

**BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF COLORADO**

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IN THE MATTER OF ADVICE NO. 1828-)
ELECTRIC OF PUBLIC SERVICE)
COMPANY OF COLORADO TO REVISE)
ITS COLORADO P.U.C. NO. 8 - ELECTRIC) PROCEEDING NO. 20AL-XXXXE
TARIFF TO IMPLEMENT AN ADVANCED)
GRID RIDER TO BE EFFECTIVE ON)
AUGUST 17, 2020)

DIRECT TESTIMONY AND ATTACHMENTS OF WENDALL A. REIMER

ON

BEHALF OF

PUBLIC SERVICE COMPANY OF COLORADO

July 17, 2020

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PUBLIC Attachment WAR-4	Public Version of Advanced Metering Infrastructure ("AMI") Head-End Request for Proposal ("RFP") Results
HIGHLY CONFIDENTIAL Attachment WAR-5	Highly Confidential Version of Advanced Distribution Management System ("ADMS") RFP Results
PUBLIC Attachment WAR-5	Public Version of Advanced Distribution Management System ("ADMS") RFP Results
HIGHLY CONFIDENTIAL Attachment WAR-6	Highly Confidential Version of Field Area Network ("FAN") RFP Results
PUBLIC Attachment WAR-6	Public Version of Field Area Network ("FAN") RFP Results

GLOSSARY OF ACRONYMS AND DEFINED TERMS

<u>Acronym/Defined Term</u>	<u>Meaning</u>
ADMS	Advanced Distribution Management System
AGIS	Advanced Grid Intelligence and Security
AGIS CPCN Proceeding	Proceeding No. 16A-0588E
AGIS CPCN Settlement	Unopposed Comprehensive Settlement Agreement approved in Proceeding No. 16A-0588E
AMI	Advanced Metering Infrastructure
AMR	Automated Meter Reading
Business Systems	Business Systems Business Area
CPCN	Certificate of Public Convenience and Necessity
CPCN Projects	AMI, IVVO, and the components of the FAN that support these components
CPE	Customer Premise Equipment
CRS	Customer Resource System
DERs	Distributed Energy Resources
Distribution	Distribution Business Area
ENGO	Edge of Network Grid Optimization
EPRI	Electric Power Research Institute
ESB	Enterprise Service Bus
FAN	Field Area Network
FCC	Federal Communications Commission
FERC	Federal Energy Regulatory Commission
FLISR	Fault Location Isolation and System Restoration
FLP	Fault Location Prediction
GB CMD	Green Button Connect My Data

<u>Acronym/Defined Term</u>	<u>Meaning</u>
GEMS	Grid Edge Management System
GIS	Geospatial Information Systems
HAN	Home Area Network
HAN Proceeding	Proceeding No. 18A-0194E
ICCP	Inter-Control Center Communications Protocol
IT	Information Technology
IVVO	Integrated Volt-VAr Optimization
kW	Kilowatt
kWh	Kilowatt Hours
LBNL	Lawrence Berkeley National Laboratory
LTCs	Load Tap Changers
MDM	Meter Data Management
MDMS	Meter Data Management System
NIC	Network Interface Cards
Non-CPCN Projects	ADMS, FLISR, FLP and APT projects, and the non-CPCN FAN, that were undertaken as ordinary course of business
O&M	Operations and Maintenance
OMS	Outage Management System
Public Service	Public Service Company of Colorado
RFP	Request for Proposal
ROW	Right of Way
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
SCADA	Supervisory Control and Data Acquisition

<u>Acronym/Defined Term</u>	<u>Meaning</u>
SMS	Sensor Management System
SVC	Secondary Static VAr Compensators
VAr	Volt-Ampere reactive
WAN	Wide Area Network
WiMAX	Worldwide Interoperability for Microwave Access
WiSUN	Wireless Smart Utility Network
Xcel Energy	Xcel Energy, Inc.
XES	Xcel Energy Services Inc.

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DIRECT TESTIMONY AND ATTACHMENTS OF WENDALL A. REIMER

**I. INTRODUCTION, QUALIFICATIONS, PURPOSE OF TESTIMONY, AND
RECOMMENDATIONS**

Q. PLEASE STATE YOUR NAME AND BUSINESS ADDRESS.

A. My name is Wendall A. Reimer. My business address is 3115 Centre Pointe Drive,
St. Paul, MN 55113.

Q. BY WHOM ARE YOU EMPLOYED AND IN WHAT POSITION?

A. I am employed by Xcel Energy Services Inc. ("XES") as a Director, Advanced Grid
Intelligence and Security ("AGIS") Portfolio Delivery. XES is a wholly-owned
subsidiary of Xcel Energy Inc. ("Xcel Energy") and provides an array of support
services to Public Service Company of Colorado ("Public Service" or "Company") and
the other utility operating company subsidiaries of Xcel Energy on a coordinated
basis.

Q. ON WHOSE BEHALF ARE YOU TESTIFYING IN THE PROCEEDING?

A. I am testifying on behalf of Public Service.

1 **Q. PLEASE SUMMARIZE YOUR RESPONSIBILITIES AND QUALIFICATIONS.**

2 A. My current responsibilities include overseeing and directing various aspects of the
3 AGIS technical solutions, from design through run state for each of Xcel Energy's
4 operating companies. My current focus is on head-end systems and network
5 solutions. I also serve as a primary representative from the Business Systems
6 Business Area to the regulatory teams within Xcel Energy's operating companies. A
7 description of my qualifications, duties, and responsibilities is set forth in my
8 Statement of Qualifications at the conclusion of my Direct Testimony.

9 **Q. WHAT IS THE PURPOSE OF YOUR DIRECT TESTIMONY?**

10 A. The purpose of my Direct Testimony is to support the Company's request for
11 Business Systems' capital and operations and maintenance ("O&M") cost recovery
12 for the AGIS initiative through establishment of a rider mechanism. To support this
13 request, I explain and support the Company's proposed implementation of, and
14 capital and O&M forecasts for, the Business Systems' components of the AGIS
15 initiative. Company witness Mr. Steven P. Berman discusses the policy aspects of
16 the AGIS initiative for this rider filing, and Company witness Mr. Chad S. Nickell
17 provides an overview of the AGIS initiative and supports the Distribution Business
18 Area's implementation of the AGIS projects.

19 Since the Company previously received a Certificate of Public Convenience
20 and Necessity ("CPCN") for certain components of the AGIS initiative in Proceeding
21 No. 16A-0588E, and further discussed other components in the Company's 2019
22 Public Service Phase I Electric Rate Case (Proceeding No. 19AL-0268E) ("2019
23 Electric Rate Case"), I provide updated information for the foundational components

1 of the AGIS initiative, which include the Advanced Metering Infrastructure (“AMI”);
2 Advanced Distribution Management System (“ADMS”), including the Geospatial
3 Information System (“GIS”); Intelligent Field Devices that include Integrated Volt-VAR
4 Optimization (“IVVO”), Fault Location Isolation and Service Restoration (“FLISR”),
5 including Fault Location Prediction (“FLP”), the Field Area Network (“FAN”); and the
6 Advanced Planning Tool (“APT”).¹ Additionally, my Direct Testimony supports the
7 prudence of the Business Systems costs related to both the CPCN projects (AMI,
8 IVVO, and the associated mesh network portion of the FAN), as well as the overall
9 prudence of the non-CPCN projects (ADMS, FLISR, FLP, the private network portion
10 of the FAN, and the APT) that are planned at this time, and the prudence of the
11 Company’s current and ongoing implementation of all foundational components of
12 the AGIS initiative.

13 I also support the current Business Systems’ capital and O&M forecasts for all
14 foundational components of the AGIS initiative through 2025, when implementation
15 of these foundational components is expected to be complete. Overall, my Direct
16 Testimony is intended to support the Company’s request for cost recovery for these
17 projects through the new Advanced Grid Rider (“AGR”) Mr. Berman proposes in his
18 Direct Testimony.

¹ APT is included in the “other” budget category in the tables presented in my testimony.

1 **Q. HOW IS THE TECHNICAL DISCUSSION OF THE AMI PROJECT DIVIDED**
2 **BETWEEN YOUR BUSINESS SYSTEMS' TESTIMONY AND MR. NICKELL'S**
3 **DISTRIBUTION TESTIMONY?**

4 A. Since most of the benefits of the AGIS initiative reside at the Distribution level and
5 the initiative supports the distribution system, Mr. Nickell provides the project
6 overview and discusses the integration of benefits into the overall forecasts. As I
7 previously noted, I focus on the Business Systems or Information Technology ("IT")
8 integration necessary to implement these projects. However, some components of
9 the AGIS initiative – like ADMS, the AMI head-end system and Home Area Network
10 ("HAN") capabilities, and the FAN private network – are primarily Business Systems
11 efforts. Where Business Systems has primary responsibility for a project, I describe
12 the development of that project's forecast, and discuss the Business Systems' capital
13 and O&M forecasts. Where the Distribution Business Area has primary responsibility
14 for the project's implementation, I defer to Mr. Nickell, as set forth in Table WAR-D-1
15 below.

Table WAR-D-1: AGIS Program Witness Support

AGIS Project	Component	Witness
AMI	IT Integration and AMI head-end application	Reimer Direct, Section III
	Meters and deployment	Nickell Direct, Section IV
ADMS	ADMS system and integration	Reimer Direct, Section IV
	GIS	Nickell Direct, Section V
FAN	IT Integration and deployment	Reimer Direct, Section VIII
	Installation of pole-mounted devices	Nickell Direct, Section VIII
FLISR	System development	Reimer Direct, Section VI
	Advanced application and field devices	Nickell Direct, Section VII
IVVO	System development	Reimer Direct, Section V
	Advanced application and field devices	Nickell Direct, Section VI
APT	System development	Reimer Direct, Section VII
	Advanced application	Nickell Direct, Section IX

1 **Q. ARE YOU SPONSORING ANY ATTACHMENTS AS PART OF YOUR DIRECT**
 2 **TESTIMONY?**

3 A. Yes, I am sponsoring Attachments WAR-1 through WAR-6, which were prepared by
 4 me or under my direct supervision. The attachments are as follows:

- 5 • Attachment WAR-1: Business Systems AGIS Capital Additions for 2019-2025;
- 6 • Attachment WAR-2: Business Systems AGIS Operations and Maintenance
 7 (“O&M”) Expenses by Cost Element for 2020-2025;
- 8 • Attachment WAR-3: Business Systems AGIS O&M Expenses by Federal Energy
 9 Regulatory Commission (“FERC”) Account for 2020-2025;

- 1 • Highly Confidential Attachment WAR-4 and Public Attachment WAR-4: highly
2 confidential and public versions, respectively of the AMI Head-End Request for
3 Proposal (“RFP”) Results;
- 4 • Highly Confidential Attachment WAR-5 and Public Attachment WAR-5: highly
5 confidential and public versions, respectively of the ADMS RFP Results; and
- 6 • Highly Confidential Attachment WAR-6 and Public Attachment WAR-6: highly
7 confidential and public versions respectively of the FAN RFP Results.

1 **II. OVERVIEW OF BUSINESS SYSTEMS' TESTIMONY**

2 **A. Business Systems' Role in AGIS**

3 **Q. PLEASE DESCRIBE THE AGIS INITIATIVE AND BUSINESS SYSTEMS' ROLE IN**
4 **PROVIDING SUPPORT FOR AGIS IN THIS PROCEEDING.**

5 A. The Company's AGIS initiative involves the following foundational projects: ADMS,
6 including the GIS, AMI, the FAN, IVVO, FLISR, FLP, and APT. Each of these projects
7 involves a coordinated approach – i.e., planning, design, build, deployment and
8 ongoing support from Business Systems and Distribution. Extensive IT integration is
9 needed to support these new technologies. Mr. Nickell provides an overview of the
10 AGIS initiative and supports the Company's overall technical strategy for AGIS and
11 the Distribution Business Area's AGIS implementation. I provide support for the IT
12 integration necessary to carry out the AGIS initiative.

13 **Q. WHAT WORK HAS BUSINESS SYSTEMS ALREADY UNDERTAKEN IN**
14 **COLORADO WITH RESPECT TO THE AGIS INITIATIVE?**

15 A. As previously noted, the Company previously obtained a CPCN for the CPCN
16 Projects in 2017. Before and after the CPCN was obtained, Business Systems has
17 been working toward implementation of the various components of the AGIS
18 initiative. Public Service has undertaken scoping, planning, design, RFP, and
19 contracting with respect to a number of the AGIS components.

20 Further, Public Service is already deploying and operating some components
21 and facets of the AGIS initiative. For example, the first deployment phase of ADMS
22 was placed in service in April 2019 with the second, and final deployment planned
23 for the fourth quarter of 2020. Public Service has also deployed IVVO field devices

1 and 13,000 AMI meters and is utilizing the FAN to support AMI and IVVO. Public
2 Service is utilizing the AMI interfaces to provide customers who have AMI meters
3 with valuable information on their energy use. In the coming years, the Company will
4 continue to deploy the FAN and AMI, continue to add capabilities and functionality to
5 AMI thru interfaces and customer systems to deliver more value to customers. Public
6 Service has also started to deploy FLISR and FLP devices on some of the lower
7 performing feeders within the service territory and those devices have begun to be
8 used to generate reliability benefits for customers.

9 Ultimately, implementing the AGIS initiative is a partnership between multiple
10 areas within Public Service and across Xcel Energy, with the primary responsibility
11 falling within the Distribution and Business Systems Business Areas.

12 **Q. PLEASE INTRODUCE THE WORK THAT IS REQUIRED OF BUSINESS**
13 **SYSTEMS TO SUPPORT THE AGIS INITIATIVE.**

14 A. Overall, Business Systems is responsible for the IT integration of AGIS systems and
15 data with other back office applications existing at the Company. For example,
16 Business Systems is implementing the FAN that allows intelligent field devices,
17 ADMS, AMI, and other systems to connect and communicate. From the AMI head-
18 end, a combination of new or enhanced interfaces will be built to transfer the data to
19 other applications, such as ADMS, the meter data management system, the billing
20 and customer resource system, and the asset inventory management system.

21 Implementing AGIS will require the various interfaces to transfer large volumes
22 of data in a small amount of time. Public Service is also obtaining significantly more
23 data from the field devices than we have in the past. This additional data will require

1 additional space for storage and a data management plan to ensure Public Service
2 is keeping the necessary data only for as long as it is needed. The new software,
3 additional server hardware, and increase in quantity of data stored will all need to be
4 supported, which will require an increase in the number of support staff.

5 **Q. WHAT DO YOU MEAN BY IT INTEGRATION?**

6 A. By IT integration, I refer to the need to integrate the technical components of the
7 AGIS initiative with other Company applications to allow the efficient, timely, and
8 secure transfer of data between AGIS systems and other Company systems. The
9 goal of integration is to ensure new applications and data are able to communicate
10 with the Company's existing applications, so Public Service is able to use the data to
11 improve Company operations and provide a better customer experience.

12 As one example, AMI meter data must be communicated to the ADMS for
13 operations and management of the grid, and to back-office applications such as
14 billing and other customer care applications for the data to be used consistently and
15 as effectively as possible. As the business processes are defined or refined, the
16 necessary data and applications requiring the new data gathered from the AGIS
17 components will be identified. Interfaces will be designed or significantly enhanced
18 to transfer the data between the applications. New interfaces to support the new
19 business processes will require significant labor to design and implement. The
20 Company will need to use existing tools, such as an Enterprise Service Bus ("ESB"),²
21 to make the implementation and support of the interfaces consistent and efficient.

² The ESB is a type of software platform that works behind the scenes to aid application-to-application communication. The ESB can be thought of as a "bus" that picks up information from one system and delivers it to another.

1 **Q. TO WHAT EXTENT DOES BUSINESS SYSTEMS ANTICIPATE ENHANCEMENTS**
2 **TO BACK-OFFICE APPLICATIONS MAY BE NECESSARY AS A RESULT OF**
3 **THE IMPLEMENTATION OF AGIS?**

4 A. The new AMI field devices provide data the Company has not stored in its systems
5 before and this data will be in larger quantities than it has obtained before. As a
6 result, effective use and communication of this data will require upgrades to many of
7 our existing business processes. While Public Service's project plans have identified
8 these upgrades and enhancements, there may be some additional requirements as
9 Public Service continues with implementation.

10 **Q. CAN YOU DISCUSS FURTHER THE TYPES AND VOLUME OF DATA PUBLIC**
11 **SERVICE IS RECEIVING FROM THE FIELD AND MANAGING AS A RESULT OF**
12 **AGIS IMPLEMENTATION?**

13 A. Yes. The volume of data is increasing by orders of magnitude. Related to AMI
14 metering, Public Service is gaining the capability to obtain data from meters many
15 times a day – and will be able to provide this data to customers on a daily basis (or
16 more frequently) via the customer data web portal or smartphone application. Not
17 only will the AMI meters provide energy usage data, they can also measure voltage,
18 current, frequency, and power quality. Additionally, these meters can detect outage
19 events, restoration events, tampering, energy theft events, and perform meter
20 diagnostics. This is in contrast to the current metering system which generally
21 provides energy usage data once per month for billing purposes.

22 In addition to the meter data, the advanced grid components FLISR and IVVO
23 will provide outage and voltage information that will be used for outage response as

1 well as for grid management and planning purposes.

2 To support the new data and processes, the Company will need to enhance
3 some software applications to accommodate new fields and increase the
4 applications' data storage capacity and processing.

5 **Q. TO WHAT EXTENT IS CYBER SECURITY INTEGRAL TO THE AGIS INITIATIVE?**

6 A. Cyber security is a significant element of the AGIS initiative. First, devices in the field
7 must be protected. Consequently, unlike internal business technology, the
8 distribution components are out in the field and at customers' residences; devices
9 can only be hardened so much, and security must also rely on other controls.
10 Additionally, although even legacy distribution systems and meters are vulnerable to
11 physical tampering and disabling, adding a communications network enhances the
12 potential impact of a security compromise. In short, the endpoints and the
13 communications between them all require security protections.

14 **Q. WHAT IS BUSINESS SYSTEMS' ROLE WITH RESPECT TO CYBER SECURITY**
15 **FOR AGIS?**

16 A. It starts with identification and protection of all components of the intelligent grid, both
17 for the protection of customers and for the reliable and safe delivery of energy to
18 customers. Also included are detective controls at strategic locations to provide early
19 notification of suspicious behavior or anomalous activity. Further, the Company
20 plans, refines, and tests security controls and response processes to react
21 appropriately to threats to the intelligent grid. Security costs are therefore included in
22 the capital and O&M costs of each project.

B. Introduction to Business Systems' AGIS Costs

Q. HOW ARE BUSINESS SYSTEMS' AGIS COSTS PRESENTED IN YOUR TESTIMONY?

A. AGIS capital expenditures, capital additions, and O&M costs are stated for the Public Service electric utility and are denoted by the term "Total Company", consistent with how Business Systems costs are typically presented in rate cases. I present costs to date, as well as costs planned for in the remainder of the implementation of the AGIS projects.

Q. WHAT TYPES OF IT CAPITAL COSTS IS BUSINESS SYSTEMS INCURRING TO IMPLEMENT THE AGIS PROJECTS?

A. The types of IT capital costs being incurred by Business Systems include project implementation costs related to software licensing, hardware (servers and network), and implementation labor. Labor costs include requirement specification, design, application configuration, screen display development, network security configuration, testing, and implementation.

Q. WHAT ARE THE AGIS-RELATED IT CAPITAL COSTS YOU ARE SUPPORTING IN THIS PROCEEDING?

A. The Business Systems' AGIS capital expenditures and capital additions that I am supporting for rider recovery are shown in the following tables. These costs are forecasts (with the exception of 2019 being actuals), intended to illustrate the scope of projected costs, subject to annual forecasts and true-ups through the AGR as described by Company witness Mr. Berman.

1

Table WAR-D-2
AGIS Capital Expenditures, Business Systems
(Total Company)
(Dollars in Millions)

Program	2019	2020	2021	2022	2023	2024	2025
AMI	\$32.51	\$32.51	\$37.00	\$26.82	\$23.38	\$14.63	\$0.24
ADMS	\$12.57	\$12.04	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
IVVO	\$2.44	\$0.10	\$0.00	\$0.00	\$4.85	\$0.00	\$0.00
FLISR	\$0.30	\$0.77	\$0.26	\$0.00	\$1.10	\$0.00	\$0.00
FAN	\$2.87	\$0.03	\$15.43	\$6.01	\$18.24	\$0.13	\$0.13
Other (including APT)	\$0.02	\$3.67	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Total	\$50.72	\$49.11	\$52.69	\$32.83	\$46.57	\$14.77	\$0.37

There may be differences between the sum of the individual AGIS program amounts and total amounts due to rounding.

2

Table WAR-D-3
AGIS Capital Additions, Business Systems
(Total Company)
(Dollars in Millions)

Project	2019	2020	2021	2022	2023	2024	2025
AMI	\$51.67	\$44.74	\$38.16	\$27.75	\$26.07	\$14.72	\$0.24
ADMS	\$40.53	\$24.48	\$0.16	\$0.00	\$0.00	\$0.00	\$0.00
IVVO	\$3.48	\$2.63	\$0.00	\$0.00	\$4.85	\$0.00	\$0.00
FLISR	\$0.00	\$1.74	\$0.27	\$0.00	\$1.10	\$0.00	\$0.00
FAN	\$3.81	\$0.02	\$34.47	\$6.18	\$18.24	\$0.13	\$0.13
Other (including APT)	\$0.03	\$3.75	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Total	\$99.51	\$77.36	\$73.05	\$33.93	\$50.26	\$14.85	\$0.37

There may be differences between the sum of the individual AGIS project amounts and total amounts due to rounding.

3 Total AGIS Business Systems' capital additions are also set forth in
4 Attachment WAR-1 to my Direct Testimony. I provide additional details and support
5 for the Business Systems' capital costs below, organized by AGIS component.

1 **Q. WHAT TYPES OF IT O&M COSTS IS BUSINESS SYSTEMS INCURRING TO**
2 **IMPLEMENT THE AGIS PROJECTS?**

3 A. The types of O&M costs Business Systems is incurring and expects to incur for AGIS
4 include hardware support, data storage, annual software maintenance, external labor
5 for software support, and application support, which includes ongoing testing, review
6 of processes, application of security patches to respond to evolving threats. All
7 internal labor costs have been excluded as they are already reflected in base rates.

8 **Q. WHAT ARE BUSINESS SYSTEMS' FORECASTED O&M COSTS FOR AGIS**
9 **IMPLEMENTATION THAT THE COMPANY IS SEEKING TO INCLUDE IN THE**
10 **RIDER?**

11 A. The forecasted AGIS O&M expenses for Business Systems are shown in the table
12 below. As with capital costs, these O&M costs are intended to illustrate the scope of
13 projected costs, subject to annual forecasts and true-ups through the AGR as
14 described by Company witness Mr. Berman.

Table WAR-D-4
AGIS O&M Expenditures, Business Systems
(Total Company)
(Dollars in Millions)

Program	2021	2022	2023	2024	2025
AMI	\$5.70	\$5.55	\$7.25	\$7.79	\$8.51
ADMS	\$1.96	\$1.99	\$3.14	\$3.27	\$1.96
IVVO	\$0.18	\$0.18	\$0.18	\$0.19	\$0.20
FLISR	\$0.04	\$0.05	\$0.07	\$0.07	\$0.00
FAN	\$0.06	\$0.06	\$0.06	\$0.06	\$0.06
Other (including APT)	\$0.32	\$0.49	\$0.49	\$0.49	\$0.41
Total	\$8.26	\$8.32	\$11.19	\$11.87	\$11.14

Total AGIS IT O&M costs are also set forth in Attachment WAR-2 to my Direct Testimony by cost element and in Attachment WAR-3 by FERC account. I provide additional details and support for the Business Systems' O&M costs below, organized by AGIS project.

Q. YOU MENTIONED THAT THE COMPANY PREVIOUSLY RECOVERED A PORTION OF THE AGIS COSTS IN ITS 2019 ELECTRIC RATE CASE. CAN YOU PLEASE EXPLAIN?

A. The costs I present above are indicative of the overall costs of the AGIS initiative and associated projects as a whole. As Company witnesses Mr. Berman and Ms. Blair explain, certain AGIS capital additions in service in 2019 and O&M costs related to these capital additions, as well as internal labor, are included in base rates as a result of the Company's 2019 Electric Rate Case. As further detailed by Company witnesses Mr. Berman and Ms. Blair detail the, adjustments that will be made to the

1 revenue requirements in this proceeding to account for O&M and capital additions
2 that were previously recovered in the 2019 Electric Rate Case.

1 **III. ADVANCED METERING INFRASTRUCTURE**

2 **Q. WHAT IS THE PURPOSE OF THIS PORTION OF YOUR DIRECT TESTIMONY?**

3 A. In this section of my testimony, I describe the IT integration that is necessary for the
4 AMI project that was approved in the Proceeding No. 16A-0588E (the “AGIS CPCN
5 Proceeding”) and describe the type of work that Business Systems is doing to
6 implement the AMI project as support for the Company’s request for current cost
7 recovery through the AGR. Then, I provide the most current information regarding
8 the implementation plan for each component of AMI from a Business Systems/IT
9 perspective and the Business Systems’ work that needs to be done to successfully
10 complete the associated projects. Finally, I discuss Business Systems’ IT capital and
11 O&M forecasts for the AMI project, identifying the drivers of various IT costs.

12 **A. Overview of AMI IT Integration**

13 **Q. WHY DOES AMI REQUIRE IT INTEGRATION?**

14 A. AMI is a system of advanced meters, communications networks, and data
15 management systems that enable two-way communication between utilities’
16 business and operational data systems and meters enabling added benefits for
17 customers and the utilities. AMI meters are able to measure and transmit voltage,
18 current, and power quality data and can act as a “meter as a sensor,” and for instance
19 can provide near real-time monitoring between the meter and ADMS. Since AMI
20 consists of both software and hardware and works with other Company systems,
21 information technology integration is key to the success of AMI.

1 **Q. HOW DOES BUSINESS SYSTEMS PARTICIPATE IN THE AMI DEPLOYMENT?**

2 A. The AMI meters will be integrated with the Company's IT system. AMI is data
3 intensive with meter readings, energy usage interval profiles, power outage and
4 restoration events, power quality information and other data transmitted and collected
5 frequently. All data from the AMI meters is transmitted to the AMI head-end
6 application (which is managed by Business Systems) and, depending on what the
7 data is, needs to be integrated and made available to the applicable business system
8 in an accurate and timely manner. Business Systems manages the integration of the
9 varying systems.

10 **Q. CAN YOU PROVIDE ADDITIONAL INFORMATION REGARDING THE SPECIFIC**
11 **FUNCTIONS BUSINESS SYSTEMS PROVIDES FOR AMI?**

12 A. Yes. To support AGIS implementation and integration of AMI projects with other
13 Company systems, Business Systems is charged with:

- 14 1. Managing/Coordinating the delivery of incremental technology services
15 releases;
- 16 2. Blueprinting the technology requirements for all technology delivered in the
17 AMI project to support the customer and business objectives;
- 18 3. Leading the design of the overall system and components mentioned above;
- 19 4. Procurement and installation of all hardware components that will run the
20 software;
- 21 5. Procurement of the software;
- 22 6. Configuration of the software and hardware;
- 23 7. Designing, procuring and installation of the necessary hardware and software
24 referred to as the "head-end" application that reads the meters and other field
25 devices in the AMI solution and monitors and manages the network and
26 attached devices. The head-end application will also be used by the other

Xcel Energy operating companies when they deploy AMI meters subject to any necessary regulatory approvals;³

8. Building and installation of any required interfaces throughout all applications involved in the AMI solution including Meter Data Management (“MDM”), Customer Resource System (“CRS”), Portals/Mobile Applications, Meter Device Management System (“MDMS”) – device inventory and configuration management) and Outage Management System;

9. Designing and integration of security into all aspects of the AMI solution;

10. Thorough unit, system, regression, and end-to-end testing of the AMI solution;

11. User Acceptance Testing with Distribution, Customer Care and Customer Solutions business resources;

12. Deployment of technology releases for the AMI project in coordination with other enterprise technology services; and

13. Establishment of a full ongoing support structure including process and operational requirements.

Most importantly, Business Systems will implement new AMI head-end software. The AMI head-end software has been installed and configured to run on new server hardware. From the AMI head-end, interfaces have been built, and continue to be built, to transfer the data to other Company applications and systems.

Q. WHAT APPLICATIONS AND SYSTEMS WILL BE INTEGRATED WITH AMI?

A. The following applications have been, or will be integrated so they can use AMI data:

- *ADMS*: ADMS provides an integrated operating and decision software support system to assist control room, field personnel, and engineers with the monitoring, control and optimization of the electric distribution system. ADMS uses the AMI data to deliver automated grid capabilities, such as IVVO and FLISR. AMI provides the ADMS with timely real and reactive power measurement data that are used in load flow and IVVO calculations. AMI meters also provide voltage measurements at various points on the distribution system to support IVVO calculations. Additionally, AMI meters will report a power-out or “last gasp” event

³ Full AMI meter deployment is scheduled to commence in 2021 and continue through 2024 for Northern States Power Company, a Minnesota corporation.

1 to the AMI head-end application and report a power-on event when power is
2 restored. "Last gasp" is defined as the final message transmitted by the meter
3 upon detection of an outage. This information flows from the head-end application
4 into ADMS, improving the calculations for the FLISR and FLP applications.

- 5 • *CRS*: The application provides capabilities for customer service, billing, service
6 orders, and payments. CRS is currently integrated with the Meter Asset Lifecycle
7 Management System and MDMS. AMI head-end integration with CRS allows
8 Public Service to streamline multiple processes. As an example of a process
9 improvement resulting from integrating the AMI head-end with CRS, Public
10 Service is able to obtain a meter reading to begin or end a billing cycle when a
11 customer moves into or out of a premise without a visit to the customer's premise.
12 As another example, when a disconnected customer needs to be reconnected,
13 an order generated in CRS can be sent to the AMI head-end to reconnect the
14 service automatically, returning the customer to service more quickly. Reconnect
15 processes previously were manual processes that require a person to physically
16 visit the customer's site.

- 17 • *Meter Asset Lifecycle Management System*: This system manages the entire life
18 cycle of serialized metering devices, including purchasing, testing, field
19 installation location, field removal, and retirement of the asset. The Meter Asset
20 Lifecycle Management System is currently integrated with the MDMS and CRS.
21 The integration of the AMI head-end with the Meter Asset Lifecycle Management
22 System allow it to remain as the Company's primary source of location information
23 and attributes for serialized metering devices. The AMI head-end can receive the
24 meter location and attribute information to enable provisioning of the meter,
25 understand its location, and obtain data from the meter.

- 26 • *MDM*: This system provides capabilities to validate, edit, and estimate meter
27 readings and manages events from the meter, such as power outages and
28 tampering. The MDM can also assist in facilitating communication to, and
29 receiving data from, the AMI head-end. The MDM is currently integrated with the
30 Meter Asset Lifecycle Management System and CRS. The MDM serves as the
31 central repository for the Company's meter reading data. The MDM also validates
32 the meter data and export it for use in billing, customer viewing, and analytics.

- 33 • *Network Management System ("NMS")*: NMS is the vendor supported application
34 for the Company's Outage Management System ("OMS"). OMS is the enterprise
35 solution for the electric trouble distribution control centers outage event
36 management. OMS is critical to outage restoration and generally critical to the
37 Company's operations. This would be a new integration for Xcel Energy, requiring
38 standard software lifecycle management. The AMI meter events and functionality
39 can be utilized to better identify and manage service outages and restoration
40 activity, and the volume of data available from AMI systems must be pre-
41 processed to produce timely, accurate, consumable, and actionable information

1 for NMS. Such an integration of AMI and NMS would improve customer
2 experiences during service outages by making the associated event details
3 proactively available to personnel managing, communicating and making
4 decisions during service restoration.

- 5 • *Customer portal*: The customer portal (the current version is available on the Xcel
6 Energy website and is known by customers as “My Account”) is used by
7 customers to obtain account information, track energy usage, view billing history,
8 pay bills, and sign up for notifications. AMI data from field devices (i.e., the
9 customer’s meter) will move through the AMI head-end, and be integrated with
10 other customer information, to the customer portal, where customers will have the
11 ability to see more granular meter reading data than they see today.

12 While our final design has not yet been determined, our current customer
13 portal design plan will provide routine meter readings, which will be obtained from
14 the meters several times a day and will provide the majority of the data that is
15 shown when customers request a display of their usage. The customer will also
16 be able to use the portal to send an “on demand” read request to the meter,
17 obtaining the latest readings from the meter; the portal will then combine this new
18 data with the data obtained from the routine reading process for customer viewing.
19 A smartphone application will also provide customers with similar capabilities.

- 20 • *HAN*: The AMI meters will be capable of providing data that will be available to a
21 customer’s HAN. A HAN is a customer’s electronic data network of devices within
22 their premise. Although customers will select their own HAN hardware and
23 software, the Company is creating a technology infrastructure in order to enable
24 communication between customers’ devices and the AMI meter through the HAN.
25 Mr. Nickell provides an introduction to the Company’s adoption of HAN
26 capabilities, and the costs associated with which are part of the AGIS AMI
27 forecasts. The technical aspects of the HAN are discussed below. The HAN was
28 the subject of a separate application in Proceeding No. 18A-0194E, and
29 Commission Decision No. R18-0590 approved the Company’s Amended HAN
30 Application, including incremental expenditures of \$4 million in capital and \$3
31 million in O&M for implementation of the HAN, and use of a NIC and ZigBee SEP
32 1.1 communications profile.
- 33 • *Green Button Connect My Data (“GB CMD”)*: is a standard ratified by the North
34 American Energy Standard Board that allows customers to access their electricity
35 usage data and share that data with third-party service providers. As part of the
36 AGIS CPCN Settlement Agreement, the Company is implementing a GB CMD
37 system that will allow customers to download or view information related to their
38 energy usage and communicate that information to third parties through the GB
39 CMD communication portal.

- *FAN*: The AMI meter's two-way communication module is a component of the mesh network layer of the FAN, which is the component of the FAN included in the CPCN Projects.⁴ The meter's communication module retrieves meter data that is stored within the meter as prescribed by ANSI C12.19 meter table implementation standards. The radio frequency communications modules in the meters may also act as a repeater for other mesh network devices, enabling two-way communication between the meters and the mesh network. This function has the benefit of increased reliability of communication between the AMI meters and the head-end application. In limited circumstances where deployment of the WiSUN mesh network is not practical (such as remote locations on the edge of Public Service's distribution system), meter data may be transmitted over the FAN via public cellular or other wireless technologies. The FAN is discussed in more detail below in Section IV.

Q. WHICH OF THESE INTEGRATED SYSTEMS ARE INCLUDED IN THE COMPANY'S REQUEST FOR COST RECOVERY THROUGH THE ADVANCED GRID RIDER?

A. As described earlier in my Direct Testimony, the other AGIS initiative projects (such as ADMS and FAN) are included in the AGR. Likewise, the AMI head-end and the components in the AMI meter that will support HAN, including the microprocessor, memory and Wi-Fi radio are also included in the AGR costs. Additionally, AGR costs include Business Systems' costs which include the work of integrating the AGIS programs with other existing Company systems. However, the additional costs for HAN including software applications and back-end systems are not included in the AGR costs. Similarly, GB CMD costs have not been included in the AGR at this time.

Q. HAS THE COMPANY UPDATED ANY OF ITS PLANS FOR THESE AMI-RELATED SYSTEMS SINCE THE CPCN WAS APPROVED?

A. Yes, in addition to normal planning and refinements as the Company has moved through RFP and system design processes, the Company has identified three updates: First, Xcel Energy has identified the need to replace its MDM, as the

1 existing system has reached the end of its life and will not support enterprise-wide
2 AMI as initially expected. Second, as Mr. Nickell discusses in more detail, the
3 Company has re-aligned its meter deployment schedule in light of the need to identify
4 a new meter vendor able to provide emerging meter capabilities. Third, emerging
5 technologies in relation to the HAN have prompted Public Service to move away from
6 ZigBee technology and toward Wi-Fi to better serve customers. While Mr. Nickell
7 supports the meter deployment schedule, I discuss the Business Systems
8 implications, as well as HAN and MDM changes, in my Direct Testimony.

9 **Q. PLEASE EXPLAIN WHY THE COMPANY NEEDED TO UPDATE THE MDM**
10 **SYSTEM TO ACCOMMODATE AMI?**

11 A. AMI will significantly increase the number of meters and amount of data loaded to the
12 MDM, and Public Service will need to upgrade the currently deployed software
13 solutions for managing the meter inventory and configurations. This MDM system
14 update was anticipated as part of the implementation of AMI. However, in 2019 Xcel
15 Energy completed an evaluation of the current MDM system application and
16 infrastructure and determined that an entirely new software solution is needed to fulfill
17 the requirements for AMI. The current MDM system application is approaching end
18 of life and does not have the capacity and security elements required to support AMI,
19 including the volume and technical capabilities needed for the enterprise-wide
20 deployment of AMI meters. A new MDM solution will be utilized enterprise-wide
21 across Xcel Energy operating companies. The Company is finalizing the full scope
22 of work and total costs, as well as determining the operating company allocations.

1 Ultimately, the MDM solution will support the security, functionality, scalability, and
2 performance requirements of AMI meter data management.

3 **Q. IS THE COMPANY PROPOSING TO INCLUDE MDM REPLACEMENT COSTS**
4 **FOR RECOVERY IN THE AGR?**

5 A. The costs associated with the procurement and hosting of the new MDM system that
6 will support the AMI meter data and associated integrations listed above are included
7 in the AGR for recovery. The costs associated with converting legacy MDM system
8 integrations or data conversions are not being requested for recovery in the AGR but
9 will be part of the Company's next general electric rate case.

10 **Q. CAN YOU PROVIDE ADDITIONAL DESCRIPTION OF THE CHANGES TO THE**
11 **HAN SINCE THE AGIS CPCN SETTLEMENT AGREEMENT WAS APPROVED?**

12 A. Yes. As required by the AGIS CPCN Settlement, in March of 2018, the Company
13 filed an application that presented its plan to activate the HAN capability in the AMI
14 meters. The Company's amended application was approved by Commission
15 Decision No. R18-0590, in Proceeding No. 18A-0194E ("HAN Proceeding").

16 Throughout 2019, the Company continued to engage with the AMI meter
17 manufacturer in the development of the software-defined radio solution that will
18 enable AMI meters to support HAN. To future-proof HAN technologies and provide
19 customers with more device flexibility, the new Itron AMI meters that the Company
20 plans to deploy will support HAN capabilities via Wi-Fi and will not support previous
21 generation of Smart Energy Profile 1.1 standards, nor contain a Zigbee radio as
22 anticipated in the HAN Proceeding. The Company's product development efforts
23 also include working with Itron, our AMI meter vendor, to develop meter-to-HAN

communication capabilities and enhancements, and the Company will test to those capabilities as appropriate during the testing phase.

Q. HOW DOES THE CHANGE FROM A ZIGBEE RADIO TO WI-FI FOR METER TO HAN COMMUNICATION BENEFIT THE CUSTOMER EXPERIENCE?

A. The shift to Wi-Fi enhances our customers' experience because this change will eliminate the need (and associated costs) for customers to purchase an additional device with a ZigBee radio to facilitate communications between the AMI meter and their HAN devices. As shown in Table WAR-D-6 below, most of our customers already own a device that they can connect to the AMI meter via Wi-Fi. By switching to Wi-Fi communications, customers can utilize one of their existing Wi-Fi devices to facilitate communications with the AMI meter.

**Table WAR-D-6
Prevalence of Wi-Fi Capable Devices in the Home**

DEVICE	ADOPTION RATE
Wi-Fi Router	84%
Smart Phone	83%
Tablet	70%
Desktop Computer	53%
Laptop Computer	79%
Smart Speaker	35%

In contrast, had the Company pursued a Zigbee based, "bring your own device" program, customers would have needed to purchase a Zigbee device in addition to their existing Wi-Fi devices. Costs for these devices can vary; however, as an illustrative example, the Rainforest EMU-2 retails for \$69.99.⁴ For a customer that already has a Wi-Fi enabled device in their home, such as a smart phone or

⁴ <https://rainforestautomation.com/us-retail-store/>

1 tablet, this is an additional cost for the customer and one that may not offer any more
2 benefit than Wi-Fi enables devices can offer.

3 The shift to Wi-Fi also reflects the direction of the market. Device
4 manufacturers such as Google, Amazon, and Apple have indicated a clear
5 preference for Wi-Fi as the primary communication channel for their devices. Our
6 adoption of Wi-Fi as the meter-to-HAN communication channel reflects this reality of
7 the device ecosystem and supports our customers by bringing them a technology
8 they are invested in and with which they are familiar. This helps reach a wider
9 audience of customers, such that the Company may be able to drive additional benefit
10 from the HAN functionality than was possible under a Zigbee based solution. To
11 effectuate approval of the change in technology, the Company expects to file an
12 amended application from Proceeding No. 18A-0194E further detailing the impact
13 that the change to Wi-Fi communications will have on the HAN functionality.

14 **Q. IS THE COMPANY PROPOSING TO INCLUDE HAN COSTS IN THIS ADVANCED**
15 **GRID RIDER?**

16 A. The components of the AMI meter that will support HAN to meter communications,
17 i.e., the HAN radio, are integral parts of the AMI meters and are included in the AGR
18 costs. The additional costs for backend system improvements needed to support
19 HAN are not included in the AGR costs.

B. AMI Deployment Timeline

Q. CAN YOU PROVIDE AN OVERVIEW OF THE TIMELINE TO IMPLEMENT AND INTEGRATE AMI WITH THE COMPANY'S EXISTING SYSTEMS?

A. Yes. The Company plans to deploy approximately 1.6 million AMI meters in Colorado from 2021 to 2024. The deployment of the IT components of the AMI project are set forth in specific Releases as shown in Table WAR-D-7. Each of these Releases will provide the necessary functionality to the AMI meters.

**Table WAR-D-7
Forecasted AMI Project Milestones⁵**

YEAR	Quarter 1	Quarter 2	Quarter 3	Quarter 4
2019 Complete	AMI Head-end Deployment in production without interfaces	AMI Head-end Deployment in production with interfaces	AMI Release 1: Software in production. Test of sample meters prior to installation of 13,000 meters in the field to support IVVO	Completed deployment of 13,000 meters to support IVVO
2020				AMI Release 2: Interfaces code in production
2021	AMI Release 3: Functions deployed to support mass AMI deployment		Begin deployment of 395,000 AMI meters	Complete deployment of 395,000 AMI meters AMI Release 3: Interfaces code in production
2022	Begin deployment of 534,000 AMI meters			Complete deployment of 534,000 AMI meters AMI Release 4: interfaces in production
2023	Begin deployment of 504,000 AMI meters			Complete deployment of 504,000 AMI meters
2024	Begin deployment of remaining AMI meters			Complete deployment of remaining AMI meters

⁵ See, e.g., AGIS CPCN Settlement at 15. The Company is currently working with Parties to the AGIS CPCN Settlement to update the meter deployment schedule.

As new system releases are brought on-line, the overall level of functionality of the system increases, including customer applications. The functionality associated with each Release is shown in the following table.

Table WAR-D-8
Release Functionality by Year

2019⁶ (Release 1)	2020 (Release 2)	2021 (Release 3)	2022 (Release 4)
Head-end live with interfaces	MDM – Installation and Integration	395,000 AMI meters installed	534,000 AMI meters installed
13,000 meters installed to support IVVO	Reporting	My Account/Mobile – customer access to usage information	Analytics – and additional use cases
Billing of 13,000 meters	Meter Installation Vendor (MIV) Integration	Analytics – additional use case	Additional reporting – data warehouse used for business reporting and data retention
Event processing		Remote connect	
Over the air meter - basic configuration		Expanded events processing capability	
		<i>HAN*</i>	
		<i>Green Button Connect My Data*</i>	
		<i>Real-time Customer Care data access*</i>	
		<i>Expanded over the air programming and configuration use cases*</i>	
		<i>Interval Billing*</i>	

I walk through each of these Releases in more detail below.

Q. HOW DOES THIS TIMELINE COMPARE TO THE TIMELINES SET FORTH IN THE AGIS CPCN SETTLEMENT?

A. As noted above and described in more detail by Mr. Nickell, the Company has re-aligned its AMI meter deployment schedule. The Business Systems' technology delivery was therefore re-sequenced to support, and align to, the new Company

⁶ Projects completed at the end of 2019.

1 meter deployment schedule. This included support for the 13,000 IVVO bellwether
2 meters deployed in 2019 and support for the full AMI meter deployment that will
3 commence in 2021. The re-sequence focused on Business Systems' work in three
4 categories: 1) functions required in advance of full AMI meter deployment, 2)
5 functions required at the time full AMI meter deployment begins, and 3) functions that
6 can be delivered during full AMI meter deployment.

7 **Q. PLEASE IDENTIFY THE IT SOFTWARE INTEGRATION REQUIREMENTS FOR**
8 **AMI IN MORE DETAIL, BEGINNING WITH THE WORK COMPLETED PRIOR TO**
9 **2019.**

10 A. In 2017, the Business Systems and Distribution Business Areas jointly undertook a
11 programmed approach for staffing and vendor selection for AMI system integration.
12 Business Systems and Distribution participated in contract awards (from RFPs) for a
13 network vendor to support WiSUN (the mesh network portion of the FAN that will
14 utilize the AMI meters' communications modules). The Company has also
15 commenced design and planning processes for AMI.

16 In 2018, Public Service engaged in detailed design and planning of all
17 interfaces with the AMI solution, and undertook the installation and testing of the
18 head-end system to support reading data from field devices. No AMI components
19 were placed in service in 2017 or 2018.

20 **Q. WHAT BUSINESS SYSTEMS' WORK WAS COMPLETED IN 2019?**

21 A. The largest facet of Business Systems' work completed in 2019 for the AGIS initiative
22 was completion of the deployment of the AMI head-end software in August 2019,
23 which has been installed and configured to run on new server hardware. From the

1 AMI head-end, interfaces have been built to transfer the data to other applications,
2 such as the billing and customer service system. This integration work allows the
3 Company's existing infrastructure to "speak with" the new infrastructure being
4 implemented pursuant to the AGIS initiative.

5 In 2019, Business Systems completed work on the integration, testing, and
6 deployment for the AMI head-end software to support reading, monitoring, and
7 controlling the AMI meters. All required initial interfaces for communications and
8 billing support have been validated to be able to enter the Meter Validation Test
9 Phase of the initial 30 test meters. The successful 2019 deployments for Release 1
10 also provided the baseline functionality required for all releases and software solution
11 capabilities upcoming in 2020 and 2021.

12 **Q. WHAT OTHER WORK WAS COMPLETED BY BUSINESS SYSTEMS IN 2019 TO**
13 **SUPPORT AMI?**

14 A. Business Systems has implemented the following functionalities and completed the
15 following work as of 2019, and further itemizes how the 2019 accomplishments tie
16 into future milestones (see Release descriptions from Table WAR-D-8 above):

- 17 • Meter Data Management (MDM) - (Release 2): The selection of the MDM was
18 completed in the fourth quarter of 2019. The selection process involved
19 numerous architectural options, before coming to the most logical and cost-
20 efficient conclusion for the AGIS initiative and the Company's customers.
- 21 • Interval Billing functionality - (Release 3): Release 3 will be the first Release
22 to feature Interval Billing capability. Up to this point, billing has been performed
23 with Register Billing capability. Interval Billing provides more flexibility and
24 control for the customer billing options. This capability was originally
25 scheduled to be delivered during 2020 at the same time the mass meter
26 deployment commenced. Since the mass meter deployment start has been
27 adjusted to 2021, the capability will be delivered in 2021. Beginning with AMI
28 meters deployed in 2021, the AMI meters will be programmed to record the

time blocks proposed in the Residential Energy Time-of-Use ("RE-TOU") proceeding (Proceeding No. 19AL-0687E) for which the Company entered into a Settlement Agreement with all parties on June 11, 2020. AMI meters will be programmed with the new RE-TOU rates.

- Meter Installation Vendor (MIV) Integration - (Release 2): Contract negotiations for the mass deployment MIV for the Company were completed in the third quarter of 2019. Integration of Company and MIV systems will allow the MIV to receive installation orders from the Company, complete the orders using their field tools, and send the results of the order to the Company.
- Reporting: Reporting is an ongoing requirement throughout all the Releases. A select subset of reports based on business requirements will be identified and delivered in each Release.
- Over the Air ("OTA") - (Release 3): Meter programming, updates to network equipment, and firmware updates to field device capability will be delivered in 2021. OTA meter capability currently uses a manual process to update meters. Beginning in 2021, the OTA meter programming will be updated to automated functionality. This capability was originally scheduled to be delivered during 2020 at the same time the mass meter deployment commenced. Since the mass meter deployment start has been adjusted to 2021, the capability will be delivered in 2021.
- Customer Care - (Release 3): Real-time data access for the Company's customers and employees will be delivered in 2021. Currently, customers with interval data meters can access their data up through midnight the previous day through My Account. In the Fall of 2021, customers will be able to access near real-time data through My Account. This capability was originally scheduled to be delivered during 2020 at the same time the mass meter deployment commenced. Since the mass meter deployment start has been adjusted to 2021, the capability will be delivered in 2021.
- My Account - (Release 3): The capability to deliver meter usage information to our customers, in accordance with Section III, H of the AGIS CPCN Settlement, will be delivered in 2021. This capability was originally scheduled to be delivered during 2020 at the same time the mass meter deployment commenced. Since the mass meter deployment start has been adjusted to 2021, the capability will be delivered in 2021 as customers receive their AMI meter.

1 **Q. WITH RESPECT TO AMI, WHAT ADDITIONAL WORK WILL BE NEEDED**
2 **BETWEEN THE TIME OF THIS FILING AND 2025?**

3 A. Business Systems will work with Distribution and other Business Areas to deliver
4 the technology services to support the remaining AMI functions that are noted within
5 the Release descriptions from Table WAR-D-7 above. These additional AMI
6 functions are:

- 7 • Analytics – Additional Use Case - (Release 3): While complete requirements
8 are yet to be defined, some data utilized within this use case are correlation
9 and comparisons of specific event types, energy usage levels and patterns,
10 data abnormalities, and expected meter communications.
- 11 • Remote Connect- (Release 3): While complete requirements are yet to be
12 defined, the AMI technology will be integrated into Public Service processes
13 to enable timelier connection or disconnection of service at the customer's
14 convenience. As noted above, Public Service is not requesting any change to
15 its current connection and disconnection processes as part of this proceeding.
- 16 • Expanded Event Processing – (Release 3): While complete requirements are
17 yet to be defined, the general area of delivery will be integrating and
18 automating required actions based on the receipt of certain types of meter
19 events. There are hundreds of event types that AMI meters can generate,
20 many of which require analysis and action in business processes. Example
21 broad categories of events include import/export, metrology, configuration,
22 status, communication, and health.
- 23 • HAN – (Release 3): As stated in Mr. Nickell's testimony, Public Service will
24 allow customers to "bring your own device." The current AMI meter
25 communication protocol allows HAN devices that are IEEE 2030.5 compliant
26 (which includes Smart Energy Profile 2.0) to connect to the meter and the
27 Company is in the process of reviewing other options with Itron for connecting
28 HAN devices to the AMI meters. For devices that are compliant with the meter
29 communication protocol, there is a two-step process that will involve
30 customers submitting an activation request for their HAN devices and the
31 Company processing that request and activating the NIC within the AMI meter
32 to communicate with the customer's HAN device.
- 33 • Green Button Connect My Data (Release 3): The Company's customer web
34 portal will include the ability for all customers to access their energy usage
35 data and provide that data to third parties.

- 1 • Analytics – Additional Use Cases - (Release 4): While complete requirements
2 are yet to be defined, these use cases are intended to support AMI and grid
3 operations. As such, this analysis will be guided to improve power quality,
4 improve customer satisfaction, reduce meter reading costs, support field meter
5 services, and support distribution systems management.
- 6 • Additional Reporting (Release 4): Reporting is an ongoing requirement to be
7 identified and delivered in each Release. For example, Public Service will be
8 able to deliver reports that summarize data from the AMI infrastructure to
9 monitor and improve operations, trending, reliability, and efficiency.

10 **C. Business Systems' Capital Costs for AMI**

11 **Q. WAS BUSINESS SYSTEMS PRIMARILY RESPONSIBLE FOR DEVELOPING**
12 **THE FORECAST FOR AMI?**

13 A. Business Systems is responsible for developing the forecasts for the AMI head-end
14 application and integration. Therefore, I describe the forecast development process
15 for these aspects in more detail in my Direct Testimony. Mr. Nickell addresses the
16 forecast for the meters themselves.

17 **Q. WHAT ARE THE PRIMARY COMPONENTS OF THE AMI CAPITAL FORECAST**
18 **FOR BUSINESS SYSTEMS?**

19 A. Business Systems' AMI capital forecast has three key components: (1) hardware, (2)
20 software, and (3) labor. The tables below provide a breakdown of Business Systems'
21 capital expenditures and capital additions forecast for AMI for 2020 through 2025.

1

Table WAR-D-9
AMI Business Systems - Capital Expenditures
(Total Company)
(Dollars in Millions)

	2020	2021	2022	2023	2024	2025	Total
AMI	32.51	37.00	26.82	23.38	14.63	0.24	134.58

2

Table WAR-D-10
AMI Business Systems - Capital Additions
(Total Company)
(Dollars in Millions)

	2020	2021	2022	2023	2024	2025	Total
AMI	44.74	38.16	27.75	26.75	14.72	0.23	152.35

3 **Q. WHAT HARDWARE IS NEEDED FOR BUSINESS SYSTEMS TO IMPLEMENT**
4 **AMI?**

5 A. The additional hardware necessary for AMI implementation consists of computing
6 components used for data processing and storage to support AMI services across all
7 environments that are used in the software lifecycle of a particular service. Examples
8 of environments that may be applicable to a service are production, disaster recovery,
9 development, testing, and quality assurance. The functions that were analyzed
10 within the hardware cost estimates are to support outage event processing, security,
11 the head-end application, meter data management software, Customer Care support,
12 reporting, database and operational storage, middleware, and field deployment. In
13 other words, due to the increased volume of data from the AMI meters and processes
14 necessary to use that data in a meaningful way for our customers and the Company,
15 additional servers with computing and storage capabilities will be needed.

1 **Q. HOW DID BUSINESS SYSTEMS DERIVE THE HARDWARE PORTION OF THE**
2 **AMI IT FORECAST?**

3 A. Xcel Energy has standards for all hardware that is deployed in our data centers.
4 These standards define hardware for which the Company has industry benchmarked,
5 negotiated pricing. The cost estimates were then derived utilizing the hardware
6 requirements of the applications(s) and applying standard pricing.

7 **Q. HOW DID BUSINESS SYSTEMS DEVELOP THE SOFTWARE PORTION OF THE**
8 **AMI IT FORECAST?**

9 A. The initial estimates were derived utilizing pricing gained from industry benchmarks
10 and reviewed with other utilities and industry research organizations such as Electric
11 Power Research Institute ("EPRI"). These benchmarks drove the negotiations with
12 the software vendors selected through RFP processes from which final cost
13 estimates were created. The software portion of the AMI head-end forecast includes
14 a detailed list of software components provided and offered from the vendor. The
15 RFP process identified these specific software components and included those that
16 are required (mandatory) and those that are optional. These estimates will be
17 reviewed and refined throughout the lifecycle of the project.

18 **Q. PLEASE DISCUSS THE RFP PROCESS USED TO SELECT THE VENDOR FOR**
19 **THE AMI HEAD-END SOLUTION.**

20 A. A series of RFPs was conducted to determine the most appropriate AMI head-end
21 solution for the Company. The Company received responses from industry leaders
22 in the space as part of its competitive bidding process. From that process, vendors
23 were chosen for the AMI head-end software as well as the system integration work.

1 A detailed project estimate was created from the pricing and contract information, as
2 well as labor and hardware to support the overall AMI project. Itron was selected
3 based on optimal pricing, strategic fit, and industry experience. This effort was
4 benchmarked and reviewed with other utilities and industry research organizations
5 such as the EPRI.

6 **Q. DESCRIBE THE RFP PROCESS USED TO SELECT THE VENDOR FOR THE**
7 **WISUN MESH SOLUTION FOR THE AMI HEAD-END SOFTWARE.**

8 A. Xcel Energy issued an RFP in 2015 to select a vendor to provide the WiSUN mesh
9 solution for the AMI head-end software. Responses were received from three
10 different companies. Xcel Energy evaluated these vendors and responses on a
11 number of factors including:

- 12 • Technical performance;
- 13 • Operational performance;
- 14 • System long-term survivability;
- 15 • Adequacy of security capabilities;
- 16 • Warranty and support;
- 17 • Manageability with operational model;
- 18 • Ability to design mesh systems;
- 19 • Ability to implement;
- 20 • Ability to meeting scope and schedule;
- 21 • Acceptability of business terms and conditions;
- 22 • Industry experience;

- Adequacy of support systems; and
- Pricing.

In 2016, Xcel Energy selected Silver Springs (now Itron) and began contract negotiations. Contract negotiations were finalized in late 2016.

Q. WHY DID XCEL ENERGY SELECT ITRON AS THE VENDOR FOR BOTH THE AMI HEAD-END AND MESH SOLUTION?

A. The primary factors in the decision were:

- Favorable pricing;
- Industry experience and track record with other utilities the Company benchmarked against;
- Performance in on-site testing of products against the Company requirements in the RFP;
- Breadth of solution; and
- Interoperability capabilities.

A summary of the RFP selection process and results are provided as Highly Confidential Attachment WAR-4 to my Direct Testimony.

Q. DESCRIBE THE RFP PROCESS USED TO SELECT THE VENDOR FOR OVERALL TESTING OF THE AGIS PROGRAM.

A. Xcel Energy issued an RFP in February 2018 to select a vendor to provide overall testing for the AGIS program on an enterprise-wide basis. The RFP sought a vendor to provide planning and execution of all AGIS testing phases including system acceptance, integration acceptance, performance acceptance, end-to-end and user acceptance testing. Responses were received from three different companies. Xcel Energy evaluated these responses on a number of factors including:

- Approach or methods recommended for testing;
- Environment and release management;
- Resource plan efficiency and effectiveness;
- Situational problem solving; and
- Pricing.

In April 2018, Xcel Energy selected Accenture and began contract negotiations, which were finalized in June 2018.

Q. WHY DID XCEL ENERGY SELECT ACCENTURE AS THE VENDOR FOR OVERALL AGIS PROGRAM TESTING?

A. The primary factors in the decision were:

- Experience delivering similar testing for other utility customers;
- Experience and strength of team members who have previously done this work;
- Strong methodology; and
- Favorable pricing.

Q. PLEASE DESCRIBE THE RFI PROCESS USED TO SELECT A VENDOR FOR THE METER DATA MANAGEMENT SOFTWARE.

A. In 2019, the Company initiated an RFI process to select a vendor to provide MDM software. The Company evaluated MDM options from three vendors and selected a vendor based on: simplicity of technical architecture; strong availability commitment; and favorable pricing. Once the vendor was selected, the Company evaluated three different technology options, and made a final technology selection. In June 2019, Xcel Energy selected Itron's MDM product (Itron Enterprise Edition) and began contract negotiations, which were finalized on December 18, 2019.

1 **Q. HOW DID THE COMPANY DERIVE THE LABOR PORTION OF THE AMI IT**
2 **FORECAST?**

3 A. It is expected that the selected vendors will provide the majority of the labor required
4 to deliver the AMI project. The initial estimates were derived utilizing pricing gained
5 from industry benchmarks and reviewed with other utilities and industry research
6 organizations such as EPRI. These benchmarks drove the negotiations with the
7 selected vendor(s) and final estimates were created.

8 **D. Business Systems' O&M Costs for AMI**

9 **Q. WHAT ARE THE PRIMARY COMPONENTS OF BUSINESS SYSTEMS' AMI O&M**
10 **FORECAST?**

11 A. The primary components of Business Systems AMI O&M costs include: (1) planning
12 phase activities, including scope definition and solution selection (for example, the
13 AMI RFP and vendor selection); and (2) support activities that will occur after AMI is
14 implemented, including contractor labor, maintenance, and warranty. In other words,
15 these cost forecasts encompass the incremental work related to hardware and
16 software maintenance, licensing, and the other work described above to support the
17 increased data storage and processing related to AMI implementation.

18 Table WAR-D-11 below provides a summary of Business Systems' O&M
19 expense forecast for AMI for 2021 through 2025. As shown in Table WAR-D-11, as
20 additional AMI meters are deployed starting in 2021, there is a corresponding
21 increase in the associated Business Systems' O&M expenses related to supporting
22 these additional meters. For instance, additional AMI meters require additional
23 software licenses to operate associated software.

Table WAR-D-11
AMI – O&M Expenses for Business Systems
(Total Company)
(Dollars in Millions)

	2021	2022	2023	2024	2025
AMI	\$5.71	\$5.55	\$7.25	\$7.79	\$8.51

Q. HOW DID BUSINESS SYSTEMS DEVELOP ITS O&M FORECAST FOR AMI?

A. The AMI O&M forecast was developed based on industry benchmarking information as well as the Company's previous experience with similar systems implementations and support models.

Q. WHAT ARE THE CURRENT BUSINESS SYSTEMS CONTINGENCIES FOR AMI?

A. The Business Systems AMI budget forecast for the period 2021-2025 includes capital contingency amount of approximately 24 percent.

Q. WHY IS IT STILL NECESSARY TO CARRY A CONTINGENCY FOR BUSINESS SYSTEMS' AMI WORK?

A. Due to the integrated nature of deployment and implementation of AMI and the FAN, several reasons for including contingency amounts in the AMI budget are applicable to the FAN as well. While the FAN budget is discussed separately in the following section, I address the budget contingencies overall here to avoid duplication.

First, budget contingency amounts are appropriate due to the scale of the deployment and the volume of data that will be handled as a result of AMI implementation. As discussed above, the volume of data provided by AMI metering is orders of magnitude larger than our current metering system provides. While our project plans are appropriate with respect to the IT architecture, software, hardware,

1 and integrations necessary to manage and use this data, additional work may be
2 required as the Company cannot replicate in a test environment what will actually
3 occur during full roll-out.

4 In addition, geography is important in the deployment and functioning of the
5 AMI meters and FAN network devices. Similarly, weather may have an impact as it
6 can result in delays in implementation or require replacement of weather damaged
7 devices. Business Systems has conducted field coverage studies to ensure the FAN
8 will provide adequate coverage for both deployment of meters and other devices, and
9 our deployment plans are specific to the Colorado geography and weather. However,
10 we cannot duplicate some of the realities of field deployment in a test environment,
11 so some level of contingency is appropriate.

12 The multi-year implementation schedule is also a reason using contingencies
13 is appropriate. Part of IT planning requires that Business Systems will be able to
14 address new security threats that may evolve over the implementation timeline.
15 While the Company budgets for these eventualities at some level, contingency
16 amounts are included because Public Service must ensure the ability to implement
17 security controls as new cyber threats arise.

18 **Q. DOES THE COMPANY BELIEVE THE CONTINGENCY AMOUNTS WILL BE**
19 **USED?**

20 A. Yes, while the Company does not necessarily anticipate using all of the
21 contingencies, some amount of contingency will be used based on experience with
22 prior projects. Contingency amounts are included to avoid the need for tradeoffs in
23 schedule and/or scope and functionality. In this way, Public Service can ensure

1 implementation of the project will help maximize benefits for our customers. The
2 overall AGIS governance structure provides for review and approval of any project
3 changes that will affect the scope, costs, or benefits of implementation. Any changes
4 from budgeted amounts and any specific use of budget contingencies will need
5 approval according to the established AGIS governance processes.

6 **Q. IN SUMMARY, WHY ARE BUSINESS SYSTEMS' AMI COSTS REASONABLE**
7 **FOR CUSTOMERS TO SUPPORT?**

8 A. AMI is a foundational component of AGIS. As discussed above, AGIS is a long-term
9 strategic initiative to transform our electrical distribution system to enhance security,
10 efficiency, and reliability, to safely integrate more DERs, including those that are
11 customer owned, and to enable improved customer products and services. The IT
12 components described above are necessary to implement AMI and the AMI IT
13 forecast is reasonable in enabling technologies that improve customer products and
14 services.

15 In addition, as previously discussed, the Company employs standard
16 processes and procedures for selecting vendors and technologies to be deployed in
17 the Company's environment, as well as for the execution of large capital projects.
18 For AMI, this included a robust RFP process. The Company used multiple RFP
19 processes to select the optimal vendor partners for various aspects of the AMI
20 delivery. A competitive bid was completed at the end of 2017 resulting in the
21 selection of Itron for the AMI head-end software solution. An additional competitive
22 bid process was completed in 2018 to select a vendor partner for all project testing.

1 **IV. Advanced Distribution Management System**

2 **Q. WHAT IS THE PURPOSE OF THIS PORTION OF YOUR DIRECT TESTIMONY?**

3 A. In this section of my Direct Testimony, I review the purpose of the Advanced
4 Distribution Management System or ADMS and the IT integration to support it,
5 provide updates on the deployment timeline for ADMS, and identify the Business
6 Systems' current capital and O&M cost forecasts for ADMS. ADMS was
7 introduced in the AGIS CPCN filing but has been implemented by the Company
8 in the normal course of business – that is, the Company did not seek a CPCN for
9 ADMS. ADMS was discussed further in Public Service's 2019 Electric Rate Case.⁷

10 **A. Overview of ADMS Integration**

11 **Q. WHAT IS THE ADMS?**

12 A. ADMS will provide an integrated operating and decision software and hardware
13 support system to assist control room, field personnel, and engineers with the
14 monitoring, control, and optimization of the electric distribution system. It will
15 manage the complex interaction of distributed energy resources ("DER"), outage
16 events, feeder switching operations and advanced applications such as IVVO and
17 FLISR. ADMS gives access to real-time and near real-time data to provide all
18 information on an operator console(s) at the control center in an integrated
19 manner, which means the different operating systems and technologies will
20 communicate with and update each other in the ADMS platform. ADMS is the
21 fundamental platform that utilizes the updated data the Distribution area is

⁷ Proceeding No. 19AL-0268E, Direct Testimony of David C. Harkness

1 gathering as part of the AGIS GIS project, and manages advanced applications
2 (IVVO, FLISR).

3 **Q. HAS THE COMPANY DISCUSSED ADMS IN PAST FILINGS WITH THE**
4 **COMMISSION?**

5 A. Yes. In addition to an overview in the AGIS CPCN Proceeding, Company witness
6 Mr. David C. Harkness provided a detailed description of ADMS in the Company's
7 2019 Electric Rate Case. Mr. Nickell's current Direct Testimony highlights
8 progress made to implement ADMS since that proceeding. For my Direct
9 Testimony, I highlight the Business Systems' role in developing and deploying
10 ADMS for Public Service customers.

11 **Q. WHY DOES ADMS NEED TO BE INTEGRATED WITH THE COMPANY'S**
12 **EXISTING SYSTEMS?**

13 A. ADMS provides an integrated operating and decision software and hardware
14 support system to assist control room, field personnel, and engineers with the
15 monitoring, control and optimization of the electric distribution system. ADMS is
16 the fundamental platform that manages each of the other AGIS projects. It is
17 composed of hardware, software, distribution Supervisory Control and Data
18 Acquisition ("SCADA"), and an impedance model, which is an accurate electrical
19 representation of the distribution grid, including substations, feeders, and field
20 devices. ADMS leverages sensor data for use by the core and advanced
21 applications to make accurate and informed decisions to manage power flow on
22 the distribution grid.

1 From a Business Systems perspective, ADMS has core applications, which
2 make up the foundation of ADMS, as well as advanced applications. The core
3 applications include distribution network modeling, network topology processor,
4 impedance calculation, unbalanced load allocation, unbalanced load flow, state
5 estimation, and distribution SCADA. These applications provide the basis for
6 running load flow and state estimation on the distribution system providing near
7 real-time calculations of the state of the network including factors such as voltages,
8 currents, real and reactive power, amps, voltage drops, and losses. The ADMS
9 advanced applications utilize the core applications and provide additional
10 capability. As Mr. Nickell describes, Public Service utilizes two such advanced
11 applications: IVVO and FLISR, which rely on accurate power flow calculations to
12 determine the power flow at points on the grid where sensor information does not
13 exist.

14 **Q. WITH WHAT SYSTEMS IS ADMS INTEGRATED?**

15 A. The ADMS integrates with a number of other systems using real-time and on-
16 demand interfaces. ESB interfaces are used where technically and economically
17 feasible. Additionally, some interfaces exist as a combination of different interface
18 methods—in particular, interfaces to the SCADA systems may utilize a
19 combination of industry-standard interfaces such as Inter-Control Center
20 Communications Protocol (the “ICCP”), file transfers, or web services. Below is a
21 list of systems with which ADMS is integrated that includes existing systems as
22 well as AMI.

- 1 • *AMI*: ADMS integrates with AMI, which has its own head-end system, to
2 improve load-flow calculation accuracy and IVVO performance. ADMS
3 receives voltage and power measurements from bellwether AMI meters
4 through the AMI head-end system. Additionally, ADMS will benefit from
5 improved load profiles enabled by AMI interval data.

- 6 • *General Electric (“GE”) SmallWorld GIS*: The ADMS integrates with Xcel
7 Energy’s GE SmallWorld GIS. SmallWorld GIS contains the “As Engineered”
8 network model of Xcel Energy’s distribution feeders. The ADMS uses the
9 network model as a basis for all of the basic and advanced applications of the
10 ADMS. Additionally, the ADMS receives land-based vector data to underlay
11 feeder maps within the geospatial view, which provide better operational
12 context and enhanced situational awareness. The GIS is part of the ADMS
13 project for AGIS implementation.

- 14 • *CRS*: The ADMS integrates with Xcel Energy’s CRS. CRS manages customer
15 service and billing processes. CRS provides customer information to the
16 ADMS and is used by Control Center personnel and ADMS applications.

- 17 • *Decentralized Energy Management System (“DEMS”) SCADA*: ADMS
18 integrates with the DEMS in the following ways: analogs and status for
19 substation devices from DEMS to ADMS; control requests from ADMS to
20 DEMS for substation devices; Status & Distributed Energy Resources analogs
21 from ADMS to DEMS; fault currents and relay targets from DEMS to ADMS;
22 tags from ADMS to DEMS; and SCADA database and ICCP database
23 configuration from DEMS to ADMS.

- 24 • *Oracle NMS*: Xcel Energy currently uses Oracle NMS to manage electric
25 distribution network outages and planned switching. Currently, the as-operated
26 network model resides in NMS to support the outage management process.
27 Because NMS will continue to perform outage management after ADMS is in
28 use, the network model in the ADMS and the network model in NMS shall
29 remain “in-sync”, with changes in one model being reflected in the other model.
30 Specifically, any state changes made to non-telemetered devices in the NMS
31 model shall be automatically reflected in the ADMS. Additionally, any state
32 changes made to telemetered devices in the ADMS model shall be
33 automatically reflected in NMS. Tags and notes will also be transferred
34 between ADMS and NMS.

- 35 • *Weather Data Service*: Weather data is used to support load forecasting and
36 DER output modeling within the ADMS. Weather data from the Weather Data
37 Service includes current and forecasted temperature, wind speed, and solar
38 irradiance.

- 1 • *SailPoint*: SailPoint is Xcel Energy's Identity and Access Management solution.
2 SailPoint supports the Company's technologies to securely govern and
3 manage access into technology resources. SailPoint provides access review
4 services and user provisioning. The ADMS sends user permission information
5 to SailPoint in support of the Quarterly Access Review process.
- 6 • *SAP*: SAP is Xcel Energy's Enterprise Resource Planning system. ADMS
7 integrates with SAP to initiate work orders for equipment in electric substations
8 and on distribution feeders. This interface minimizes dual entry of equipment
9 information already available in ADMS when generating SAP work orders.

10 **Q. PLEASE DESCRIBE FURTHER HOW ADMS AND AMI AND BACK OFFICE**
11 **APPLICATIONS ARE INTEGRATED.**

12 A. Public Service connects AMI meters with the AMI head-end software that sends
13 commands to meters and receives data from the meters using the FAN for
14 communication. From the AMI head-end, data is distributed to ADMS and other
15 back office applications, using an ESB, to enable the capabilities to deliver benefits
16 to the Company and its customers. ADMS data from field devices, including AMI
17 meters, is also be distributed to various back office applications, using an ESB, to
18 enable more effective and efficient management of the distribution grid.

19 **Q. WHAT WORK IS BUSINESS SYSTEMS UNDERTAKING TO INTEGRATE THE**
20 **ADMS PROJECT?**

21 A. The specific functions Business Systems provided, and continues to provide in
22 some cases for ADMS, include:

- 23 • Led the design of ADMS including software installation, configuration,
24 interfaces required with the ADMS and operational procedures impacted by the
25 system;
- 26 • Procurement and installation of all hardware components that run the software,
27 procurement of the ADMS software;
- 28 • Configuration of the software and hardware;

- 1 • Build and installation of any required interfaces;
- 2 • Design and integration of security into all aspects of the ADMS solution;
- 3 • Thorough unit, system, end-to-end and performance testing of the ADMS
- 4 solution;
- 5 • User Acceptance Testing with the Distribution business resources; and
- 6 • Establishment of a full ongoing support structure including process and
- 7 operational requirements.

8 **Q. SPECIFIC TO THE GIS PORTION OF THE ADMS PROJECT, WHY IS**
9 **INTEGRATION NEEDED?**

10 A. The GIS provides location information about all physical assets that make up the
11 Company's distribution system, as well as specification information of the physical
12 assets, such as a distribution feeder's size. ADMS uses the location and
13 specification information to maintain the as-operated electrical model and
14 advanced applications. While GIS is an existing system, the Company needed to
15 engage in a data gathering effort to validate and update the information in GIS
16 because the ADMS model needs accurate information to operate effectively.

17 **Q. WHAT WORK DID BUSINESS SYSTEMS UNDERTAKE WITH RESPECT TO**
18 **THE GIS PROJECT?**

19 A. Business Systems' role in the GIS aspects of AGIS was to partner with the
20 Distribution Business Area in the data collection effort, validate data accuracy, and
21 establish ongoing data collection/update processes. The costs associated with the
22 GIS data collection and validation are included in Distribution's costs. Software
23 integration, storage, and automated processes are included in Business Systems
24 integration costs. This cost allocation ensures that costs are appropriately applied

1 to either the creation of the data asset, with data itself being an asset associated
2 with the management of the distribution system, or to the implementation and
3 management of the supporting technology.

4 **Q. WAS BUSINESS SYSTEMS PRIMARILY RESPONSIBLE FOR DEVELOPING**
5 **THE FORECASTS FOR THE GIS WORK?**

6 A. No, therefore, Mr. Nickell provides the primary support for the forecasts for the GIS
7 data work. However, Business Systems partnered with Distribution to help
8 develop this forecast in some respects, including through the performance of a gap
9 analysis between what information is required by the ADMS and what is currently
10 stored and available in the Company's GIS data model; assessing the quality of
11 data currently held in the GIS and external sources; and determining if additional
12 data cleanup activities are required. As a result of this effort, a unit cost for each
13 required data element was derived by using the amount of assets in the GIS and
14 applying a data capture cost from each field inspection vendor. This information
15 was documented and managed via a formal RFP process. The GIS activities
16 undertaken by Distribution are discussed by Mr. Nickell.

17 **B. ADMS Deployment Timeline**

18 **Q. PLEASE DESCRIBE THE WORK BUSINESS SYSTEMS HAS ALREADY**
19 **COMPLETED TO SUPPORT THE IMPLEMENTATION OF ADMS**
20 **IMPLEMENTATION.**

21 A. Distribution and Business Systems have conducted their ADMS implementation
22 activities in partnership with each other. In 2017, Business Systems completed
23 the detailed design of ADMS. Business Systems also conducted the installation,

1 configuration, and initial testing of the core components of the software solution
2 and built the system interfaces. Business Systems also engaged in data collection
3 activities and formatted substation and field data for system acceptance and
4 testing, as well as built the network model for substations and feeders to be used
5 in system acceptance and testing.

6 In 2018, Business Systems performed detailed unit, system, and end-to-
7 end testing of the ADMS solution as well as testing of all interfaces. Business
8 Systems continued data collection and formatting of all substation and field data
9 required for system acceptance and testing. Business Systems completed the
10 building of the network model and performed activities to prepare for ADMS to “go
11 live” and operational in 2019.

12 **Q. CAN YOU PROVIDE KEY MILESTONES SPECIFIC TO ADMS**
13 **IMPLEMENTATION THAT WERE ACCOMPLISHED IN 2019?**

14 A. Yes. Business Systems’ first deployment of ADMS in the production environment
15 occurred in the second quarter of 2019 and was called the “PSCo Grid
16 Management Go Live.” At that time, Business Systems deployed the core ADMS
17 applications, infrastructure, and relevant integrations (e.g., GIS, CRS, Outage
18 Management, Weather). In addition, Business Systems also deployed an initial
19 internal network model while Distribution deployed field devices to begin realizing
20 the benefit of IVVO functionality.

21 In the third quarter of 2019, Business Systems implemented the SAP
22 Integration with ADMS. At that time, Business Systems deployed the SAP

1 integration which provides the ability to send work notification requests initiated in
2 ADMS to SAP.

3 In the fourth quarter of 2019, Business Systems deployed the Grid Edge
4 Management System (“GEMS”) software to support IVVO, which is described later
5 in the IVVO section.

6 **Q. WHAT WORK REMAINS TO BE COMPLETED BY BUSINESS SYSTEMS IN**
7 **2020 TO IMPLEMENT ADMS?**

8 A. The Company is currently planning to have the next major deployment of ADMS
9 in the fourth quarter of 2020, called the “PSCo Control Center Go Live – Q4 2020.”
10 At the time of this key milestone, the Company will activate the control center’s use
11 of ADMS for management and control of the Public Service’s distribution system.
12 This means that ADMS will be used to manage substations and telemetered field
13 devices and ADMS’s integration to the outage management system will be
14 activated. Following the completion of this major milestone in the fourth quarter of
15 2020, barring unforeseen circumstances and outside of upgrades and
16 maintenance, there are no additional major Business Systems deliverables for
17 initial implementation of ADMS for Public Service.

18 **C. Business Systems’ Capital Costs for ADMS**

19 **Q. WAS BUSINESS SYSTEMS PRIMARILY RESPONSIBLE FOR DEVELOPING**
20 **THE CAPITAL FORECAST FOR ADMS?**

21 A. Yes, Business Systems is responsible for the hardware, software, and labor
22 associated with the design and build of the ADMS system and interfaces.
23 Therefore, I describe the forecast development process for ADMS in more detail

1 here. Mr. Nickell provides the primary discussion of Distribution's data collection
2 efforts associated with the GIS for use in the ADMS, and I provide some additional
3 discussion of the GIS data collection project. I note that since ADMS is being
4 developed as one software system that will be used by all of the Xcel Energy
5 operating companies, costs for ADMS are allocated to each operating company as
6 described by Company witness Ms. Laurie J. Wold.

7 **Q. WHAT PORTION OF THE CAPITAL COSTS FOR ADMS AND GIS HAVE**
8 **ALREADY BEEN PLACED IN SERVICE?**

9 A. Public Service began implementing ADMS and GIS data collection efforts in 2016
10 and, as a result, a significant portion of these costs have been placed in service
11 and are currently being recovered in base rates. Company witness Ms. Blair
12 provides details as to the portion of AGIS costs that are currently being recovered
13 through base rates.

14 **Q. WHAT ARE THE FORECASTED CAPITAL ADDITIONS FOR BUSINESS**
15 **SYSTEMS FOR ADMS?**

16 A. The tables below provide a breakdown of Business Systems' capital expenditures
17 and capital additions forecast for ADMS and GIS for 2020 through 2025. As
18 discussed above, since Public Service plans to make ADMS operational in the
19 control center in the fourth quarter of 2020, there are no anticipated capital
20 expenditures for this project beyond 2020 and a limited amount of forecasted
21 capital additions for 2021.

Table WAR-D-13
ADMS Business Systems - Capital Expenditures
(Total Company)
(Dollars in Millions)

	2020	2021	2022	2023	2024	2025	TOTAL
ADMS	\$12.04	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$12.04

Table WAR-D-14
ADMS Business Systems - Capital Additions
(Total Company)
(Dollars in Millions)

	2020	2021	2022	2023	2024	2025	TOTAL
ADMS	\$24.48	\$0.16	\$0.0	\$0.0	\$0.0	\$0.0	\$24.64

Q. WHAT ARE THE PRIMARY COMPONENTS OF BUSINESS SYSTEMS' ADMS CAPITAL COSTS?

A. There are three key components: (1) labor; (2) software; and (3) hardware.

Q. PLEASE PROVIDE AN OVERVIEW OF THE PROCESS FOR DEVELOPING THE BUSINESS SYSTEMS' ADMS CAPITAL BUDGET.

A. The Company issued an RFP in 2015 to determine the most appropriate distribution management system for the Company. Out of that process, a vendor, Schneider Electric, was chosen for the software as well as the systems integration work. The Company selected Schneider Electric for the following key reasons:

- Industry's best and most complete DMS application suite;
- Industry's largest, qualified DMS applications staff;
- Strong track record of ADMS implementations; and
- Large US customer base.

1 A summary of the RFP selection process and results for ADMS are provided as
2 Highly Confidential Attachment WAR-5 to my Direct Testimony. After the ADMS
3 vendor was selected, a detailed project cost estimate was created from the pricing
4 and contract information as well as labor and hardware to support the overall
5 ADMS project. This effort was benchmarked and reviewed with other utilities and
6 industry research organizations such as EPRI. Upon completion of the detailed
7 design, a detailed implementation plan was developed and the ADMS project cost
8 estimates were updated.

9 **Q. PLEASE PROVIDE ADDITIONAL DETAILS AS TO HOW THE LABOR**
10 **PORTION OF THE ADMS FORECAST WAS DEVELOPED.**

11 A. The ADMS labor estimate was developed from a bottom-up forecast of all
12 resources required to complete the implementation phase. The estimates included
13 labor costs already incurred through the detail design phase along with estimates
14 to complete the implementation phase work. Labor components for the
15 implementation phase included external vendors (Schneider, General Electric and
16 Oracle), and contractors. Vendor cost estimates were based on contractual
17 agreements with each vendor. The contractor labor forecast was based on a roll-
18 up of all resources required, including estimated durations and rates for each.

19 **Q. HOW DID THE COMPANY DERIVE THE SOFTWARE PORTION OF BUSINESS**
20 **SYSTEMS' ADMS COSTS?**

21 A. The software portion of the ADMS costs consisted of a license agreement with the
22 ADMS vendor, Schneider, and various third-party (i.e., Microsoft, VMware,
23 InfoBlox and Leidos) infrastructure licenses. The Schneider license agreement

1 was a fixed cost and has been fully executed. The third-party software consists of
2 licenses for the operating systems, databases and security products to operate
3 and secure the ADMS system. The cost estimates were based on the number of
4 hardware environments, servers, and processors based on existing license
5 agreement costs with the third-party companies.

6 **Q. HOW DID THE COMPANY DERIVE THE HARDWARE PORTION OF**
7 **BUSINESS SYSTEMS' ADMS IT FORECAST?**

8 A. Detailed system processing requirements were gathered through the RFP process
9 as well as the contract process with the selected vendor for the ADMS system.
10 These detailed requirements were used by the project team and the Company's
11 infrastructure team, in conjunction with the ADMS vendor's technical experts, to
12 determine size, scale and costs for all aspects of the infrastructure needed to
13 adequately, securely and reliably operate the ADMS system for the Company. The
14 types of hardware required include processors, data storage, security
15 hardware/software, network devices such as firewalls and core switches, as well
16 as critical data center infrastructure including power, cooling and cabling.

17 **D. Business Systems' O&M Costs for ADMS**

18 **Q. WHAT ARE THE PRIMARY COMPONENTS OF BUSINESS SYSTEMS' ADMS**
19 **O&M COSTS?**

20 A. The primary components of Business Systems' ADMS O&M costs include: (1)
21 planning phase activities; and (2) support activities that will occur after ADMS is
22 implemented, including contract labor, ongoing hardware and software

1 maintenance and warranty. The table below provides a breakdown of Business
2 Systems' O&M expense forecast for ADMS and GIS for 2021 through 2025.

3
Table CSN-D-15
ADMS Business Systems – O&M Expenses
(Total Company)
(Dollars in Millions)

	2021	2022	2023	2024	2025	TOTAL
ADMS	\$1.96	\$1.99	\$3.14	\$3.27	\$1.96	\$12.32

4 **Q. HOW DID BUSINESS SYSTEMS DERIVE THE ADMS O&M BUDGET?**

5 A. The largest component of the ADMS O&M budget is support. The Company
6 developed a support model to fulfill the new requirements of the ADMS
7 operation. The Company analyzed specific needs for support of the ADMS
8 components (e.g., application, infrastructure, network, integrations) to develop the
9 initial support model. The Company then validated and refined based on
10 comparisons to similar internal integrated operating and decision support systems.
11 Finally, the Company validated and refined against industry benchmarks which
12 were obtained from peer utilities.

13 **Q. DOES THE BUSINESS SYSTEMS' ADMS PROJECT FORECAST INCLUDE A**
14 **CONTINGENCY?**

15 A. No. The Company is in the final stages of implementing ADMS and the forecasted
16 capital expenditures for 2020 do not include any contingency.

1 **Q. WHY ARE THE BUSINESS SYSTEMS' ADMS COSTS REASONABLE FOR**
2 **CUSTOMERS TO SUPPORT?**

3 A. ADMS is the fundamental platform that manages each of the other AGIS programs.
4 ADMS will provide an integrated operating and decision software and hardware
5 support system to assist control room personnel, field personnel, and engineers
6 with the monitoring, control and optimization of the electric distribution system. For
7 ADMS to operate as intended, this software had to be integrated with a number of
8 existing systems as well as AMI. These integration costs are reasonable and
9 necessary expenses to enable the ADMS capabilities, which in turn provide the
10 customer benefits. Further, the Company underwent an extensive RFP process
11 to select an ADMS vendor. Finally, the initial budget for ADMS was developed
12 using information collected from other utilities, industry experts, consultants, and a
13 rigorous sourcing process.

V. Integrated Volt-Var Optimization

Q. WHAT IS THE PURPOSE OF THIS SECTION OF YOUR TESTIMONY?

A. In this section of my testimony, I discuss the IT integration necessary for IVVO to function, as well as providing an update on work remaining for Business Systems to implement IVVO and Business Systems' capital and O&M cost forecasts for IVVO.

A. Overview of IVVO Integration

Q. WHAT IS IVVO AND WHY IS IT INTEGRATION IMPORTANT FOR IMPLEMENTATION OF IVVO?

A. IVVO, which was approved by the Commission as part of the AGIS CPCN Settlement, is an advanced application that automates and optimizes the operation of the distribution voltage regulating devices located on distribution feeders. IVVO allows Public Service to more efficiently and accurately maintain proper voltage levels throughout the system, thereby reducing energy usage without any action by customers. The advanced application IVVO relies on accurate power flow calculations to determine the power flow at points on the grid where sensor information does not exist. As such, they require integration with the core ADMS systems. IVVO needed to be integrated with the ADMS core applications and other critical systems to provide its intended benefits to the Company's customers.

IVVO is on a five-year deployment schedule that began in late 2017. Currently, Distribution is working on installing additional voltage control devices

1 and enabling IVVO on more feeders. Additional detail on the IVVO rollout is
2 documented in Mr. Nickel's Direct Testimony.

3 **Q. WHAT WORK IS BUSINESS SYSTEMS RESPONSIBLE FOR WITH RESPECT**
4 **TO THE IVVO?**

5 A. Business Systems has responsibility to complete the following tasks in support of
6 the implementation of IVVO:

- 7 • Lead the design of the system components;
- 8 • Configuration of the required software and hardware;
- 9 • Building and installation of any required interfaces;
- 10 • Designing and integrating security into all aspects of IVVO;
- 11 • Thorough unit, system, and end-to-end testing;
- 12 • User Acceptance Testing with the Distribution business resources.

13 Overall, Distribution installs the IVVO equipment, and the Company
14 captures data and configure equipment, and then tunes ADMS models. Business
15 Systems will support this IVVO implementation by adding and conditioning field
16 devices to support IVVO functionality and will perform testing to support the
17 expansion of IVVO. Business Systems also implemented the GEMS software for
18 the secondary static VAR compensator ("SVC") devices that are part of the IVVO
19 implementation and will complete IT integration of the IVVO advanced sub-
20 application with ADMS.

1 **Q. PLEASE DESCRIBE THE GEMS SOFTWARE THE COMPANY HAS**
2 **SELECTED TO SUPPORT THE IVVO FIELD DEVICES.**

3 A. The GEMS software was included in the package from the vendor supplying the
4 SVC devices. As discussed in Mr. Nickell's Direct Testimony, the Company
5 selected Varentec's Edge of Network Grid Optimization ("ENGO") unit as the
6 winning bidder for the SVC devices. The GEMS software to manage and control
7 the SVC devices was included in the package. Business Systems will deploy the
8 GEMS software for management and control of the ENGO SVC devices. The
9 Company will host the server in-house for IVVO deployment.

10 **B. IVVO Deployment Timeline**

11 **Q. WHAT WORK ON IVVO HAS BEEN COMPLETED TO DATE BY BUSINESS**
12 **SYSTEMS?**

13 A. The IVVO advanced application was initially enabled at one transformer area in
14 April 2019, and enablement occurred at five additional transformers through the
15 end of 2019. To support this functionality, the installed IVVO field devices were
16 integrated into ADMS and are controlled by the IVVO application.

17 In 2019, the Company continued with the deployment of IVVO-enabling
18 devices, including capacitors, SVCs, and Load Tap Changer ("LTC") controllers.
19 The initial deployment of 13,000 AMI meters necessary to support IVVO bellwether
20 functionality were installed by year-end 2019. The 13,000 AMI meter deployment
21 created the necessary mesh communication network and enabled approximately
22 200 residential meters as bellwether meters, allowing the near real-time voltage
23 insights from these meters to flow into ADMS.

1 In the fourth quarter of 2019, the Company deployed the GEMS software.
2 This deployment provided the ability to manage ENGO field devices and receive
3 voltage information. ENGO field devices provide voltage regulation which supports
4 IVVO functionality.

5 **Q. WHAT WORK WILL BE COMPLETED IN 2020 BY BUSINESS SYSTEMS TO**
6 **IMPLEMENT IVVO?**

7 A. During 2020, the Company will finalize the integration between AMI and ADMS
8 and refine IVVO settings and objectives. The deployment of the integration with
9 the AMI head-end system will facilitate the ability to receive voltage information
10 from the IVVO bellwether AMI meters to support IVVO functionality, load flow, and
11 state estimation.

12 Beginning in the third quarter of 2020, the Company will start using the
13 bellwether functionality to provide additional insights to the ADMS using the
14 installed AMI meters as described above. The primary functionality of this initial
15 deployment of bellwether meters is providing voltage at desirable locations on the
16 feeder. The Company will also continue to remove legacy devices and reprogram
17 compatible devices.

18 The Company also plans to complete the integration of GEMS with ADMS
19 in the third quarter of 2020, which will allow the IVVO SVC units to provide real-
20 time monitoring and control to ADMS.

21 **Q. IS THERE ANY ADDITIONAL WORK PLANNED FOR IVVO BEYOND 2020?**

22 A. No, not for Business Systems. As noted by Mr. Nickell, Distribution will continue
23 to deploy IVVO devices through 2023.

1 **C. Business Systems' IVVO Capital Costs**

2 **Q. WAS BUSINESS SYSTEMS PRIMARILY RESPONSIBLE FOR DEVELOPING**
3 **THE FORECASTS FOR IVVO?**

4 A. No. However, Business Systems was responsible for developing the forecast for
5 the GEMS software and for managing the integration of the IVVO advanced sub-
6 application with ADMS. Mr. Nickell provides a discussion of the cost forecast
7 process with respect to the IVVO advanced application and its related field
8 devices.

9 **Q. WHAT ARE THE CAPITAL COSTS OF IVVO FOR WHICH BUSINESS**
10 **SYSTEMS IS RESPONSIBLE?**

11 A. The tables below provide a breakdown of Business Systems' capital expenditures
12 and capital additions forecast for IVVO for 2020 through 2025. As demonstrated
13 by these tables, there are limited capital investments by Business Systems beyond
14 2020. The \$4.85 million in forecasted capital investment in 2023 is a contingency
15 amount for additional hardware or software that may be needed as additional IVVO
16 devices are deployed by Distribution in this time frame. As noted earlier, these
17 costs are subject to annual forecasts and true-ups through the AGR as described
18 by Company witness Mr. Berman.

1

Table WAR-D-16
IVVO Business Systems - Capital Expenditures
(Total Company)
(Dollars in Millions)

	2020	2021	2022	2023	2024	2025	Total
IVVO	0.10	0	0	4.85	0	0	4.95

2

Table WAR-D-17
IVVO Business Systems - Capital Additions
(Total Company)
(Dollars in Millions)

	2020	2021	2022	2023	2024	2025	Total
IVVO	2.63	0.00	0.00	4.85	0.00	0.00	7.48

3 **Q. WHAT ARE THE PRIMARY COMPONENTS OF BUSINESS SYSTEMS' IVVO**
4 **CAPITAL FORECAST?**

5 A. The IVVO capital forecast has three key components: (1) hardware; (2) software;
6 and (3) labor.

7 **Q. WHAT HARDWARE IS NEEDED TO COMPLETE THE IVVO**
8 **IMPLEMENTATION BY BUSINESS SYSTEMS?**

9 A. The additional hardware necessary for implementation consists of computing
10 components used for data processing and storage to support IVVO services.
11 Additional servers are needed due to the increased volume of data and processes
12 necessary to implement IVVO capabilities.

1 **Q. HOW DID THE COMPANY DERIVE THE HARDWARE PORTION OF THE IVVO**
2 **FORECAST?**

3 A. Xcel Energy has standards for all hardware that is deployed in our data centers.
4 These standards define hardware for which the Company has industry
5 benchmarked, negotiated pricing. Based on these standards, the hardware
6 estimates were derived utilizing the hardware requirements of the applications and
7 applying standard pricing.

8 **Q. HOW DID THE COMPANY DEVELOP THE COST FORECAST FOR IVVO**
9 **SOFTWARE COSTS?**

10 A. Pricing for the IVVO software is provided in the contract with Varentec, selected
11 through the RFP process noted above. Pricing is consistent with industry
12 benchmarks and our review with other utilities and industry research organizations
13 such as EPRI. These benchmarks drove the negotiations with the selected
14 vendor. Varentec provided budgetary quotes for their ENGO device licensing
15 based on a cloud-based approach and an in-house server-based approach. The
16 in-house approach was used to develop cost estimates, consistent with the
17 Company's security requirements.

18 **Q. HOW DID BUSINESS SYSTEMS DEVELOP THE FORECAST FOR THE**
19 **CAPITAL LABOR COSTS?**

20 A. This forecast includes both internal and external labor. External labor costs are
21 based on the contract pricing described above. The internal labor forecast is
22 based on our experience and work that has already been completed for IVVO
23 implementation.

D. Business Systems' O&M Costs for IVVO

Q. WHAT ARE THE O&M COSTS OF IVVO FOR WHICH BUSINESS SYSTEMS IS RESPONSIBLE?

A. The table below provides a summary of Distribution's O&M expense forecast for IVVO for 2021 through 2025.

**Table WAR-D-18
IVVO Business Systems– O&M Expenses
(Total Company)
(Dollars in Millions)**

	2021	2022	2023	2024	2025	TOTAL
IVVO	\$0.18	\$0.18	\$0.18	\$0.19	\$0.20	\$0.93

Q. WHAT ARE THE PRIMARY COMPONENTS OF BUSINESS SYSTEMS' FORECASTED O&M COSTS FOR IVVO?

A. The primary components of Business Systems' IVVO O&M costs include ongoing hardware support, data storage, annual software maintenance, application support, and labor for software support.

Q. HOW DID BUSINESS SYSTEMS DERIVE ITS IVVO O&M FORECAST?

A. The IVVO O&M forecast was developed based on vendor quotes, existing internal support team estimates of the work required, and industry benchmarking information. Each AGIS component has an IT team responsible for project delivery. Public Service's forecasts for labor costs related to IVVO are based on estimates from previous experience with similar systems implementations and support models.

1 **Q. DOES BUSINESS SYSTEMS HAVE ANY CONTINGENCY REMAINING FOR**
2 **IVVO?**

3 A. As discussed above, Business Systems currently has \$4.85 million in contingency
4 budgeted for 2023 to account for any additional hardware or software needs that
5 arise as more IVVO field devices are deployed across the system by Distribution.
6 This contingency will allow Business Systems to purchase additional hardware and
7 software as may be required to support the additional IVVO devices that are
8 deployed by Distribution through 2023.

9 **Q. IN SUMMARY, WHY ARE THE BUSINESS SYSTEMS' IVVO COSTS**
10 **REASONABLE FOR CUSTOMERS TO SUPPORT?**

11 A. As discussed by Mr. Nickell, IVVO automates and optimizes the operation of the
12 distribution voltage regulating and VAr control devices to in turn, reduce electrical
13 losses, electrical demand, and energy consumption. Fundamentally, IVVO is a
14 demand side management tool that does not require any behavioral changes from
15 customers. In addition, by automating and improving voltage management and
16 power quality, IVVO provides increased capacity to host DER. The Business
17 Systems work will provide for the implementation of IVVO and integration with the
18 advanced grid technologies, enabling these benefits for our customers and the
19 system. The Business Systems IVVO forecast is reasonable based on the details
20 provided above.

1 **VI. FAULT LOCATION ISOLATION SYSTEM RESTORATION**

2 **Q. WHAT IS THE PURPOSE OF THIS SECTION OF YOUR TESTIMONY?**

3 A. In this section of my testimony, I will describe the IT integration necessary to
4 support FLISR, provide updates on the deployment timeline for FLISR, and discuss
5 Business Systems' current cost forecast for FLISR. FLISR and FLP were
6 introduced and discussed in the AGIS CPCN Proceeding but have been
7 implemented by the Company in the normal course of business. FLISR and FLP
8 were also discussed in Public Service's 2019 Phase I Electric Rate Case.

9 **A. Overview of FLISR Integration**

10 **Q. WHAT ARE FLISR AND FLP AND WHY IS IT INTEGRATION IMPORTANT FOR**
11 **THE IMPLEMENTATION OF FLISR AND FLP?**

12 A. FLISR is an integrated system that includes the advanced application within
13 ADMS, a communication network, and automated field devices that enable
14 automated switching devices to decrease the duration and number of customers
15 affected by any individual outage. FLP is a subset application of FLISR that
16 leverages sensor data from field devices to locate a faulted section of a feeder line
17 and reduce patrol times needed to physically locate a failure on the system. I note
18 that when I refer to FLISR in my testimony, these discussions include FLP.

19 FLISR relies on accurate power flow calculations to determine the power
20 flow at points on the grid where sensor information does not exist. As such, they
21 require integration with the core ADMS systems and other critical systems to be
22 able to accurately locate faults, isolate faults, and restore power to the Company's
23 customers.

1 **Q. WHAT WORK IS BUSINESS SYSTEMS UNDERTAKING WITH RESPECT TO**
2 **FLISR?**

3 A. The work Business Systems will undertake with respect to FLISR is as follows:

- 4 • Leading the design of the system components;
- 5 • Configuration of the required software and hardware;
- 6 • Building and installation of any required interfaces;
- 7 • Designing and integrating security into all aspects of FLISR;
- 8 • Thorough unit, system, and end-to-end testing; and
- 9 • User Acceptance Testing with the Distribution business resources.

10 **B. FLISR Deployment Timeline**

11 **Q. WHAT WORK HAS BUSINESS SYSTEMS ALREADY COMPLETED TO**
12 **SUPPORT FLISR IMPLEMENTATION?**

13 A. As discussed by Mr. Nickell, Public Service is deploying FLISR and FLP devices
14 are on a nine-year deployment schedule that began in 2016. Business Systems
15 completed the work necessary to test the functionality of FLISR for Public Service
16 in 2019.

17 **Q. PLEASE DESCRIBE THE WORK BUSINESS SYSTEMS WILL UNDERTAKE**
18 **TO SUPPORT IMPLEMENTATION OF FLISR IN 2020 THROUGH 2025.**

19 A. As discussed in Mr. Nickell's Direct Testimony, the Company proposes to
20 implement FLISR on 205 total feeders through 2026, and Distribution will install
21 the FLISR equipment. Business Systems will support this FLISR implementation
22 by adding and conditioning field devices to support FLISR functionality. Business
23 Systems will also perform testing to support the FLISR implementation.

1 **Q. CAN YOU PROVIDE ADDITIONAL INFORMATION REGARDING THE**
2 **UPCOMING WORK BUSINESS SYSTEMS IS UNDERTAKING TO SUPPORT**
3 **FLISR?**

4 A. Yes. In the fourth quarter of 2020, Business Systems will deploy an integration to
5 the Aclara /Tollgrade Sensor Management System ("SMS") to receive voltage and
6 line measurement information to support FLISR functionality.

7 **Q. WHAT IS THE ACLARA/TOLLGRADE SMS FOR FLISR?**

8 A. The SMS is software which provides control and reporting on sensors across the
9 Company's distribution system. It also acts as a virtual RTU, providing the ability
10 to integrate the sensor data with the SCADA system. The sensors and SMS will
11 be used in conjunction with each other to support FLISR. FLISR requires that the
12 substation relay provide certain signals in order to communicate to the ADMS to
13 begin automatic locating of the fault and subsequent restoration. The Company's
14 current substation standard requires a specific make and model of relay which
15 many of the Company's substations do not have, so these sensors provide a low-
16 cost alternative that can provide that telemetry. Since the SMS software is
17 currently used for other purposes across the Company's distribution system, no
18 new software is needed to implement FLISR.

19 **C. Business Systems' Capital Costs for FLISR**

20 **Q. WAS BUSINESS SYSTEMS PRIMARILY RESPONSIBLE FOR DEVELOPING**
21 **THE FORECASTS FOR FLISR?**

22 A. No. However, Business Systems is responsible for the integration of the SMS for
23 Aclara sensors into ADMS. Mr. Nickell provides a discussion of the process to

forecast costs for the FLISR advanced application and its related field devices in his Direct Testimony, whereas I discuss the SMS below.

Q. WHAT ARE THE PROJECTED BUSINESS SYSTEMS' CAPITAL COSTS FOR FLISR?

A. The tables below provide a breakdown of Business Systems' capital expenditures and capital additions forecast for FLISR for 2020 through 2025.

Table WAR-D-19
FLISR Business Systems - Capital Expenditures
(Total Company)
(Dollars in Millions)

	2020	2021	2022	2023	2024	2025	Total
FLISR	\$0.77	\$0.26	\$0.00	\$1.10	\$0.00	\$0.00	\$2.13

Table WAR-D-20
FLISR Business Systems - Capital Additions
(Total Company)
(Dollars in Millions)

	2020	2021	2022	2023	2024	2025	Total
FLISR	\$1.74	\$0.27	\$0.0	\$1.10	\$0.0	\$0.0	\$3.11

Q. WHAT ARE THE PRIMARY COMPONENTS OF THE CAPITAL FORECAST FOR FLISR?

B. The FLISR IT capital forecast is primarily composed of labor costs for the SMS work described above. The majority of these labor costs are for adding SMS devices into the ADMS database, developing templates to manage those devices, and mapping the devices to the DEMS SCADA system.

Q. HOW DID THE COMPANY DEVELOP THESE COST ESTIMATES?

A. The Company developed labor estimates primarily using actual labor costs in the detailed work plans for the design and implementation of the FLISR functionality testing described above as part of ADMS implementation.

D. Business Systems' O&M Costs for FLISR

Q. WHAT ARE BUSINESS SYSTEMS' O&M COSTS ASSOCIATED WITH THE IMPLEMENTATION OF FLISR?

A. The Business Systems' O&M costs for FLISR include costs for (1) software support and (2) application support. The table below provides a breakdown of Business Systems' O&M expense forecast for FLISR for 2021 through 2025.

**Table WAR-D-21
FLISR Business Systems – O&M Expenses
(Total Company)
(Dollars in Millions)**

	2021	2022	2023	2024	2025	Total
FLISR	\$0.04	\$0.05	\$0.07	\$0.07	\$0.00	\$0.23

Q. HOW DID BUSINESS SYSTEMS ESTIMATE THESE O&M EXPENSES FOR FLISR?

A. Business Systems' forecast for O&M expenses for FLISR are estimated based on experience to-date with maintaining devices in the ADMS database, maintaining RTU templates, testing templates as new device subtypes are added, and providing ongoing management of the mapping of the FLISR devices in the ADMS system to the devices as represented in the DEMS SCADA system.

1 **Q. DOES BUSINESS SYSTEMS' FLISR CAPITAL FORECAST INCLUDE**
2 **CONTINGENCY?**

3 A. The Business Systems' FLISR capital forecast for the period 2020-2025 includes
4 a contingency of \$1.10 million in 2023. A significant portion of the IT work and
5 costs for FLISR is to develop templates which provide the computer screen
6 interface for managing field devices used for FLISR functions. Each device
7 requires a corresponding template. Base Templates are created as generic
8 templates across a product family. These are used as the starting point to create
9 Subtype Templates, which include the attribute variations needed by each device
10 subtype in the product family. Significant work is required for each Subtype
11 Template build.

12 The amount of re-use of the Base Template to create the Subtype
13 Templates is estimated, but not precisely known until the detailed build work
14 begins. Public Service has included a contingency for FLISR implementation due
15 to this unknown.

16 **Q. WHY IS BUSINESS SYSTEMS' FLISR FORECAST REASONABLE FOR**
17 **CUSTOMERS TO SUPPORT?**

18 A. FLISR is an advanced grid component that will enable significant reliability
19 improvements for our customers, and operational efficiencies for the Company.
20 Overall, implementing FLISR allows the Company to more efficiently restore power
21 with the use of fewer resources and will improve the customer reliability
22 experience. The Business Systems work will provide for the implementation of
23 FLISR and integration with the advanced grid technologies, enabling these

1 benefits for our customers and the Company. The Business Systems FLISR
2 forecast is reasonable based on the details provided above.

VII. FIELD AREA NETWORK

Q. WHAT IS THE PURPOSE OF THIS SECTION OF YOUR TESTIMONY?

A. In this section of my testimony, I provide an overview of FAN and discuss the progress that Public Service has made in the implementation of FAN since approval of the AGIS CPCN Settlement. I also discuss the integration work that will be necessary to integrate FAN with the other components of the AGIS initiative. Further, I discuss new Federal Communications Commission ("FCC") regulations and the impact of these regulations on the WiMAX portion of the FAN. Finally, I discuss Business Systems' capital and O&M forecasts for FAN.

A. Overview of FAN IT Integration

Q. WHAT IS THE FAN?

A. Public Service's FAN will be a resilient wireless communications network that will provide connectivity and enable two-way communications between the existing infrastructure at the Company's substations and new and planned field devices up-to and including the customer meter.

Q. WHY DOES THE FAN REQUIRE IT INTEGRATION?

A. The FAN is the communications network that will enable communications between the communications infrastructure that already exists at the company's substations, the ADMS and AMI software systems, the new AMI meters and the new intelligent field devices associated with advanced applications, including IVVO and FLISR. The FAN will provide benefits to all AGIS projects, but is designed and built according to the needs of various specific components, and each has different communication network requirements.

1 **Q. HOW WILL THE FAN CONNECT TO THE COMPANY'S EXISTING**
2 **INFRASTRUCTURE?**

3 A. The FAN will be connected to Public Service's pre-existing Wide Area Network
4 ("WAN"). Public Service's WAN is a communications network primarily composed
5 of private optical ground wire fiber and a collection of routers, switches, and private
6 microwave communications that are supplemented by leased circuits from a
7 variety of carriers as well as satellite backup facilities. The WAN is an intermediate
8 link in the Company's communication system that provides high-speed, two-way
9 communications capabilities and connectivity in a secure and reliable manner
10 between Public Service's core data centers and its service centers, generating
11 stations, and substations. The connections will be primarily at substations on the
12 distribution system. This connection at the substation will be via private fiber or
13 alternate cabling within the substation from the WiMAX base station radios to the
14 routers at the substations which are connected to the WAN. The WAN is monitored
15 at all times by the Network Operations Center ("NOC").

16 The WAN is designed to communicate to and through substations
17 (transmission and distribution) to ensure the security and future-proofing of the
18 network. The WAN also provides primary and backup communication capabilities
19 to the service centers, office locations, and generation facilities in Public Service's
20 areas of operation.

21 While the WAN will be the main linkage for transporting data from the FAN
22 to the Company's data centers upstream, it already carries a lot of other traffic (that
23 is, the actual digits and bytes of data that flow over the wired and wireless

1 networks) to support utility operations. The data centers are the locations that
2 house the Company's servers and store data. The data centers will also house
3 the advanced applications associated with AGIS (such as ADMS and AMI, and the
4 sub-applications, including IVVO, FLISR, FLP, and GIS).

5 **Q. WHAT ARE THE COMPONENTS OF THE FAN?**

6 A. The FAN will consist of two separate wireless technologies: (a) a lower-speed
7 WiSUN mesh network, and (b) a high-speed point-to-multipoint private wireless
8 network to connect the WiSUN mesh network to the WAN. Initially, including in
9 the CPCN and subsequent reports, the Company proposed to accomplish the
10 private wireless network by the deployment of the Worldwide Interoperability for
11 Microwave Access ("WiMAX") network. Later in my Direct Testimony, I explain
12 how recent FCC rule changes have necessitated a change in private network
13 technology.

14 **Q. PLEASE DESCRIBE THE INFRASTRUCTURE AND DEVICES THAT WILL BE**
15 **INTEGRATED WITH THE WISUN MESH PORTION OF THE FAN.**

16 A. The core infrastructure for the WiSUN mesh network will consist of two main device
17 types: (1) access points; and (2) repeaters.

18 **Q. WHAT IS AN ACCESS POINT?**

19 A. An access point is a device that will link the Company's endpoint devices that are
20 enabled with wireless communication modules with the rest of the Company's
21 communications network. The access points will wirelessly connect directly to
22 backhaul (which is an intermediate link in the communications network, WiMAX in
23 this case), in order to pass traffic between the mesh network and the WAN. Access

1 points will extend the reach of Public Service's communications network and will
2 define the boundary of the mesh itself.

3 **Q. WHAT IS A REPEATER?**

4 A. Repeaters are range extenders and are used to fill in coverage gaps where devices
5 would be otherwise unable to communicate. These two device types will be
6 principally located on distribution poles and other similar structures.

7 **Q. ARE THERE OTHER DEVICES THAT WILL UTILIZE THE MESH NETWORK?**

8 A. Yes. Other devices that will participate in the mesh include AMI meters and DA
9 devices, such as the intelligent FLISR and IVVO field devices, that have built-in
10 mesh radios. The former will be located on customer premises; the latter will be
11 co-located with either pole-mounted or pad-mounted distribution devices. The
12 radio frequency communication modules in these devices will enable two-way
13 communication between the AMI meters and the mesh network.

14 In addition to their metering function, the AMI meters will have embedded
15 communication modules that will allow the devices to communicate as part of the
16 WiSUN network. The Company estimates that the AMI meters themselves (and
17 their communications modules) will make up over 90 percent of devices that will
18 communicate as part of the mesh network. The WiSUN component transfers
19 information between meters and transmits data over the mesh network to an
20 access point device that transitions the data from the mesh network to the WiMAX
21 tier of the FAN. The mesh network allows multiple devices to connect with each
22 other, which provides multiple potential communication routes, ensuring a robust
23 communications network. In most cases this communication will be with the

1 WiSUN mesh radios via IEEE's 802.15.4g standard described above. This
2 standard for local and metropolitan area networks is well-accepted in the utility and
3 communications industries. WiSUN can wirelessly connect meters, sensors,
4 distribution devices, street lights, and signal repeaters to create a robust and
5 reliable wireless network. Xcel Energy, on behalf of Public Service and the other
6 operating companies, participates as a full member in the WiSUN Alliance with
7 other utilities and equipment manufacturers. By selecting a technology that
8 conforms to the IEEE standard, Public Service will ensure the interoperability of
9 the FAN with other systems.

10 **Q. PLEASE DESCRIBE THE INFRASTRUCTURE AND DEVICES THAT WILL BE**
11 **INTEGRATED WITH THE MESH PORTION OF THE FAN.**

12 A. As noted above, data from the mesh network will be transmitted across a private
13 wireless network (initially WiMAX) to the WAN for data backhaul. The WiMAX
14 technology used for this network segment will wirelessly connect directly to devices
15 on the Company's distribution feeder lines as well as provide the secure, reliable
16 connectivity between Public Service's WAN and mesh networks.

17 The point-to-point network consists of two main components: (1) base
18 stations; and (2) customer premise equipment ("CPE"). To provide context, CPE
19 is a common term in the network industry that refers to specific equipment. In the
20 term CPE, the "customer" refers to Public Service (or a similarly-situated entity
21 using this equipment), which is a customer of the equipment manufacturer. It does
22 not refer to any specific customers of Public Service, or to Public Service's
23 customers generally.

1 Base stations⁸ serve as the key communication points between the
2 substation WAN and the WiSUN (mesh) network. The point-to-multi-point network
3 is based in Public Service's substations and enables high-speed connectivity at
4 locations across the distribution system. At substations, there will be a base
5 station with up to three radios that will communicate multi-directionally with CPEs
6 out in the field of operations. Through the substations' connection to the WAN, the
7 base stations will enable end-to-end communication between the intelligent field
8 devices and the Company's advanced applications and other back office
9 applications.

10 In the case of a CPE that is wirelessly connected to a WiSUN access point,
11 this will further enable the back-office applications to communicate with any device
12 accessible to that access point's connections to the mesh network. For any
13 particular mesh "cluster" (that is, a logical collection of mesh nodes), there will be
14 multiple access points connected to the base station radios that will provide
15 redundant paths of communication to the WAN. This will result in a more reliable,
16 robust field area network.

17 Xcel Energy, on behalf of Public Service and the other operating
18 companies, participates fully as a member of the numerous network industry
19 forums and work closely with EPRI, UTC, and EEI, along with other energy
20 companies, to support continued development, maintenance, and certification of
21 products for the 802.16 standards. By selecting a technology that conforms to the

⁸ It should be noted that with a private LTE replacement the radios and the CPE's are replaced but all the other infrastructure (towers, H frames, trenching, other communication equipment like routers and firewalls) all would remain in place.

1 IEEE standards, Public Service will ensure the interoperability of the FAN with
2 other systems.

3 **Q. HOW WILL THE COMPONENTS OF THE FAN INTERACT WITH THE OTHER**
4 **AGIS COMPONENTS?**

5 A. The FAN is the primary communication network for many of the AGIS components
6 to communicate with each other as well as Company's back-office systems.

7 **Q. HOW WILL THE FAN INTERACT WITH THE AMI METERS?**

8 A. The AMI meters will have embedded communication modules that will allow the
9 devices to communicate with the WiSUN network. This will allow data to be
10 transferred between the meters and the AMI head-end application, including
11 interval reads, register reads, voltage information, and power quality data. The
12 FAN will also allow AMI meters to send and receive of commands like power
13 outage notifications. Once fully deployed, the AMI meters will make up over 90
14 percent of the devices that will communicate as part of the mesh network.

15 **Q. HOW WILL THE FAN INTERACT WITH FLISR?**

16 A. The FLISR distribution equipment (i.e., feeder-level devices) will have
17 communication modules that will communicate with access points in the mesh
18 network.

19 **Q. HOW WILL THE FAN INTERACT WITH THE COMPONENTS OF IVVO?**

20 A. Most devices that control or inform IVVO (such as capacitors, SVCs and power
21 line sensors) will have communication modules that will allow them to
22 communicate as part of the mesh network or directly on WiMAX. Through this
23 network, the FAN will allow data to be transferred between the IVVO devices in the

1 field and the ADMS. This will enable the field devices to report their current
2 operating conditions and allow the ADMS to send commands to the devices,
3 thereby enabling the entire system to dynamically react to changing load
4 conditions and voltage levels.

5 **Q. HOW WILL THE FAN INTERACT WITH ADMS?**

6 A. The FAN enables data and information from field devices to be communicated to
7 ADMS, and also enables commands to be transmitted to the field devices from
8 ADMS.

9 **Q. WHAT SYSTEMS WILL BE INTEGRATED WITH THE FAN?**

10 A. The following applications will be integrated with the FAN:

- 11 • *AMI*: The WiSUN mesh network, including the meters' communication
12 nodes that will communicate as part of the network, will support AMI through
13 the meters' communication function. The FAN will provide the transport for
14 data transfer between the meters and the AMI head-end application,
15 including interval reads, register reads, voltage information, and power
16 quality data. It will also provide the sending and receiving of commands like
17 power outage notifications and remote connect/disconnect commands.
- 18 • *ADMS*: The FAN infrastructure will provide data from field devices to the
19 WAN, which will then deliver data to ADMS. The FAN enables data and
20 information from field devices to be communicated to ADMS, and also
21 enables commands to be transmitted to the field devices from ADMS. The
22 FAN infrastructure will provide data from endpoint devices, such as meters
23 and field devices, to a common ESB via the WAN, which will then deliver
24 data to ADMS. The ESB will also receive commands from ADMS that will
25 be delivered to the devices connected to the FAN via the WAN. The FAN
26 enables data and information from field devices to be communicated to
27 ADMS, and also enables commands to be transmitted to the field devices
28 from ADMS.

1 **Q. WHAT WORK IS BUSINESS SYSTEMS UNDERTAKING TO IMPLEMENT THE**
2 **FAN PROJECT?**

3 A. The specific functions Business Systems provides for FAN implementation
4 include:

- 5 1. Leading the design of the network systems (WiMAX and WiSUN);
- 6 2. Procurement and installation of all hardware components that will operate the
7 network. This task is a joint effort between Business Systems and Distribution
8 in the procurement and deployment of the hardware components with Business
9 Systems primary responsible for the installation of WiMAX base stations and
10 Distribution Business Area resources responsible for the installation of devices
11 that will be located on Distribution poles (CPE's, AP's and repeaters primarily).
12 Company witness Mr. Nickell discusses the costs associated with the
13 Distribution Business Area's participation in the procurement and installation of
14 pole-mounted FAN devices;
- 15 3. Configuration of the software and hardware;
- 16 4. Designing and integrating security into all aspects of the FAN solution;
- 17 5. Thorough unit, system and end-to-end testing of the FAN solution;
- 18 6. User Acceptance Testing with the Distribution, Customer Care and Customer
19 Solutions business resources; and
- 20 7. Establishment of a full ongoing support structure including process and
21 operational requirements.

22 **B. FAN Deployment Timeline**

23 **Q. CAN YOU PROVIDE AN OVERVIEW OF HOW THE WISUN WILL BE**
24 **IMPLEMENTED AND INTEGRATED?**

25 A. Yes. The WiSUN network implementation includes the planning and studies to
26 ensure the devices are located at specific locations (usually distribution poles) to
27 ensure network reliability and optimum operation of the network when fully
28 deployed. The devices are then installed at specified locations in the planning and

design by field crews. Once devices are installed, they are tested and recognized by the NOC to ensure they are operating as expected.

The following table provides a schedule of significant WiSUN milestones organized by year:

Table WAR-D-22 – WiSUN Release Projected Timeline

YEAR	Quarter 1	Quarter 2	Quarter 3	Quarter 4
2018				Completed WiSUN Design for Release 1
2019	Completed WiSUN Surveys for Release 1	Started WiSUN Installation for Release 1	Completed WiSUN Installation for Release 1	
		Complete WiSUN Surveys for Release 2	Complete WiSUN Design for Release 2	Start WiSUN Surveys for Release 3
2020	Started WiSUN Installation for Release 2	Complete WiSUN Installation for Release 2	Complete WiSUN Design for Release 3	Start WiSUN Installation for Release 3
	Complete WiSUN Surveys for Release 3	Network Optimization for Release 1	Complete WiSUN Surveys for Release 4	Complete WiSUN Design for Release 4
2021	Complete WiSUN Installation for Release 3	Start WiSUN Installation for Release 4		Complete WiSUN Installation for Release 4
2022-2024	Continuation of WiSUN installation for all future Meter installations			

Q. PLEASE DESCRIBE THE WORK BUSINESS SYSTEMS WILL UNDERTAKE TO SUPPORT THE IMPLEMENTATION OF FAN.

A. Phase I of the WiSUN implementation was the design phase. In 2017, the Company completed its RFP for a WiSUN design vendor and in December of 2017, WiSUN devices were selected. The WiSUN devices are located on the

1 Company's distribution poles or pad-mounted equipment to have effective
2 communication coverage with end-devices.

3 The Company engaged in 119 site surveys in 2019 as part of Phase II of
4 the WiSUN FAN implementation. The Company is inspecting each location
5 identified in the design phase and has been evaluating the potential to install a
6 WiSUN device. These inspections confirm that the Company can receive the
7 appropriate signal anticipated in the design phase at the height and location on the
8 pole where the WiSUN device is planned to be located. In instances where the
9 Company cannot add a WiSUN device to the existing pole, a new location is
10 evaluated. This work will be ongoing at a pace of approximately 100 surveys per
11 year through 2024.

12 Installation began in second quarter 2019 as part of Phase III of the WiSUN
13 implementation and will continue through 2024 to support AMI deployments. In
14 2021, the Company will perform the first Network Optimization (a process where
15 the network is tested and tuned to ensure optimal performance) for the WiSUN
16 network supporting IVVO. Network Optimization will occur throughout the project
17 as AMI deployments complete.

18 In 2018, Public Service continued the deployment of WiMAX installations at
19 substations in the Denver metropolitan area and in areas outside of the Denver
20 area, conducted planning activities for 2019 installations, and tested WiMAX
21 installations. In addition, the installation of CPE devices on Distribution poles was
22 also begun. A number of FAN sites in the Denver metro area were placed in-serve
23 in 2018 to support installation of IVVO intelligent field devices.

1 As noted above, the WiMAX technology initially implemented to support the
2 point-to-point network and implementation of IVVO devices was amended due to
3 FCC regulation changes in 2020. The Company is therefore currently evaluating
4 alternative solutions, as discussed later in my Direct Testimony.

5 **C. FAN WiMAX Replacement**

6 **Q. EARLIER YOU NOTED THAT FCC CHANGES MEAN THE ORIGINAL WIMAX**
7 **PRIVATE NETWORK MAY NO LONGER BE VIABLE. CAN YOU PLEASE**
8 **EXPLAIN WHY THAT IS?**

9 A. Yes. The FCC ruled in late 2018, with an implementation date of April 2020, that
10 the use of a network spectrum (frequency) called Citizen Band Radio Spectrum
11 was going to be controlled by third parties to minimize congestion and interference,
12 particularly for U.S. Coast Guard and Navy, which also used this spectrum for
13 operations. This is the spectrum that Xcel Energy chose to use in 2014 for
14 deployment of the WiMAX technology as a part of the FAN. The FCC ruling that
15 impacted the spectrum used with WiMAX not only made using that frequency more
16 expensive to operate (with high O&M service fees to the third parties mentioned),
17 but also fast-tracked the WiMAX technology to extinction because the cost to
18 network vendors to upgrade to meet FCC rules was cost-prohibitive with WiMAX.
19 This requirement has driven U.S. vendors to abandon support of the WiMAX
20 product in July of 2019, thus forcing the Company to look for alternative technology
21 in lieu of WiMAX. The impact of the FCC rule impaired the Company's ability to
22 effectively utilize WiMAX technology as designed.

Q. IS A PRIVATE NETWORK SOLUTION STILL THE PREFERRED CHOICE?

A. Yes. The FAN is a private, Company-owned network that will securely and reliably address the need for increased communication capacity that arises from distribution grid advancements. The advantages of the FAN over other alternatives include that:

1. Private networks are capital investments serving multiple use cases, versus increased O&M associated with data fees and other costs associated with cellular.
2. Private networks allow for greater resiliency and reliability integrated into the network design for automatic failover and increased uptime (i.e., fewer and shorter network outages).
3. Company-owned network solution enhances security against cyber threats by reducing the use of third-party networks, the use of public networks (i.e., cellular), and the reliance on external entities for communications support.
4. Developing the FAN as an internal private network allows us to implement our cyber security measures into the design at all levels.
5. Private network solution allows the Company to utilize the network's full bandwidth and all capacity is dedicated to the Company's use, which is particularly critical during emergency and outage situations.
6. The FAN also integrates with the communication systems used for current components of our distribution system, allowing for peer-to-peer communication of devices in the field at low latency.
7. Overall, the FAN provides for greater security and efficiency and avoids requiring the Company to incur monthly usage fees that would otherwise be paid to private vendors.

Q. WHAT IS THE CURRENT STATUS OF THE COMPANY'S ANALYSIS OF A WIMAX REPLACEMENT?

A. These new FCC regulations require the Company to replace WiMAX with new versions of hardware and software equipped with SAS capability, no later than

1 October 14, 2020. In 2020, Xcel Energy replaced all WiMAX supported technology
2 with public cellular data technology to support continued connectivity to the WiSUN
3 network. This is a reasonable interim solution because it is a proven technology
4 in use by other utilities with similar needs and will ensure the Company meets its
5 commitments to our customers and the state of Colorado as well as position the
6 Company to convert to private LTE should that decision be made. However, the
7 Company still plans to deploy a private wireless network to connect the WiSUN
8 Mesh to the WAN as stated earlier. For the longer term, the Company is currently
9 analyzing the potential for a long-term private LTE solution and the prudence of
10 that solution for both AGIS and the Company in general. It is expected that
11 analysis will be completed at the end of 2020.

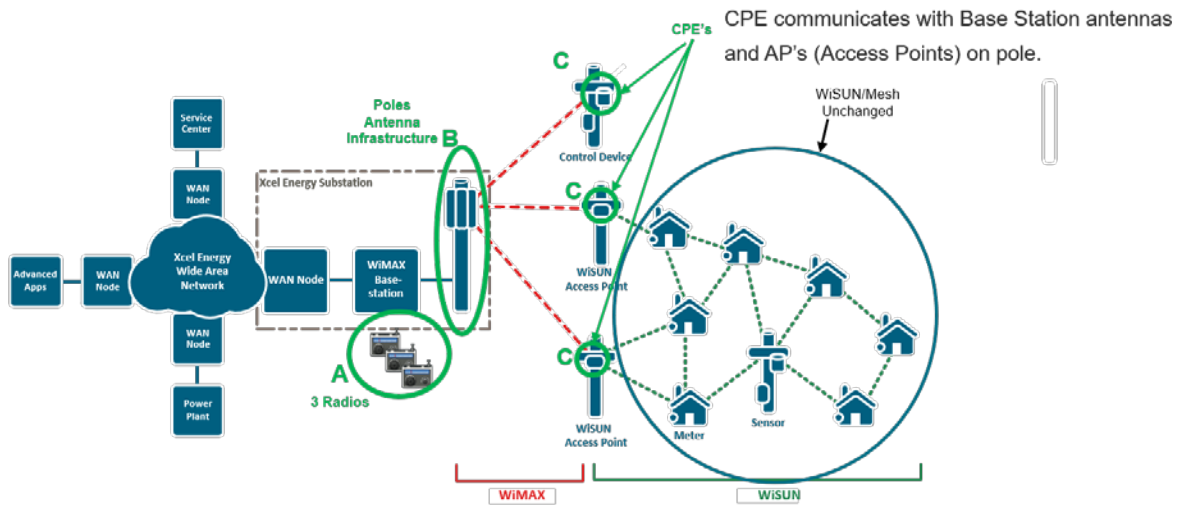
12 With that in mind, the Company plans to deploy a cellular modem solution
13 described above for all AMI meters and other AGIS field devices deployed in Public
14 Service in 2021. The Company anticipates making a decision in 2021 on what
15 solution it will be deploying for meters and other devices deployed after 2021 by
16 the end of the 2nd quarter of 2021.

17 **Q. CAN YOU PROVIDE A VISUAL DEPICTION OF THE DIFFERENCE BETWEEN**
18 **THE FAN UTILIZING WIMAX AS COMPARED TO CELLULAR OR LTE?**

19 A. Yes. The diagrams below highlight the key differences between the use of WiMAX
20 technology and cellular versus private LTE. First, Figure WAR-D-1 outlines the
21 architecture of the FAN utilizing WiMAX.

1

**Figure WAR-D-1
FAN Network with WiMAX**



2

3

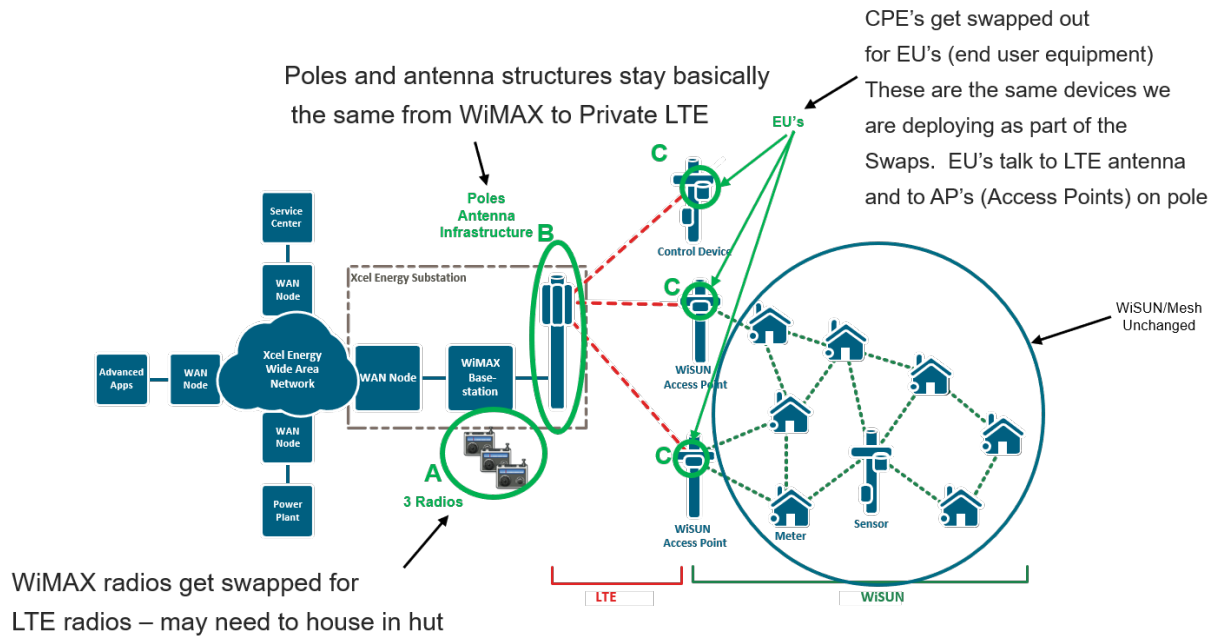
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5

By comparison, Figure WAR-D-2 illustrates the changes to implement private LTE in place of WiMAX. Note the overall architecture stays the same with changes of base station radios and CPE's. The other infrastructure elements used to implement WiMAX would be reused in the deployment of private LTE.

1

**Figure WAR-D-2
FAN Network with LTE**



4

2

3

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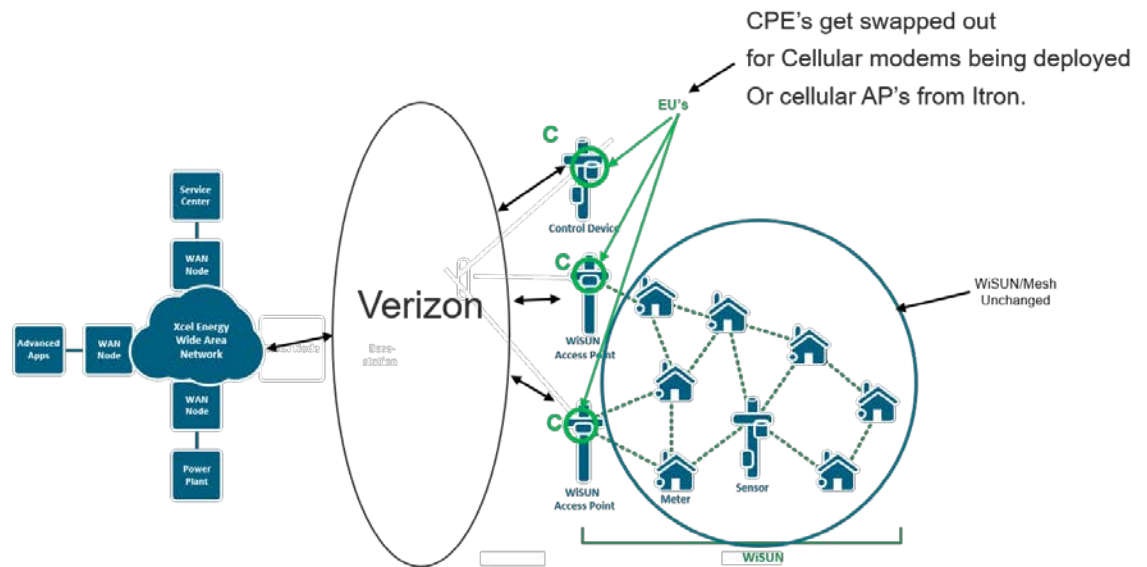
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6

Figure WAR-D-3 highlights the changes implemented to deploy cellular connectivity to the access points and other field devices and shows how the substation and WAN are bypassed. As noted previously, the Company's preferred direction is a private network but cellular is an acceptable and workable interim solution.

1

**Figure WAR-D-3
FAN Network with Cellular**



5

2 **Q. CAN YOU SUMMARIZE THE CONSIDERATIONS NECESSARY TO**
3 **DETERMINE WHICH SOLUTION SHOULD BE SELECTED?**

4 **A.** Yes. The figure below highlights the decision-making elements the Company used
5 in evaluating alternative network options for the AGIS field devices including the
6 AMI meters. This evaluation covers all of the pertinent decision points used in
7 evaluating options and determining the Company's strategy.

1

**Figure WAR-D-4
 Communications Least-Cost Best-Fit Alternative**

Item	Feature/ Requirement	Cellular LTE	Private LTE
Network Capabilities	Two way communications	•	•
	Peer-to-Peer	◐	•
	Multipurpose	•	•
	Latency Requirements	◐	•
	Security	•	•
	Dedicated traffic	◐	•
	Priority traffic	◐	•
	O&M Costs Impact (run state)	◐	•
	Resiliency	◐	•
Operational Features	Cost of paying a third party for service	A	NA
	Unable to fully control the system "end-start"	A	NA
	Relying on technology	A	A
	BENEFITS-Incremental to current reading/ billing		\$0M

Legend for Capabilities

Full	Most	Partial	Minimal	None
•	◐	◑	◒	◓

Applicable	Non-Applicable
A	NA

2 **Q. WHAT DO YOU CONCLUDE FROM THIS COMPARISON?**

3 A. While both the cellular and private LTE facilitate the necessary two-way
 4 communications, the private LTE solution has several advantages over a cellular
 5 solution. A private LTE network provides more control and integration of security
 6 standards and control as well as being more scalable and providing a more
 7 resilient solution compared to a cellular solution. This is because a private LTE
 8 system runs on its own dedicated equipment and its coverage, performance, and
 9 security can be controlled by the Company. The Company is still continuing its

1 evaluation of these solutions and expects that it will select a solution by the end of
2 2020.

3 **Q. WHAT ARE THE POTENTIAL IMPACTS TO THE AGIS FAN BUDGET OF**
4 **IMPLEMENTING A SOLUTION OTHER THAN WIMAX?**

5 A. There is no impact on the core CPCN identified elements of the AGIS FAN. The
6 WiSUN mesh network is being deployed the same as it was always planned. The
7 cellular modems being deployed are the equivalent of the CPE devices used for
8 WiMAX and will be reused with a new SIM card for private LTE when, and if, the
9 decision is made to move to private LTE. At the current time, the Business
10 Systems' budgets attributed to the WiMAX portion of the FAN have been moved
11 to outer years of the AGIS initiative while a determination is made on the long-term
12 strategy. However, the original forecasts are expected to be reasonably
13 representative of a future WiMAX replacement costs.

14 **D. Business Systems' Capital Costs for FAN**

15 **Q. WAS BUSINESS SYSTEMS PRIMARILY RESPONSIBLE FOR DEVELOPING**
16 **THE FORECASTS FOR THE FAN?**

17 A. Yes. Business Systems was responsible for developing the forecast for both the
18 WiSUN and the point-to-point components of the FAN. Therefore, I describe the
19 forecast development process for these aspects in more detail below. As noted
20 above, Mr. Nickell discusses the costs associated with Distribution's procurement
21 and installation of the pole-mounted FAN devices.

1 **Q. PLEASE PROVIDE AN OVERVIEW OF THE PROCESS FOR DEVELOPING**
2 **THE WISUN FORECAST.**

3 A. As previously noted, Business Systems employs standard processes and
4 procedures for selecting technologies to be deployed in the Company's
5 environment, as well as the execution of large capital projects. These standard
6 processes are being utilized for deployment of the FAN, as follows:

- 7 • *Product Selection:* The Company awarded a contract for the WiSUN mesh
8 network in 2017; and
- 9 • *Project and Initiative Governance:* The AGIS initiative's formal project
10 governance processes are incorporated into the FAN project.

11 **Q. PLEASE PROVIDE AN OVERVIEW OF THE PROCESS FOR DEVELOPING**
12 **THE WIMAX FORECAST.**

13 A. The Company's standard forecast development processes were followed, as set
14 forth below:

- 15 • *Product Selection:* An RFP was issued and awarded for the point-to-point
16 primary vendor in 2015. The Company awarded a contract for this part of the
17 AGIS solution in 2017. In conjunction with the RFP for the AMI head-end
18 software selection noted above, Itron was also selected in 2017 for the Wi-SUN
19 mesh aspects of the FAN. This process ensured the most optimal solution for
20 the Company's needs was selected and the Company negotiated a contract
21 with reasonable costs.
- 22 • *Project and Initiative Governance:* The AGIS initiative's formal project
23 governance processes are incorporated into the FAN project.

24 A summary of the RFP selection process for the FAN components and is
25 provided as Highly Confidential Attachment WAR-6 to my Direct Testimony.

Q. WHAT ARE THE PROJECTED CAPITAL COSTS FOR FAN?

A. The tables below provide a breakdown of Business Systems' capital expenditures and capital additions forecast for FAN for 2020 through 2025.

Table WAR-D-22
FAN Business Systems - Capital Expenditures
(Total Company)
(Dollars in Millions)

	2020	2021	2022	2023	2024	2025	Total
FAN	0.03	15.43	6.01	18.24	0.13	0.13	39.97

Table WAR-D-23
FAN Business Systems - Capital Additions
(Total Company)
(Dollars in Millions)

	2020	2021	2022	2023	2024	2025	Total
FAN	0.02	34.47	6.18	18.24	0.13	0.13	59.17

Q. WHAT ARE THE PRIMARY COMPONENTS OF THE FAN IT CAPITAL FORECAST?

A. The FAN forecast has two key components: (1) labor; and (2) hardware. As noted above, Mr. Nickell discusses the costs associated with Distribution's participation in the procurement and installation of pole-mounted FAN devices.

Q. HOW DID THE COMPANY DERIVE THE LABOR PORTION OF THE FAN FORECAST?

A. The labor costs were derived utilizing pricing gained from industry benchmarks and reviewed with other utilities and industry research organizations such as EPRI. These costs were also analyzed and reviewed as the result of the limited

1 deployment of the FAN that tested out the technology, the deployment process,
2 monitoring and performance. As each stage of the FAN deployment is conducted,
3 the labor costs and estimates are reviewed on a per-site basis and forward-looking
4 estimates are refined. These costs will be reviewed and refined throughout the
5 lifecycle of the project. Labor cost types include installation labor, RF design,
6 configuration and testing, planning engineering, project management, and network
7 services.

8 **Q. HOW DID THE COMPANY DERIVE THE HARDWARE PORTION OF THE FAN**
9 **FORECAST?**

10 A. Xcel Energy has standards for all hardware that is deployed in the field. These
11 standards define hardware for which the Company has industry benchmarked,
12 negotiated pricing. In addition, Xcel Energy issued an RFP for hardware, and
13 awarded the work for the WiMAX primary vendor in 2015. Types of hardware
14 purchased included WiMAX base station antennas, radios, router, batteries, CPE
15 communications boxes, and the like. That portion of the project is in the
16 deployment process.

17 **E. Business Systems' O&M Costs for FAN**

18 **Q. WHAT ARE BUSINESS SYSTEMS' O&M COSTS ASSOCIATED WITH THE**
19 **IMPLEMENTATION OF FAN?**

20 A. The table below provides a breakdown of Business Systems' O&M expenses for
21 FAN by year from 2021 through 2025.

Table WAR-D-24
FAN Business Systems – O&M Expenses
(Total Company)
(Dollars in Millions)

	2021	2022	2023	2024	2025	Total
FAN	\$0.06	\$0.07	\$0.07	\$0.07	\$0.07	\$0.34

Q. WHAT ARE THE PRIMARY COMPONENTS OF BUSINESS SYSTEMS' FAN O&M FORECAST?

A. The primary components of Business Systems' FAN O&M forecast include ongoing field support for devices deployed, hardware maintenance (patches and firmware upgrades), technical support for the network, and NOC support for monitoring the network.

Q. HOW DID BUSINESS SYSTEMS DERIVE THE FAN O&M FORECAST?

A. Public Service used existing data from other network installations of a similar nature as well as input from our FAN vendor and information gathered from other utilities and industry organization such as EPRI.

Q. DOES THE BUSINESS SYSTEMS' CAPITAL FORECAST FOR FAN STILL INCLUDE CONTINGENCY?

A. Yes. The Business Systems' capital budget for FAN includes a contingency of approximately 46 percent. As of the date of this filing, the Company has not utilized any of the originally budgeted FAN contingency amount.

1 **Q. CAN YOU HIGHLIGHT THE PRIMARY REASONS FOR CONTINUING TO**
2 **INCLUDE A CONTINGENCY IN THE FAN BUDGET?**

3 A. Yes. In the AMI section above and in our prior filings, I discussed the reasons for
4 including contingency amounts in the AMI budget that are applicable to the FAN
5 as well. Specifically, while Business Systems has based our budget estimates on
6 all known design and installation details (i.e., number and types of devices), there
7 remain uncertainties with respect to specific deployment of the FAN devices and
8 unknowns that may develop through the installation phase.

9 For the FAN, the primary reason for contingency is to recognize there may
10 be situations where the primary solution being deployed may not work, for example
11 in remote areas at the edge of grid. Further, there may be a change in number of
12 installation sites, number of devices, or other situations that could not be
13 anticipated during the initial planning and budgeting phase. Contingencies also
14 recognize that there may be a sudden change in viable technology or identification
15 of a security risk or vulnerability that Public Service would not be able to anticipate
16 at this time. A recent example of this is the FCC regulation changes that affect the
17 Company's ability to use the WiMAX private network.

18 **Q. HOW DOES THE POTENTIAL CHANGE TO A PRIVATE LTE SOLUTION**
19 **AFFECT THESE COST ESTIMATES?**

20 A. The impact of that decision will not be known until later in 2020 or early 2021. At
21 the present time, the Company's strategy is still to implement a private network
22 and the cost estimates included in this filing reflect this approach. If the Company
23 determines that private LTE is not prudent at this time, the costs will be adjusted

1 to reflect the actual/estimated costs of the cellular backhaul specific to AGIS
2 elements.

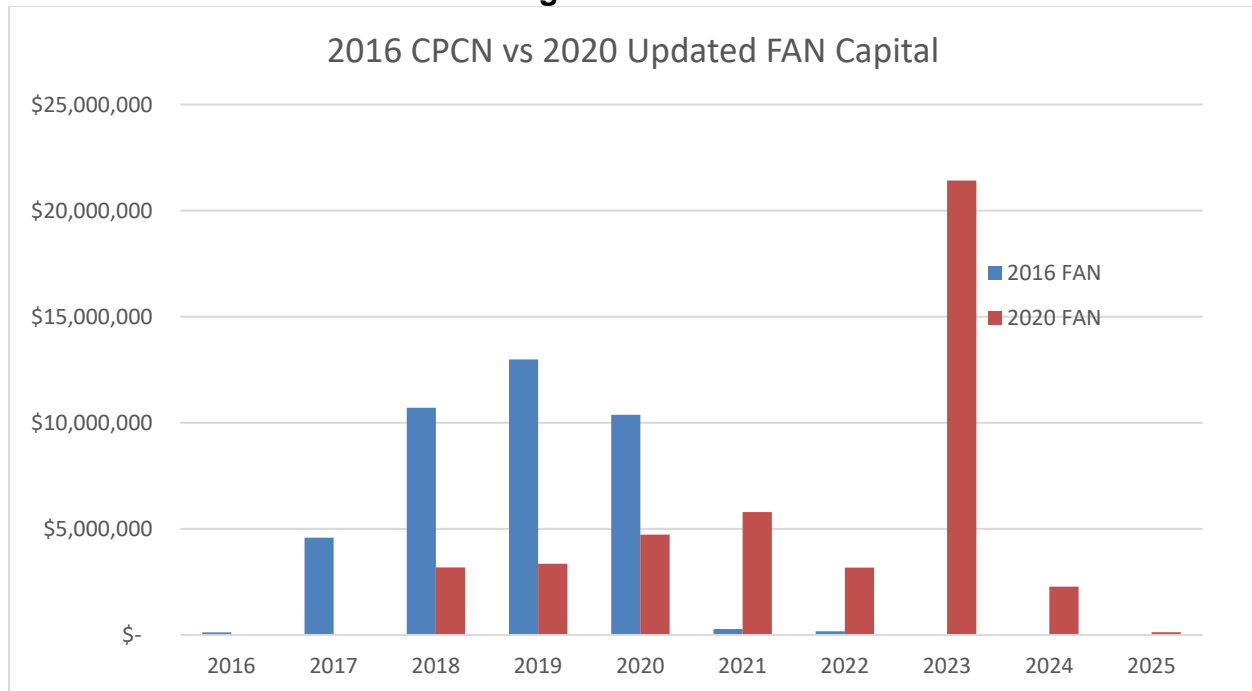
3 **F. Comparison of Costs to AGIS CPCN Settlement**

4 **Q. HOW DO THE CAPITAL COSTS THAT YOU DISCUSSED FOR WISUN**
5 **COMPARE TO THE BUDGET PRESENTED IN THE AGIS CPCN**
6 **SETTLEMENT?**

7 A. This comparison is shown in Figure WAR-D-5 below. In order to complete a fair
8 comparison of budgets, the capital budget below includes both internal and
9 contract labor, and also reflects the budget for both Distribution and Business
10 Systems. This is consistent with the cost estimates provided in the AGIS CPCN
11 Settlement. The estimated capital costs for WiSUN from the 2016 AGIS CPCN
12 Settlement were \$39.2 million and the current total capital costs for WiSUN of
13 \$44.2 million. There was an increase in capital costs for WiSUN due to the need
14 for additional hardware, software, and design work required to support a sparse
15 network for the AMI bellwether meters deployed for IVVO. In addition, there was
16 a shift in the timing of the WiSUN capital investments as a result of the delay in the
17 AMI meter deployment.

1

Figure WAR-D-5



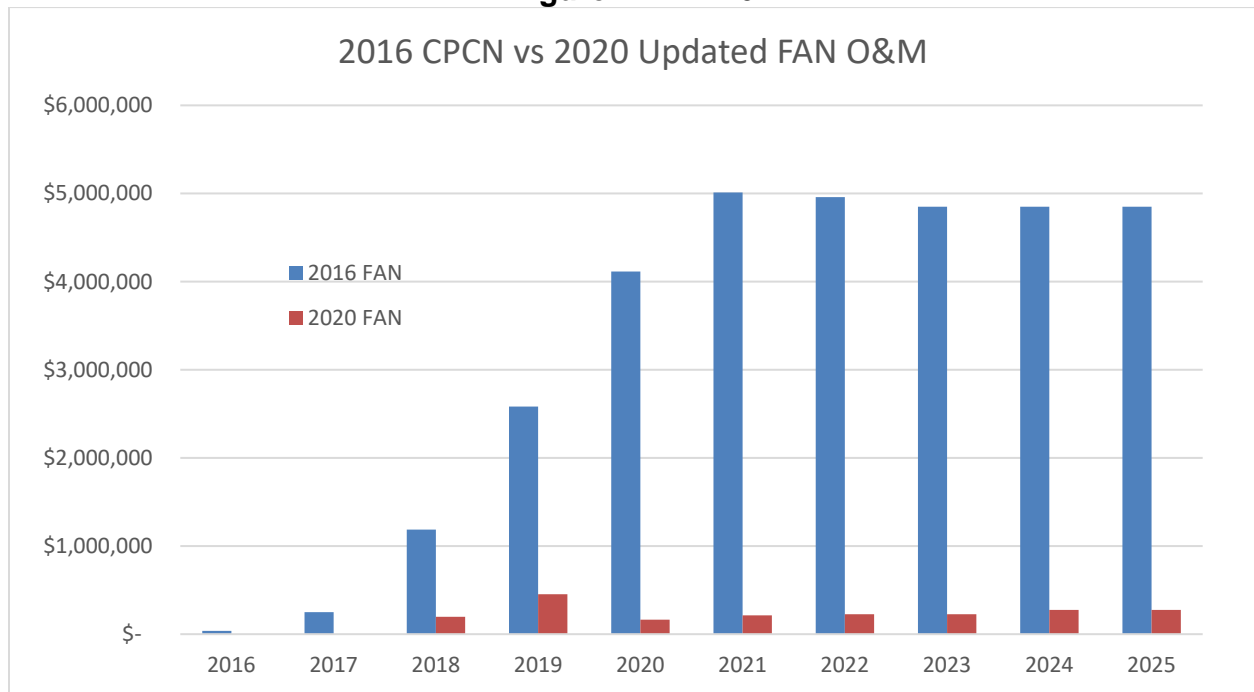
2 **Q. HOW DO THE O&M COSTS THAT YOU DISCUSSED FOR WISUN COMPARE**
3 **TO THE COSTS PRESENTED IN THE AGIS CPCN SETTLEMENT?**

4 A. This comparison is provided in Figure WAR-D-6 below. In order to complete a fair
5 comparison of budgets, the O&M budget below includes both internal and contract
6 labor, includes an allocated portion from the initiative level costs which currently
7 reside within the “Other”⁹ cost category, and also reflects the WiSUN O&M budget
8 for both Distribution and Business Systems. This is consistent with the cost
9 estimates provided in the AGIS CPCN Settlement. The estimated O&M costs for
10 WiSUN from the 2016 AGIS CPCN Settlement were \$17.7 million and the current
11 total O&M costs for WiSUN are \$6.9 million. The reason for the decrease in FAN
12 O&M costs is due to several adjustments that were made as a result of a bottoms

⁹ The allocation portion for each project was based on the percentage of the overall capital spend.

up analysis of Business Systems' FAN O&M costs for Public Service that was performed at the end of 2019. As a result of this analysis, certain run state O&M costs for FAN (i.e., O&M costs after the initial deployment) were moved to other programs such as AMI to better align these costs with the support provided by Business Systems to each of the AGIS projects. In addition, this bottoms up analysis also utilized the actual costs associated with the WiSUN deployment as a basis to update the projected FAN O&M costs. This also resulted in a decrease in FAN O&M costs as compared to the AGIS CPCN Settlement. Finally, in the AGIS CPCN Settlement, certain WiMAX O&M costs were included in the WiSUN O&M budget. These costs were removed as part of this comparison, which also contributed to a decrease in current FAN O&M costs as compared to the costs presented in the AGIS CPCN Settlement.

Figure WAR-D-6



1 **Q. IN SUMMARY, WHY ARE BUSINESS SYSTEMS' FAN COSTS REASONABLE**
2 **FOR CUSTOMERS TO SUPPORT?**

3 A. The FAN is a foundational component of AGIS, which is a long-term strategic
4 initiative to transform our electrical distribution system to enhance security,
5 efficiency, and reliability, to safely integrate more DERs, including those that are
6 customer owned, and to enable improved customer products and services. The
7 FAN will provide communications between the advanced grid devices, including
8 the AMI meters, enabling business operations efficiencies, and a better customer
9 experience to empower informed energy decisions. The IT components described
10 above are necessary to implement AMI, and the AMI IT forecast is reasonable in
11 enabling technologies that improve customer products and services.

VIII. ADVANCED PLANNING TOOL

A. Overview of Advanced Planning Tool

Q. WHAT IS THE ADVANCED PLANNING TOOL (“APT”)?

A. The APT a forecasting and planning software that will enable Public Service to implement more efficient distribution planning, enhanced load forecasting capabilities, and better integration with the Company’s other planning efforts. The Company will implement a cloud-based APT that provides a load forecasting capability to its Distribution team. The software is called LoadSeer.

LoadSeer will provide the Company with a spatial load forecasting software tool designed specifically for transmission and distribution planners who face increasingly complex grid decisions caused by emerging micro-grid technologies, extreme weather events, and new economic activity. This will replace a current end of life Distribution Asset Analysis tool which is no longer under standard support. Distribution Asset Analysis also runs on outdated SQL Server 2008 which is also no longer under standard support.

Q. WHAT IS BUSINESS SYSTEMS’ ROLE IN IMPLEMENTING APT?

A. Business Systems will be responsible for the deployment of this software tool. LoadSeer is a Software as a Service product, which will leverage support from the vendor for the Integral Analytics specifically for the hosting, management, and operation of the software itself. User administration and management of data feeds from Xcel Energy systems to this new tool will be managed under Xcel Energy’s existing contracted third-party application support model.

B. APT Deployment Timeline

Q. WHAT IS DEPLOYMENT PLAN FOR THE PLANNING AND FORECASTING TOOL?

A. The high-level deployment schedule for APT is that this software will be ready for use by Public Service in December 2020.

C. Business Systems' APT Capital Costs

Q. WHAT ARE THE CAPITAL COSTS OF APT FOR WHICH BUSINESS SYSTEMS IS RESPONSIBLE?

A. The table below provides a breakdown of Business Systems' capital expenditures and capital additions forecast for APT for 2020 through 2025.

**Table WAR-D-25
APT Business Systems - Capital Expenditures
(Total Company)
(Dollars in Millions)**

	2020	2021	2022	2023	2024	2025	Total
APT	\$3.67	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$3.67

**Table WAR-D-26
APT Business Systems - Capital Additions
(Total Company)
(Dollars in Millions)**

	2020	2021	2022	2023	2024	2025	Total
APT	\$3.75	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$3.75

Q. WHAT ARE THE PRIMARY COMPONENTS OF THE BUSINESS SYSTEMS' CAPITAL FORECAST TO IMPLEMENT APT?

A. The capital forecast has two key components: software and labor.

Q. HOW DID THE COMPANY DEVELOP THESE COST ESTIMATES?

A. The costs for the APT software are provided in the contract with the software vendor. I note that there is only one vendor for the LoadSeer software. External labor costs are based on the contract pricing. The internal labor forecast is based on our experience and work in deploying other similar software.

D. Business Systems' O&M Costs for APT

Q. WHAT ARE BUSINESS SYSTEMS' O&M COSTS FOR APT?

A. The table below provides a summary of Business System's O&M forecast for APT for 2021 through 2025. The limited O&M expenses for Business Systems for APT after the software is deployed in 2020 relate to software maintenance and licensing.

**Table WAR-D-27
APT Business Systems– O&M Expenses
(Total Company)
(Dollars in Millions)**

	2021	2022	2023	2024	2025	TOTAL
APT	\$0.32	\$0.49	\$0.49	\$0.49	\$0.41	\$2.21

Q. DOES BUSINESS SYSTEMS HAVE ANY CONTINGENCY AMOUNTS IN ITS CAPITAL FORECAST FOR APT?

A. There is a very small amount of contingency, around \$10,000, in 2020 to account for any unexpected expenses during the implementation of APT.

1 **Q. WHY IS BUSINESS SYSTEMS' APT FORECAST REASONABLE FOR**
2 **CUSTOMERS TO SUPPORT?**

3 A. The APT will enable Public Service to better understand the conditions of the
4 distribution system at a more detailed level and aid in the development of load
5 forecasts and distribution plans. This tool will be particularly helpful as DER and
6 EV adoption rates increase and require more granular and complex load
7 forecasting to maintain the reliability and stability of the distribution system.

1 **IX. CONCLUSION**

2 **Q. PLEASE SUMMARIZE YOUR RECOMMENDATIONS.**

3 A. I recommend that the Commission approve the proposed AGR and find that
4 Business Systems' AGIS capital and O&M budgets are a reasonable
5 representation of the important grid advancement activities Public Service will
6 undertake through 2025 to implement the AGIS initiative.

7 **Q. DOES THIS CONCLUDE YOUR DIRECT TESTIMONY?**

8 A. Yes, it does.

Statement of Qualifications

Wendall A. Reimer

As the Director, AGIS Portfolio Delivery, I am responsible for the delivery of all technology and systems that are part of the AGIS initiative. My duties include, among other things, the oversight and sponsorship of critical capital deployment of new technology that is included in the AGIS initiative, including the FAN and all applications and systems that are integral to AGIS.

I joined Xcel Energy in 2014 and have 14 years of experience in the utility industry. I began working with Xcel Energy on a contract-basis as a Program Manager in 2009, overseeing the deployment of significant network and telecommunication projects across all regions and facets of the company. Prior to working with Xcel Energy, I provided a variety of services to energy businesses including the design and deployment of new technology at an energy company's new headquarters, development of new data centers and security solutions for energy companies, and multiple network and communications projects for non-utility organizations.

I graduated in 1981 from Concordia College, where I earned a bachelor's degree in Business Administration, with minors in Math and Computer Science and a series in Accounting.

BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF COLORADO

* * * * *

IN THE MATTER OF ADVICE NO.)
1828-ELECTRIC OF PUBLIC SERVICE)
COMPANY OF COLORADO TO)
REVISE ITS COLORADO P.U.C. NO. 8) PROCEEDING NO. 20AL-XXXXE
- ELECTRIC TARIFF TO IMPLEMENT)
AN ADVANCED GRID RIDER TO BE)
EFFECTIVE ON AUGUST 17, 2020)

AFFIDAVIT OF WENDALL A. REIMER
ON BEHALF OF
PUBLIC SERVICE COMPANY OF COLORADO

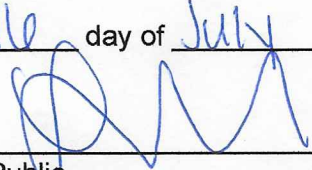
I, Wendall A. Reimer, being duly sworn, state that the Direct Testimony and attachments were prepared by me or under my supervision, control, and direction; that the Direct Testimony and attachments are true and correct to the best of my information, knowledge, and belief; and that I would give the same testimony orally and would present the same attachments if asked under oath.

Dated at Isanti, Minnesota, this 16th day of July, 2020.



Wendall A. Reimer
Director, AGIS Portfolio Delivery

Subscribed and sworn to before me this 16 day of July, 2020.



Notary Public

My Commission expires 1-31-21

