BEFORE THE
PUBLIC SERVICE COMMISSION
OF WISCONSIN

Application of Wisconsin Public Service Corporation for its System Modernization and Reliability Project — 6690-CE-198

PRE-FILED SUR-SUR-REBUTTAL TESTIMONY OF

LAWRENCE KAUFMANN

FOR
WISCONSIN PUBLIC SERVICE CORPORATION

May 6, 2013

INTRODUCTION

Q. Please state your name and business address.

A. My name is Lawrence Kaufmann. My business address is 22 East Mifflin Street, Suite 302, Madison, Wisconsin 53703.

Q. Are you the same Dr. Kaufmann who provided rebuttal testimony in this proceeding?

A. Yes.

Q. What is the purpose of your sur-sur-rebutal testimony?

A. The purpose of my testimony is to respond to the sur-rebuttal testimony of Mr. Richard Hahn, on behalf of the Citizens' Utility Board (CUB), regarding my estimate of the potential economic benefits to ratepayers associated with the System Modernization and Reliability Project (SMRP) proposed by Wisconsin Public Service Corporation (WPS).

Q. Does Mr. Hahn address the mathematical procedure you use to estimate the value of reliability improvements that will result from the SMRP?

A. No. My rebuttal testimony provides a detailed explanation of the process I use to estimate the value of reliability improvements from the SMRP to WPS customers. Mr. Hahn's testimony does not object to the mathematical procedure that I use for developing this valuation. He does, however, address two related points in my analysis: (1) my estimate of how much a residential customer would be willing to pay (WTP), per event, to avoid a one-hour outage; and (2) my conclusion (Rebuttal-WPS-Kaufmann-8) that "the benefits generated because of the SMRP will certainly exceed the total costs of the program within 20 years, which is less than half of the 60-year expected life of the assets to be installed under the program."

Q: What is your estimate of how much a residential customer would be willing to pay, per event, to avoid a one-hour outage?

A. I estimate that, in 2002 dollars, residential customers would be willing to pay $6.90 to avoid a one-hour outage. Because of price inflation between 2002 and 2012, this is equivalent to $8.88 in 2012 dollars.

Q. What is the purpose of this estimate in your analysis?

A. This estimate is used as a proxy for the value of reliability to all customers on the WPS system. Residential customers' WTP is used as a proxy because the value of service to commercial and industrial customers can vary substantially across economic sectors, and developing a highly-tailored estimate of the value of reliability that reflected WPS's actual customer mix would be very resource intensive exercise. However, commercial and industrial customers almost always value reliable power supplies more highly than residential customers. Using an estimate of residential customers' WTP for reliability improvements therefore produces a very conservative estimate of the value of reliability for all customers on the WPS system and,

accordingly, a very conservative estimate of the economic value of the SMRP (Rebuttal-WPS-Kaufmann, 4-5).

Q. What was the basis for this estimate?

A. This estimate was drawn directly from a study conducted by the Lawrence Berkeley National Laboratory (LBL) that I provide as Exhibit WPS-Kaufmann-1.

Q. How does Mr. Hahn characterize your estimate of residential customers' willingness to pay to avoid outages?

A. Mr. Hahn says that I arbitrarily chose data from the LBL study as the basis for my estimate of WPS customers' WTP (Surrebuttal-CUB-Hahn-7).

Q. Is there any merit to this claim?

A. No. In fact, Mr. Hahn arbitrarily cherry-picks data and quotes from the LBL study rather than consider the study in its totality. An objective assessment of the LBL report confirms that I "selected an appropriate, but conservative, estimate of the value of unserved energy (per kWh) for customers on the WPS system" (Rebuttal-WPS-Kaufmann-3).

Q. Why does Mr. Hahn say your estimate of the value of reliability was "arbitrarily chosen"?

A. Mr. Hahn says my estimate "relied upon a simple average of the underlying dataset rather than the (LBL) study's actual estimate of outage costs." Furthermore, he says "the study warns of the raw dataset" as a preface to quoting two sentences from the LBL report that discuss variability in customers' reported WTP (Surrebuttal-CUB-Hahn-7).

However, Mr. Hahn does not mention the two sentences in the report that immediately follow the sentences he uses to support the claim that my estimate of the value of service is "arbitrarily chosen." Those sentences read:

> The two most robust estimates (of the value of reliability) for duration are the 1-hour and 4-hour as these two scenarios were used in multiple studies across multiple regions. The average cost per event for a 1-hour using a WTP methodology is $6.90, and the average for a 4-hour is $7.14, suggesting only a modest impact of duration on residential customers' willingness to pay to avoid an outage.

The sentences that Mr. Hahn quotes therefore precede, and lead up to, two estimates of the value of reliability that the LBL authors find to be "most robust." By immediately directing the reader to the "most robust" reliability estimates after discussing the variability in WTP results, the LBL authors are clearly indicating that these estimates are least susceptible to the concerns that Mr. Hahn cites. One of these estimates is residential customers' WTP $6.90 to avoid a one-hour outage. This is the estimate I use to develop a proxy for the value of unserved energy for all customers on the WPS system.

By taking two sentences from the LBL study out of context, Mr. Hahn makes it appear as if the LBL authors warn against using my recommended estimate of $6.90 for a one-hour outage event because of variability in customers' WTP estimates. However, the authors actually say that my recommended value of $6.90 for a one-hour outage is robust across a wide range of outage scenarios. This is essentially the opposite of the impression that Mr. Hahn's testimony creates by quoting selectively from the LBL report rather than presenting its findings objectively.

Q. Does Mr. Hahn's testimony say whether other estimates of the value of reliability can be "more robust" than your recommended estimate?

A. Yes. Mr. Hahn says that "(i)n datasets such as this one that are skewed by outliers (evidenced by the large standard deviations mentioned in the quote above), the median can be a more robust descriptor that the average" (Surrebuttal-CUB-Hahn, 7-8).

Q. Does Mr. Hahn cite any passages in the LBL study that support this claim?

A. No. In fact, the sentences I reference above undermine Mr. Hahn's claim. The LBL authors specifically cite residential customers' average WTP of $6.90 to avoid a one-hour outage as one of the two most robust estimates of the value of reliability to residential customers. The authors therefore mention averages (i.e. sample means) rather than medians as being relatively more robust in their study.

Q. Is it true that datasets that have large standard errors will be "skewed by outliers," as Mr. Hahn says?

A. Not necessarily. "Outlier" observations in a sample can be one source of high standard errors, but they are not the only source. A dataset can be characterized by high standard errors even when sample data are distributed evenly around the sample mean, as in a classic "bell curve" distribution. Unless Mr. Hahn has undertaken a detailed examination of the underlying sample data of every study that is integrated into the LBL report, he has no basis for concluding that the LBL dataset is "skewed by outliers."

Q. Are there any other reasons why an average rather than median estimate of the value of reliability should be used to estimate the value of unserved energy for WPS customers?

A. Yes. SAIDI is by definition a measure of the average duration of outages experienced by customers on the WPS system. WPS is also measuring the reliability improvement from the SMRP program in terms of its impact on SAIDI. The

reduction in SAIDI from the SMRP will therefore measure the average reduction in unserved energy for a customer on the WPS system.

My rebuttal testimony calculated the value of the SMRP as the product of the reduction in unserved energy (in kWh) from the SMRP and the value of reliability (in $ per kWh). The first term in this computation is measured using changes in SAIDI, or a change in average reliability. It would not be mathematically or logically consistent to multiply this reduction in the average duration of outages by the median value of reliability. However, this is what Mr. Hahn appears to be suggesting.

Q. Does Mr. Hahn make any other points regarding your estimate of the value of reliability?

A. Yes. Mr. Hahn says that by relying on estimates for a one-hour outage, my estimate of the value reliability "ignores the non-linear cost of outages observed in the LBL study. In other words, the study finds that the value placed on lost service increases less as the duration of outage duration increases" (Surrebuttal-CUB-Hahn-8) Mr. Hahn suggests that if I used residential customers' WTP to avoid a 4-hour outage rather than a 1-hour outage, my estimated outage cost per kWh would be about 75% lower.

Q. The LBL study says two estimates of residential customers' value of reliability are most robust: their reported willingness to pay to avoid a 1-hour outage, and their reported willingness to pay to avoid a 4-hour outage. Did you consider using the residential customers' reported WTP to avoid a 4-hour outage to proxy the value of reliability for WPS customers?

A. Yes, but I concluded that this estimate was less appropriate than residential customers' WTP to avoid a one-hour outage.

Q. Please explain.

A. It must be remembered that the residential customers' WTP estimate is used to proxy the value of reliability for all customers on the WPS system. While most of WPS's customers are residential, residential customers will account for a much smaller share of kWh sales than customer numbers. In 2012, WPS actually sold more kWh in Wisconsin to small commercial and industrial customers (3.921 billion kWh) than to residential customers (2.844 billion kWh) (Rebuttal-WPS-Kaufmann-3). The SMRP will substantially reduce unserved energy for commercial as well as residential customers, so the value of service to non-residential customers must be considered when selecting an appropriate estimate for the value of reliability and computing the economic benefits from the SMRP.

The LBL report presents a great deal of evidence on the value of reliability to non-residential customers. These estimates vary by economic sector and when outages occur. Compared to residential customers, however, the LBL reports shows that the value of reliability to non-residential customers is much higher, and this valuation is more sensitive to whether outages last for one hour or four hours.

The most relevant evidence on this point is summarized in Figure 4-4 on page 32 of the LBL report. This figure presents information on estimated outage costs for small to medium commercial and industrial (C&I) customers for different outage durations and at different times for power interruptions. Nearly all the non-residential customers who will benefit from improved reliability because of the SMRP are either small or medium-sized commercial customers.

Figure 4-4 shows that the outage costs for an average small-medium C&I customer will be approximately $1200 for a one-hour summer afternoon outage and $1800 for a one-hour winter afternoon outage. The mean outage cost for an average small-medium C&I customer is therefore approximately $1500. This compares to a

$6.90 value of avoiding a one-hour outage for an average residential customer. The LBL report therefore estimates that, for a one hour outage, the valuation of reliability for an average small-medium C&I customer will be over 200 times greater than that of an average residential customer.

Figure 4-4 also shows that outage costs increase as outage durations increase from one to four hours. The costs to average small-medium C&I customers will be approximately $2900 for a one-hour summer afternoon outage and $4100 for a one-hour winter afternoon outage. The mean outage cost for an average small-medium C&I customer is therefore approximately $3500. For small C&I customers, the outage costs for a four-hour outage are therefore about 2.33 times as high as for a one-hour outage (i.e. 3500/1500 = 2.33).

The increase in outage costs between one and four hours is very different for residential customers. The LBL report says residential customers' WTP to avoid a one-hour outage is $6.90 and their WTP to avoid a four-hour outage is $7.14. The residential valuation for reliability is therefore almost completely "flat" between outages of one and four hours. Because residential customers' WTP is relatively insensitive to outage duration, if the four-hour WTP estimate is used to proxy the value of unserved energy to all customers, the estimated outage cost would decline substantially, as Mr. Hahn says.

However, this would not be reasonable since valuation of the SMRP requires a proxy for the value of reliability for residential and non-residential customers on the WPS system. Mr. Hahn's criticism about "non-linear" outage costs ignores the fact that non-residential customers' estimated value of reliability is not flat when outage durations increase from one to four hours. He also ignores the enormous differential in the value of reliability between residential and non-residential customers. To

determine a proxy for the value of reliability improvements for all customers who will be impacted by the SMRP, it would not be reasonable to take the value of a one-hour outage for one customer group only (residential customers) and reduce this estimate by 75% simply because the average duration of outages for WPS customers has exceeded one hour. This is another example of Mr. Hahn cherry-picking from the LBL report rather than considering the report in its totality.

When the entire LBL report is assessed objectively, it is clear that it does not support the opinion that the value of unserved energy on the WPS system would decline by 75% if outage durations increase from one to four hours. It is also clear that a $6.90 estimate for the value of a one-hour outage for an average customer on the WPS system is quite conservative. When I prepared my rebuttal testimony, I was aware that, according to the LBL report, the value of reliability for small-medium C&I customers is more than 200 times greater than my recommended estimate. Nevertheless, since time and resource constraints did not allow me to develop an estimate of the value of reliability that was tailored to WPS's actual mix of customers, I recommended the $6.90 valuation (in 2002 dollars) for a one-hour outage event since this estimate has a solid foundation in a report from a respected institution and is a reasonable, but conservative, proxy for the value of reliability for WPS customers.

Q. Does Mr. Hahn agree with your conclusion that "the benefits generated because of the SMRP will certainly exceed the total costs of the program within 20 years, which is less than half of the 60-year expected life of the assets to be installed under the program?"

A. In one scenario, yes, he does. When Mr. Hahn accepts my estimate of the value of unserved energy of $12.22 per kWh, he calculates that the SMRP has a payback

period of 17 years. However, Mr. Hahn also examines two other scenarios which he claims are more reasonable, and he says that in these scenarios the project does "not even come close to a payback within the 60 year asset life." He also says that the value for unserved energy would have to be at least $8.11 per kWh for the SMRP to break even (Surrebuttal-CUB-Hahn-9).

Q. Should the Commission give any weight to Mr. Hahn's "payback analysis"?

A. No. Mr. Hahn does not provide any details on how he calculated benefits under his payback scenarios. He simply makes a number of assertions that are unverifiable (given the information provided in his surrebuttal testimony) and which I believe are inaccurate.

Q. What is the basis for this opinion?

A. I have developed several estimates of the net present value (NPV) of benefits from the SMRP by adapting formulas that I have previously used in testimony on the NPV of earnings, medical expenses, or both, in employment-related litigation cases. I considered five different NPV valuation and/or project payback scenarios. In all cases, I assumed that price inflation would average 2% over the 60-year life of the assets installed in the SMRP. This is well within the recent historical experience of the US, although it is relatively conservative. More rapid inflation would increase the valuation of the SMRP and reduce its payback period.

I also assumed a "discount rate" of 4%. This discount rate represents the time value of money, and in NPV calculations should reflect the rate of return that an average investor can earn by following a conservative investment strategy. I used discount rates near 4% in several NPV calculations several years ago, and while I have retained that estimate in these simulations it is probably somewhat high at the present time given current interest rates on US Treasury bonds. If I lowered the

discount rate, it would increase the NPV of estimated benefits and reduce the payback period of the SMRP. I also assumed that the SMRP would be completed in 2019 and computed benefits over the 60-year planned life of the assets installed under the program.

I evaluated five scenarios, as follows:

1. The Base Case: an estimate of the NPV of reliability benefits from the SMRP in excess of costs using my estimated value of unserved energy of $12.22/kWh.
2. The Base Case plus Maintenance Savings: an estimate of the NPV of both reliability benefits and reductions in WPS maintenance costs under the program; I assumed these savings would be $537,000 in 2019 and grow in line with inflation in subsequent years.
3. "Break Even" Case 1: this analysis solves for the value of unserved energy per kWh that would allow the NPV of reliability benefits of the SMRP to just equal the costs of the SMRP over the 60-year life of the assets. This scenario assumes that kWh for WPS grow by 1% a year, which I believe is conservative.
4. "Break Even" Case 2: this analysis solves for the value of unserved energy per kWh that would allow the NPV of reliability benefits of the SMRP to just equal the costs of the SMRP over the 60-year life of the assets. This scenario assumes that kWh for WPS grow by 1.5% a year. This case is somewhat less conservative, but I believe it is also reasonable.
5. "Break Even" Case 3: this analysis solves for the value of unserved energy per kWh that would allow the NPV of reliability benefits of the

SMRP and maintenance savings to just equal the costs of the SMRP over the 60-year life of the assets. This scenario assumes that kWh for WPS grow by 1.5% a year.

These analyses are provided as Exhibit-WPS-Kaufmann-2.

Q. What are results of your analyses?

A. In the base case, using my estimate of the value of unserved energy of $12.22 per kWh (in 2019 dollars), I estimate that the SMRP will create a NPV of $766 million of reliability-related benefits for WPS customers. This represents $543 million NPV in excess of the $222.6 million cost of the program. I also estimate that the reliability-related benefits would lead the SMRP to recoup its costs in 2033, or in year 15 of the program.

I also estimate that the NPV of maintenance savings under the program will be $15.2 million. When these savings are added to the NPV of reliability benefits, I estimate that the NPV of total value created by the SMRP is $781 million, or $558 million more than the cost of the program. When maintenance savings are considered, I estimate that the SMRP will recoup its costs in 2032, or in year 14 of the program.

In Break-Even Case 1, the SMRP would recoup its costs over the 60-year life of the program if the critical value of unserved energy was at least $3.55/kWh in 2019 dollars. When kWh grow somewhat more rapidly in Break-Even Case 2, the critical value for unserved energy falls to $3.10/kWh in 2019 dollars. When the benefits of reduced maintenance costs are also considered in Break-Even Case 3, the critical value of unserved energy falls further to $2.89/kWh.

Q. Can you express these "critical" values for unserved energy, which are just sufficient to allow the SMRP to break even, in terms of how much customers must be willing to pay to avoid a one-hour outage?

A. Yes. These values can be easily computed. Under Break-Even Case 1, the SMRP would pay for itself as long as the average WPS customer would be willing to pay $2.01 in 2002 to avoid a one-hour outage. This is equivalent to paying $2.58 to avoid a one-hour outage in 2012.

Under Break-Even Case 2, the SMRP would pay for itself as long as the average WPS customer would be willing to pay $1.75 in 2002 to avoid a one-hour outage or, equivalently, $2.25 to avoid a one-hour outage in 2012.

Under Break-Even Case 3, the SMRP would pay for itself as long as the average WPS customer would be willing to pay $1.63 in 2002 to avoid a one-hour outage or, equivalently, $2.08 to avoid a one-hour outage in 2012.

Q. What do you conclude from these results?

A. There is no basis for Mr. Hahn's claim that the value of unserved energy must be at least $8.11 per kWh for the SMRP to pay for itself. This estimate is unsupported and inaccurate. My analysis shows that the SMRP will pay for itself as long as the critical values of unserved energy are between $2.89/kWh and $3.55/kWh, in 2019 dollars. These critical values will be attained as long as the average residential and commercial customer on the WPS system is willing to spend $2.58 to avoid a one-hour outage.

Q. Mr. Hahn has suggested that the SMRP be implemented over 10 years instead of five years. How would that affect the NPV of the project's benefits?

A. Delaying the implementation of the SMRP would reduce benefits to customers. If the project's implementation was extended to 10 years, customers would receive some of

the benefits later. Because there is a time value of money, this would reduce the project's benefits to customers.

Q. Does this conclude your testimony?

A. Yes.