BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF COLORADO

* * * * *

IN THE MATTER OF THE APPLICATION OF
PUBLIC SERVICE COMPANY OF COLORADO
FOR APPROVAL OF A NUMBER OF
STRATEGIC ISSUES RELATING TO
ITS DSM PLAN, INCLUDING MODIFIED
ELECTRIC ENERGY SAVINGS AND DEMAND
REDUCTION GOALS, AND REVISED
INCENTIVES FOR THE PERIOD 2015
THROUGH TO 2020; FOR APPROVAL OF A
DISTRIBUTION VOLTAGE OPTIMIZATION
PROGRAM TOGETHER WITH COST
RECOVERY AND INCENTIVES, AN LED
STREET LIGHTING PRODUCT AND
APPROVAL TO INCLUDE BEHAVIORAL
CHANGE PRODUCTS IN THE COMPANY’S
DSM PORTFOLIO AND OF THE
METHODOLOGY TO BE USED TO MEASURE
SAVINGS FROM SUCH PRODUCTS; AND
FOR COMMISSION GUIDANCE REGARDING
THE FACTORS TO BE CONSIDERED AND
APPROPRIATE LEVEL OF THE COMPANY’S
GAS DSM PROGRAM IN THE FUTURE.

DOCKET NO. 13A-0686EG

DIRECT TESTIMONY AND EXHIBITS OF KELLY BLOCH

ON

BEHALF OF

PUBLIC SERVICE COMPANY OF COLORADO

JUNE 17, 2013
IN THE MATTER OF THE APPLICATION OF
PUBLIC SERVICE COMPANY OF COLORADO
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BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF COLORADO

*I* * * *

IN THE MATTER OF THE APPLICATION OF PUBLIC SERVICE COMPANY OF COLORADO
FOR APPROVAL OF A NUMBER OF STRATEGIC ISSUES RELATING TO ITS DSM PLAN, INCLUDING MODIFIED ELECTRIC ENERGY SAVINGS AND DEMAND REDUCTION GOALS, AND REVISED INCENTIVES FOR THE PERIOD 2015 THROUGH 2020; FOR APPROVAL OF A DISTRIBUTION VOLTAGE OPTIMIZATION PROGRAM TOGETHER WITH COST RECOVERY AND INCENTIVES, AN LED STREET LIGHTING PRODUCT AND APPROVAL TO INCLUDE BEHAVIORAL CHANGE PRODUCTS IN THE COMPANY’S DSM PORTFOLIO AND OF THE METHODOLOGY TO BE USED TO MEASURE SAVINGS FROM SUCH PRODUCTS; AND FOR COMMISSION GUIDANCE REGARDING THE FACTORS TO BE CONSIDERED AND APPROPRIATE LEVEL OF THE COMPANY’S GAS DSM PROGRAM IN THE FUTURE.

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DIRECT TESTIMONY AND EXHIBITS OF KELLY BLOCH

I. INTRODUCTION

Q. PLEASE STATE YOUR NAME AND BUSINESS ADDRESS.

A. My name is Kelly Bloch. My business address is 1123 W. 3rd Ave Denver, CO 80223.
Q. BY WHOM ARE YOU EMPLOYED AND IN WHAT POSITION?
A. I am employed by Xcel Energy Services, Inc., a wholly-owned subsidiary of Xcel Energy Inc., the parent company of Public Service Company of Colorado. My job title is Manager Distribution System Planning and Strategy South.

Q. ON WHOSE BEHALF ARE YOU TESTIFYING IN THE PROCEEDING?
A. I am testifying on behalf of Public Service Company of Colorado ("Public Service" or the "Company").

Q. HAVE YOU INCLUDED A DESCRIPTION OF YOUR QUALIFICATIONS, DUTIES, AND RESPONSIBILITIES?
A. Yes. A description of my qualifications, duties, and responsibilities is included as Attachment A.

II. PURPOSE OF FILING

Q. WHAT IS THE PURPOSE OF YOUR DIRECT TESTIMONY?
A. The purpose of my testimony is to discuss what the Distribution Voltage Optimization ("DVO") project is, why we believe it will reduce both demand and energy use for customers as well as system losses, what our proposed implementation plan is, and how we will verify the resulting savings.
III. DESCRIPTION OF DVO

Q. WHAT ARE THE PRESENT OPERATING CHARACTERISTICS OF THE DISTRIBUTION SYSTEM REGARDING VOLTAGE?

A. Historically, utilities have controlled voltage on the distribution system by regulating the voltage at the substation so that all voltage points along the feeder, or distribution circuit, are maintained within established standards such as ANSI standard C84.1-1995; which translates to 120 V +/- 5 percent for residential customers. The determination of the voltage required at the substation is done through modeling of peak load conditions, including switching under emergency outage conditions.

Regulating voltage in the present manner means that a customer near the substation receives a higher voltage (although still within permissible limits) than one at the end of the feeder. Further, because the voltage is not constantly monitored throughout the feeder, the substation relies on models or measurements at the substation to regulate the voltage. Although this current operation process works well and allows us to provide safe and reliable service at a reasonable cost, it results in a system that is often operating at a higher voltage than what is required.

Q. HOW DOES DVO CHANGE THE OPERATING CHARACTERISTICICS OF THE DISTRIBUTION SYSTEM?

A. DVO also referred to as Integrated Volt VAr Optimization (“IVVO”) changes the way that power factor and voltage are managed on the distribution system. This is done by utilizing: system monitoring; centralized control of
distribution devices; and, two way communications. By monitoring the voltage along the feeder in a near-real time fashion the utility is able to control the voltage for the current operating conditions, not just the peak conditions. Providing the customer only the voltage they need results in reduced system demand, lower energy consumption at the customer level, and lower system losses.

Q. HOW DOES DVO WORK?

A. DVO is an advanced application that runs continually or in response to operator demand and can be run in three different operating modes:

The first is VAr optimization, which is used to improve the power factor on the distribution system and results in loss savings. Power factor is an electric term that relates to the efficiency of the delivery of energy to customers. For any conductor in a distribution network, the current flowing through it can be broken down into two components – active and reactive. Reactive power does not do real work but uses the current carrying capacity of the distribution lines and equipments, and contributes to the power loss. Reactive power compensation devices (such as capacitors) are designed to reduce or eliminate the unproductive component of the current, reducing current magnitude – and thus energy losses. VAr optimization turns the capacitors installed along the distribution circuit on and off in an optimal manner to limit the reactive power flowing on the distribution system. This improves the efficiency of the system and reduces system losses.
The second operating mode is demand reduction, where the utility operates DVO only at peak load periods or under emergency situations. The DVO application, combined with two-way communication infrastructure, sensing, and remote control capability for capacitor banks and voltage regulating transformers, allows the utility to optimize the energy delivery efficiency on distribution systems using real-time information.

The third operating mode is voltage optimization. This leverages the relationship between voltage and power consumption. Lowering voltage results in a lowering of instantaneous demand and energy consumption for many household devices. Voltage optimization can be done to achieve two different objectives: targeted demand reduction; or, overall energy consumption reduction. When the goal is energy reduction, DVO is normally operated year round.

What we are proposing in this filing is to run a voltage optimization program year round to reduce overall energy consumption.

Q. **HOW DOES THE TECHNOLOGY OPTIMIZE VOLTAGE?**

A. Voltage optimization is accomplished by flattening the voltage profile along the feeder, or in other words, narrowing the bandwidth of the voltage from the head-end of the feeder to the tail-end in concert with capacitors and voltage regulators for voltage support. As discussed earlier, DVO changes traditional voltage control. In the proposed operating model, voltage is monitored along the feeder and at select end points allowing the head-end voltage to be lowered significantly most of the year. This new model establishes an
operating environment that optimizes the voltage allowing devices to run more efficiently thus reducing customers’ energy consumption and demand.

Q. HOW EXACTLY DOES DVO REDUCE A CUSTOMER’S ENERGY CONSUMPTION?

A. Flattening the voltage profile along a feeder and operating in the lower range of 114V to 120V, reduces energy consumption for certain devices. The industry term used to describe operating in the lower voltage range is Conservation Voltage Reduction (“CVR”). Studies have shown that the CVR benefit varies with the load type and feeder characteristics.

One example of how DVO will result in savings is incandescent lighting, where the power consumed is directly proportional to the voltage. A 70W incandescent light bulb will consume around 77W at 126V and around 66W at 114V. Another example is motors, such as those found in air conditioners, dryers and refrigerators. Some motors operate more efficiently in this lower voltage range (114V to 120V). Higher voltage (120V to 126V) generates more heat that makes these motors less efficient. One of the main objectives of DVO, is so these types of devices are operating in the lower voltage range making them more energy efficient.

Q. DOES THE COMPANY HAVE ANY EXPERIENCE WITH DVO?

A. Yes. Public Service Company of Colorado has experience with DVO from its two DVO pilots and through participation in the Electric Power Research Institute’s (“EPRI”) Green Circuits program. DVO has been tested on two of the Company’s substations, the National Center for Atmospheric Research
(“NCAR”) substation and the Englewood substation. The NCAR substation pilot, which included two feeders, was done in conjunction with the Smart Grid City pilot and was chosen to be one of the DVO pilots EPRI monitored and evaluated as part of their Green Circuits program. The results from that pilot found that the voltage can be lowered on average about 2.5 percent. The corresponding energy savings as calculated by EPRI, using their statistical modeling were about 2.5 percent in 2011\(^1\). The results of the NCAR pilot were higher than the nation-wide average for the field trials in the EPRI Green Circuits study. The results from the field trials with other utilities showed an energy reduction range of 1.6-2.7 percent. The Company has presented the implementation and results of the NCAR pilot as part of the Smart Grid City docket (Docket Number 11A-1001E). In his testimony that was filed in that docket Company testimony Lynn L. Worrell discussed this pilot. That testimony is attached to my testimony as Exhibit No. KB-1. In addition, I have attached the full Green Circuits Report from EPRI to my testimony as Exhibit No. KB-2.

In that same Smart Grid City docket, we reference our other pilot at our Englewood substation. Results from the Englewood pilot have been very good, and show a voltage reduction of 1.5 percent and a CVR factor\(^2\) of 1.7 in

\(^{1}\) More detail on this can be found in the EPRI Green circuits report which is attached to this testimony as Exhibit 2 or found on EPRI’s website: [http://www.epri.com/abstracts/Pages/ProductAbstract.aspx?ProductId=000000000001023518](http://www.epri.com/abstracts/Pages/ProductAbstract.aspx?ProductId=000000000001023518)

\(^{2}\) CVR factor is defined and discussed in the following response to the question: Are results available from other utilities?
2011 and 2.7 in 2012, which would result in estimated savings of 2.55 percent in 2011 and 4.05 percent in 2012.\(^3\)

Q. **ARE RESULTS AVAILABLE FROM OTHER UTILITIES?**

A. Yes, many results have been published. The Department of Energy has reported in their December 2012 study\(^4\) that reducing feeder voltage reduces energy consumption proportionately. The proportionality constant, shown below, is called the CVR factor ("CVRf"). A CVRf of one indicates that a one percent reduction in voltage corresponds to a one percent reduction in energy consumption.

\[
\text{CVRf} = \frac{\Delta E(\%)}{\Delta V(\%)}
\]

The CVR factor can vary depending on the type of load connected to the feeder. Studies conducted by utilities in different parts of the country have shown that CVR factors between 0.7 and 1.0 are common.

Q. **WHAT ARE THE BENEFITS OF DVO FOR THE CUSTOMER AND COMPANY AS PROVEN THROUGH THESE PILOTS?**

A. Through the implementation of DVO, customers will benefit by reducing their usage and demand, which will in turn lower their bills. Customers will receive this benefit without having to take any action or make any investment. The only noticeable changes this will bring to our customers is a reduction of their energy usage and therefore a reduction of their energy bill. Using the results

\(^3\) These level of savings are not expected or forecasted for Public Service’s proposed DVO project since they have an unreliably wide confidence interval.

of our two pilots along with data from other industry studies, we are assuming,
with a tight confidence interval, that this DVO project will provide a system-
wide CVR factor of 0.8 and a voltage reduction of 2.5 percent. This will result
in energy savings of two percent. Because of required maintenance and field
switching that occurs during the normal operation of the grid, there will be
times when the system will not operate optimally or it must be disabled due to
maintenance activities up to ten percent of the time. Our expected net benefit
of a 1.8 percent energy reduction takes these factors into account.

As discussed earlier, in addition to reduced energy consumption and
lower rates for our customers, DVO offers benefits to the Company. Reduced
demand will lead to the deferred capital expenditures and improved capital
asset utilization. Energy efficiency will reduce electricity generation and
reduced emissions. Voltage optimization will also help facilitate the integration
of distributed generation, energy from renewable resources, energy storage,
and other distributed energy resources through the use of sensors.

In addition, the use of capacitors to flatten the voltage profile and
improve the power factor which will reduce line losses and result in system
savings. The line losses are a very small component of the overall savings.
With this proposed DVO project, we are not planning on taking credit for
these line losses and system benefits. We only propose to claim the energy
savings and demand savings realized by our customers. For more details on
how we propose to claim these customer energy savings, please refer to
section VII in the Direct Testimony from Ms. Debra L. Sundin.
Q. HOW DOES DVO IMPACT RESIDENTIAL, COMMERCIAL & INDUSTRIAL, AND TRANSMISSION CUSTOMERS?

A. The program will be applied to distribution substations and feeders serving residential, commercial, and industrial customers. These customers will benefit from lower energy consumption and demand as a result of reduced voltage. Transmission customers served from Public Service owned substations can choose to make an investment to install voltage sensing equipment at their site which will allow us to optimize the voltage supplied to them. If they choose to participate, these customers will also see a benefit from lower consumption and demand as a result of reduced voltage. In light of the fact that transmission customers are required to proactively opt in to the program and purchase upfront equipment, they have been excluded from our savings estimates.

IV. DVO IMPLEMENTATION

Q. WHAT IS THE PROPOSED TIMELINE AND IMPLEMENTATION PLAN FOR THE DVO PROJECT?

A. The DVO project will begin in the fall of 2014 with the selection of software, project planning and the ordering of equipment. The project will begin implementation in the field and will come online starting in 2015. Full implementation is expected to be completed by mid 2020, although the five year implementation or spending schedule may need to be adjusted to meet capital budget requirements. In addition, some service areas may be excluded from DVO if savings cannot be achieved in a cost effective manner.
Q. HOW MUCH IS DVO ESTIMATED TO COST EACH YEAR AND IN TOTAL?

A. The estimated distribution cost of the projects is approximately $18.4 million annually for five years for a total estimate of $92 million. As discussed above, the level of investment may vary within the five years depending on the availability of capital funding. Details of how we propose to recover these costs can be found in Mr. Brockett’s testimony.

Q. WHAT IS THE COST BREAKDOWN FOR THE $92 MILLION ESTIMATE?

A. The estimated $92 million total cost includes $58 million for installation of distribution equipment which will control the voltage and provide near real-time feedback, $11.5 million for distribution upgrades to limit voltage drop on the system, $3.5 million to purchase the DVO application and associated hardware, and $19 million for the two-way communications system.

Q. WHAT ARE THE ESTIMATED SAVINGS FOR THE DVO PROJECT?

A. As stated in Table 4 of Ms. Sundin’s testimony and in Table 1 below, it is estimated that DVO will save roughly 506 GWh and 56 MW over the five-year term of the project. DVO will begin to achieve savings in the second half of 2015 and will continue to bring in savings through the first half of 2020. Below is a table showing estimated annual savings. The actual savings could vary from year to year depending on the timing of implementation as described in the previous discussion regarding costs of DVO.
### Table 1: DVO Annual Savings Forecasts

<table>
<thead>
<tr>
<th>Year</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Energy Savings (GWh)</strong></td>
<td>50</td>
<td>101</td>
<td>101</td>
<td>102</td>
<td>102</td>
<td>51</td>
<td>506</td>
</tr>
<tr>
<td><strong>Demand Savings (MW)</strong></td>
<td>5</td>
<td>11</td>
<td>11</td>
<td>11</td>
<td>11</td>
<td>6</td>
<td>56*</td>
</tr>
</tbody>
</table>

* Total doesn’t match sum of all years due to rounding

These energy savings estimates (MWh) were developed using the Public Service system-wide CVR factor of 0.8 and an expected voltage reduction of 2.5 percent as supported by our previous DVO pilots and other industry studies. As explained earlier in this testimony, this will result in energy savings of two percent \((2.5 \times 0.8 = 2)\) but because of required maintenance and field switching we lowered that savings estimate to a 1.8 percent energy reduction. The 1.8 percent energy reduction was then applied to our forecasted retail sales, excluding transmission customers’ sales, to get to the annual forecasted GWh savings. The estimated demand savings (MW) were developed based on results from our pilot projects during system peak load. The voltage reduction at system peak will be lower than the average annual reduction. We saw approximately 1.4 percent lower voltage which results in a demand reduction of 1.1 percent \((1.4 \times 0.8 = 1.1)\) as with the energy savings due to required maintenance and field switching we lowered the savings to 1 percent \((1.1 \times 0.9 = 1)\).

For more information on how we plan to claim these savings towards our energy efficiency energy savings and demand savings goals, please refer to Ms. Sundin’s testimony.
V. MEASUREMENT AND VERIFICATION

Q. ARE THERE ANY CHALLENGES ASSOCIATED WITH MEASUREMENT AND VERIFICATION OF THE BENEFITS OF DVO?
A. Yes. Determining the benefits would be relatively simple if feeder loading and operating conditions were very consistent from day to day. If loading and operating conditions were identical each day, it would be a simple matter to apply DVO for a day and then compare the day’s result to with the previous day. Unfortunately the electrical conditions of every feeder can vary significantly from day to day due to environmental conditions (temperature, humidity etc.), societal issues (public events etc.), and technology/commercial issues (production schedules, manufacturing changes).

Q. WHAT METHODS HAVE BEEN USED IN THE INDUSTRY TO VERIFY SAVINGS?
A. There are two main methods that have been used in the industry for measurement and verification of DVO. The first is a model based approach typically referred to as the power flow based method. It calculates savings using a real-time power flow engine which estimates what would have occurred on the system if DVO was not implemented. It then compares the actual system measurements with DVO running with the simulated baseline model to calculate and verify the reduction. The advantage of this approach is that it allows the system to run continually. The disadvantage is that the power flow requires a load-voltage sensitivity (CVR factor) that isn’t known until the analysis is complete.
The second method involves day-on/day-off or week-on/week-off testing. This approach has been adopted by several utilities in the past along with research organizations such as EPRI. This approach involves running DVO for a short period of time (day or week) then turning it off for a similar period of time. This process is continued for a significant period of time (up to one year) and then the results are analyzed using statistics to determine the benefit. Because changes in load are impacted by more than just DVO, as we have discussed already, it is not a simple matter of comparing the two results. The EPRI statistical method involves using a statistically “similar” feeder to determine “what would have happened”. Both of these approaches are described in great detail in the attached EPRI report.

Q. WHAT METHOD OF MEASUREMENT AND VERIFICATION WAS USED DURING THE PILOT PROJECTS?

A. During the DVO pilot projects we verified the demand and energy savings in two ways. First, we conducted DVO week-on/week-off tests with EPRI to verify the demand and energy savings using EPRI’s statistical models. We also verified savings through the DVO Software Platform used in our pilot projects, which had a measurement and verification engine that calculated the demand and energy savings based on a power flow model. We compared the results of both methods. Initial results were close but over the longer period of time we have found the results to vary by approximately 40 percent.
Q. WHAT IS THE MEASUREMENT AND VERIFICATION PLAN THE COMPANY IS PROPOSING FOR THE DVO PROJECT?

A. We believe operating the fully deployed program in a week-on/week-off method using the EPRI statistical method is not practical as it is too disruptive and would reduce savings substantially. For the DVO project, we propose using the power flow based method that can continuously calculate the savings. We will use the EPRI results of our historical pilots to help refine the appropriate CVR factor. We will then apply that CVR factor the actual usage data by substation to calculate the savings for each substation where DVO is implemented.

V. CONCLUSION

Q. PLEASE SUMMARIZE YOUR TESTIMONY.

A. Distribution Voltage Optimization changes the way that power factor and voltage are managed on the distribution system. Voltage Optimization is accomplished by flattening the voltage profile along the feeder—that is, narrowing the bandwidth of the voltage from the head-end of the feeder to the tail-end in concert with capacitors and voltage regulators for voltage support. Through the implementation of DVO, customers will use less energy and will also have a reduction in demand. In addition, the company will see a reduction in distribution line losses. Reduced demand will lead to the deferred capital expenditures and improved capital asset utilization. Energy
efficiency will reduce the electricity generated and thus emissions which should help keep rates low.

The Company has some experience with DVO with SGC and through participation in the Electric Power Research Institute’s Green Circuits program. The results from the SGC pilot found that the voltage can be lowered on average about 2.5 percent. The corresponding energy savings as calculated by EPRI for the NCAR pilot were about 2.5 percent in 2011; this translates to a CVR factor of 1.0. Studies conducted by utilities in different parts of the country have shown that CVR factors between 0.7 and 1.0 are common. We have assumed an average CVR factor of 0.8 across the Public Service system.

Determining the actual benefits that are being achieved through voltage optimization is challenging. There are two main methods that have been used for measurement and verification of Voltage Optimization in the industry. As the large scale project rolls out, we plan to utilize the measurement and verification engine in our software program to verify the savings on a continual basis.

Q. DOES THIS CONCLUDE YOUR TESTIMONY?

A. Yes, it does.
Attachment A

Statement of Qualifications

Kelly Bloch

Kelly Bloch is the Manager of Distribution System Planning and Strategy, for Xcel Energy South. Kelly’s role is to provide strategic direction for the expansion and modernization of the distribution system for Xcel Energy to ensure a safe, reliable, and cost effective distribution system. Key responsibilities include 5 year distribution infrastructure planning, load forecasting, capital budget creation, distribution project management, system modernization and renewal strategy, and management of the current year capital budget for Public Service Company of Colorado and Southwest Public Service Company.

Kelly has 22 years of experience in the utility industry where she has compiled a diverse background. She joined Public Service Company of Colorado in 1991 and has served in various engineering roles in the four operating companies at Xcel Energy, Manager of Capacity Planning for Xcel Energy and Distribution Planning for Public Service, in addition to her current role.

Kelly graduated from South Dakota State University in December of 1989 where she earned a Bachelor of Science degree in Electrical Engineering.