figure that shows a bathtub curve with a "drain." The drain is located at the point in time that electronic components need to be replaced or other factors such as communication support is no longer available for the smart meter. Because of the technology obsolescence "drain," the back-end of the bathtub curve may be a relatively small contributor to the overall costs associated with meter failures. [37]



Security Risks

Security risks could be considered a subset of technology obsolescence, but I considered them a serious enough issue to mention separately. Due to the inclusion of remote disconnects in most smart meters deployed today, a hacking into the AMI system could result in widespread blackouts and catastrophic consequences. I have written a number of articles covering this issue with one of the latest being "Smart Meter Cyber Attacks: A Clear and Present Danger," [38]

My article [7] in October 2015 regarding a possible smart meter life of 5 to 7 years was based upon one utility executive's testimony at a Congressional hearing regarding *cybersecurity* for power systems. The context of the testimony was clear that

cybersecurity threats have the ability to shorten the useful life of a smart meter as compared to the classical bathtub curve where end-of-life is solely dependent on wear-out failure rates. How could a cyber threat affect the useful life of a smart meter? All it would take is a serious cybersecurity threat being identified that could not be resolved through an "over-the-air" firmware update.

According to Maxim Integrated:

> "The threats to secure smart meters are varied and evolving. Consequently, there is no single, ultimate solution to security concerns involving electricity networks. Any robust smart meter security strategy must be equipped to deal with threats as they evolve." [39]

According to a published paper on "Identifying the Cyber Attack Surface of the Advanced Metering Infrastructure":

> "[D]eploying such a large number of devices … means that hardware will remain constant for long periods of time. **This contributes to a long lifetime for vulnerabilities even once known, since upgrades are difficult or limited in scope.**"
>
> "Therefore, the compromise of even a single smart meter through focused attack or reverse engineering potentially provides access to the AMI network as a whole. … This, coupled with the extensive use of multiple wireless technologies and geographic dispersion, results in an attack surface of unprecedented scale." [40]

The hope on the part of utility companies would be that over-the-air firmware updates would be able to successfully address security threats as they arise. To some extent this may be true, but it is uncertain. The use of over-the-air updates may extend the useful life of a smart meter beyond the 5 to 7 year time frame but probably not much past the ten-year point.

Analysis and Conclusions

Meter manufacturers and most utility companies attempting to justify large-scale smart meter deployments claim useful life values in the range of 15 to 20 years. These values are generally based upon the results of classical reliability analyses which are in turn dependent on determining when equipment failures begin to occur at increasing rates signifying end-of-life "wear-out" of the equipment.

Those individuals and groups who acknowledge that electronic equipment lifetimes are heavily influenced by security issues and technology obsolescence typically forecast much shorter useful lifetimes for smart meters, anywhere from 5 to 15 years with 10 years being a good median value.

It would seem that utility companies ignore such factors as technology obsolescence due to bias, including wanting to use the higher lifetime values to more easily justify meter deployments, and "echo chamber" bias where one utility uses the same values as another peer utility had done in the past.

There is also the possibility that utility companies truly don't understand the fundamental differences between legacy meters and smart meters since it is not objectively credible that useful lifetime values for advanced meters would be solely based upon classical failures rates documented by meter manufacturers. In that regard, it is hoped that this article can shed some light on this most important issue.

In short, utility companies need to do a better job of considering security issues and technology obsolescence and how these factors shorten the estimated useful lifetimes of smart meters. Public utility commissions also need to better educate themselves on these issues, so they don't improperly approve meter deployments that are in fact not reasonable or cost-effective.

Based upon the information and evidence presented in this article, it is clear that security issues and technology obsolescence reduce the estimated useful lifetimes of smart meters as compared to solely considering classical reliability analysis.

It is recommended that useful life values for smart electric meters not be assigned values exceeding 10 years. Utility companies planning to deploy smart meters in the future should adjust their project plans and CBAs accordingly. At the very least, utility companies should be required to specifically identify how their estimated useful lifetime assumptions used in cost benefit analyses have addressed the effects of security issues and technology obsolescence.

References and Notes

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[1] The "useful life" for a piece of equipment or for a device can be defined as the estimated period of time over which an asset may be reliably used for the purpose intended. The determination of the useful lifetime value can be correlated with an associated depreciation schedule; however, for tax purposes, assets are sometimes allowed to have shorter depreciation times than the values used in the initial business case analysis. [4]

- For example, regarding depreciation schedules, an IRS Memorandum [42] issued in 2012 acknowledges the technological nature of smart meters as "information systems" and would appear to allow utilities to depreciate certain types of smart meters in the U.S. over a period of 5 years for tax purposes. This type of information supports a claim that smart meters likely have useful lifetimes less than 15 to 20 years but does not prove it technically. For business case purposes the true benefit period for a device does not always match its tax depreciation schedule. In some cases governments allow accelerated depreciation schedules as

> a form of tax incentive for businesses to invest in equipment deemed desirable to support government policy objectives.

The "useful life" values as used in this article refer to "smart meters" commonly deployed today that include 2-way data communications enabled by a processor embedded into the meter electronic circuit board (ECB), frequent meter reads that are time stamped, remote disconnect, net metering, and support for applications such as outage notification. These are the meters that are likely to have useful lifetimes in the neighborhood of ten (10) years as concluded in this article based upon the evidence presented. Earlier solid state meters that may only include one-way communications, i.e., AMRs, and meters with limited functionality, likely have longer useful lifetimes, possibly as high as 15 years. [43]

[2] Ameren Illinois Advanced Metering Infrastructure (AMI) Cost/ Benefit Analysis, June 2012; available at https://skyvisionsolutions.files.wordpress.com/2017/01/ameren-ex-3-1-ami-cost-benefit-analysis.pdf

[3] Refer to the linked document/table for a summary of useful smart meter lifetimes as mentioned in various utility-related documents worldwide. This information substantiates the assertion that most utilities tend to claim that smart meters have a useful life of 15 to 20 years:
https://skyvisionsolutions.files.wordpress.com/2018/09/summary-of-smart-meter-useful-life-values.pdf

[4] "The AMI Investment Decision and Lifetimes," by Jin Reilly, June 2008, at https://www.metering.com/the-ami-investment-decision-12636/, where it states: "Traditionally, meters were depreciated over 30 years."

[5] "Accelerated Life Testing of Electronic Revenue Meters," by Venkata Chaluvadi, *All Theses*, 2008, Paper 470; available at http://tigerprints.clemson.edu/all_theses/470/; specifically refer to page 6 where it states: "Traditionally electricity has been measured by the use of electromechanical meters. Such meters have a proven track record of lasting over 40 years in the field, and are not prone to catastrophic failures." Also refer to page 104 where it states: "However, the reliability of electronic components has been a concern and many experts believe that the electronic meters will not survive as long as their electromechanical predecessors."

[6] "Congressional Testimony: Smart meters have a life of 5 to 7 years," SkyVision Solutions Blog Article, October 2015, at https://smartgridawareness.org/2015/10/29/smart-meters-have-life-of-5-to-7-years/, where in Congressional testimony smart meters are compared to traditional analog meters: "They [smart meters] don't have the life of an existing meter which is 20 to 30 years."

[7] "Congressional Testimony: Smart meters have a life of 5 to 7 years," SkyVision Solutions Blog Article, October 2015, at https://smartgridawareness.org/2015/10/29/smart-meters-have-life-of-5-to-7-years/

[8] Ontario Auditor General 2014 Report on the Smart Metering Initiative, available for review at https://skyvisionsolutions.files.wordpress.com/2015/09/ontario-ministry-of-energy-smart-meter-initiative-audit-report.pdf

[9] "GB Smart Metering no longer financially viable," by Nick Hunn of *Creative Connectivity*, August 1, 2018, at http://www.nickhunn.com/gb-smart-metering-no-longer-financially-viable/

[10] "Protecting and Empowering Consumers in Future Smart Energy Markets," BEUC Position Paper, 2013; available at https://skyvisionsolutions.files.wordpress.com/2018/09/beuc-position-paper-on-smart-energy-markets-2013.pdf

[11] "Dan Lewis: Smart meters are a bad deal for consumers," November 22, 2015, at http://www.conservativehome.com/platform/2015/11/dan-lewis-smart-meters-are-a-bad-deal-for-consumers.html

[12] "Will Smart Meters Pass The Test of Time?," November 24, 2009, at http://pulpnetwork.blogspot.com/2009/11/will-smart-meters-pass-test-of-time.html

[13] "Responding to EPAct 2005: Looking at Smart Meters for Electricity, Time-Based Rate Structures, and Net Metering," Edison Electric Institute, May 2006; available at https://skyvisionsolutions.files.wordpress.com/2018/09/eei-responding-to-epact-2005.pdf

[14] "Realizing the Full Potential of Smart Metering," by Accenture, 2013, at https://www.accenture.com/t20160413T230144__w__/us-en/_acnmedia/Accenture/Conversion-Assets/DotCom/Documents/Global/PDF/Industries_9/Accenture-Smart-Metering-Report-Digitally-Enabled-Grid.pdf

[15] Report for the "Northeast Smart Grid Peer-to-Peer Workshop," July 18-19, 2011, Essex Junction, Vermont; report available at https://www.smartgrid.gov/files/Northeast_Regional_Report.pdf

[16] From the International Electrotechnical Commission (IEC) Strategic Business Plan for Electrical Energy Measurement and Control, 2015, at https://www.iec.ch/public/miscfiles/sbp/13.pdf

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[18] "The Evolving Digital Utility: The convergence of energy and IT," by Lynda O'Malley, August 2014, at https://www.marsdd.com/news-and-insights/the-evolving-digital-utility/

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[21] Training Developments Scotland webpage at http://www.trainingdevelopments-scotland.co.uk/smart-meter-training.php

[22] “Beyond Deployment of Smart Meter Maintenance, Repair, and Replacement, August 10, 2010, at https://www.energycentral.com/c/iu/beyond-deployment-smart-meter-maintenance-repair-and-replacement

[23] “Smart Meter Initiative,” Notes from the Cost Considerations Working Group for the Ontario Energy Board, 2004; document available at https://www.oeb.ca/documents/sm_cost_considerations_wrkgr_051104.pdf

[24] “Not too clever: will Smart Meters be the next Government IT Disaster?,” by Dan Lewis and Jamie Kerr, Institute of Directors, 2014; document available at https://skyvisionsolutions.files.wordpress.com/2018/09/smart-meters-not-too-clever-iod-2014-report.pdf

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[26] “Research into the costs of smart meters for electricity and gas DSOs,” by Frontier Economics, September 2008; report available at https://skyvisionsolutions.files.wordpress.com/2018/09/frontier-research-into-costs-of-smart-meters-2008.pdf

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[28] Final Order for New Mexico NMPRC Case No. 15-00312-UT, April 11, 2018; available at https://skyvisionsolutions.files.wordpress.com/2018/09/nm-prc-final-order-on-pnm-case-15-00312-ut.pdf

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[37] "Why the Drain in the Bathtub Curve Matters," May 23, 2012, at http://nomtbf.com/2012/05/the-drain-in-the-bathtub-curve/

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[39] "Ensuring the Complete Life-Cycle Security of Smart Meters," Application Note 5631, at https://www.maximintegrated.com/en/app-notes/index.mvp/id/5631

[40] "Identifying the Cyber Attack Surface of the Advanced Metering Infrastructure," by Foreman and Gurugubelli, *The Electricity Journal*; Volume 28, Issue 1, January–February 2015, pp 94–103; available at http://www.sciencedirect.com/science/article/pii/S1040619014002899

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- Note that the above document by Dr. Scott is undated but is believed to have been written in 2009 based upon the information at https://www.smart-energy.com/regional-news/north-america/u-s-stimulus-plan-smart-grid-funding-should-focus-on-smart-metering/

[42] IRS Taxpayer Advice Memorandum 201244015, issued November 2, 2012, at https://www.irs.gov/pub/irs-wd/1244015.pdf

[43] "Smart Metering – What Now?," Presentation by Howard A. Scott, Ph.D. of Cognyst Advisors, October 2009; document available at https://wp.me/a3nav9-4bY

Note that the above presentation contains slides with the following information:

- "Expected lifetime of meters is 10 years" (page 57 of 98)
- "Smart Metering capabilities will gradually evolve; equipment placed today may have to be replaced in 5-10 years" (page 90 of 98)

[44] Original website posting of published article is located at: "Security Risks and Technology Obsolescence Reduce Smart Meter Expected Lifetimes," SkyVision Solutions Blog Article, September 2018 at https://smartgridawareness.org/2018/09/25/technology-obsolescence-reduces-smart-meter-lifetimes/

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