APPENDICES CONTENTS

*2015 PSE Integrated Resource Plan*

**A. Public Participation**

A-2. OVERVIEW

A-3. INTEGRATED RESOURCE PLANNING ADVISORY GROUP (IRPAG)

A-4. CONSERVATION RESOURCES ADVISORY GROUP (CRAG)

*A-5. TECHNICAL ADVISORY GROUP (TAG)*

**B. Legal Requirements and Other Reports**

B-2. REGULATORY REQUIREMENTS

B-5. REPORT ON PREVIOUS ACTION PLANS

B-10. OTHER REPORTS

**C: Environmental and Regulatory Matters**

C-2. ENVIRONMENTAL PROTECTION AGENCY REGULATIONS

* Coal Combustion Residuals
* Mercury and Air Toxics Standard
* Clean Water Act
* Regional Haze Rule
* National Ambient Air Quality Standards
* Greenhouse Gas Emissions

C-9. STATE AND REGIONAL ACTIVITY

* California Cap-and-trade Program
* Washington State
* Renewable Portfolio Standards

**D: Electric Resources and Alternatives**

D-2. RESOURCE TYPES

D-5. EXISTING RESOURCES INVENTORY

* *Supply-side Thermal Resources*
* *Supply-side Renewable Resources*
* *Supply-side Contract Resources*
* *Supply-side Transmission Resources*
* *Demand-side Energy Efficiency Resources*
* *Demand-side Customer Programs*

D-32. ELECTRIC RESOURCE ALTERNATIVES

* *Generic Resource Costs and Characteristics*
* *Thermal Resources Modeled*
* *Thermal Resources Not Modeled*
* *Energy Storage Resources Modeled*
* *Renewable Resources Modeled*
* *Renewable Resources Not Modeled*
* *Demand-side Resources Modeled*

**E: Demand Forecasting Models**

E-2. ELECTRIC BILLED SALES AND CUSTOMER COUNTS

* *System-level Model*
* *County-level Model*
* *Eastside King County-level Model*

E-6. ELECTRIC PEAK HOUR LOAD FORECASTING

* *System-level Forecast*
* *County-level Forecasts*
* *Eastside King County-level Forecast*

E-11. GAS BILLED SALES AND CUSTOMER COUNTS

E-14. GAS PEAK DAY LOAD FORECAST

E-16. MODELING UNCERTAINTIES IN THE LOAD FORECAST

E-17. HOURLY ELECTRIC DEMAND PROFILE

* *Data*
* *Methodology for Distribution of Hourly Temperatures*
* *Methodology for Hourly Distribution of Load*

**F: Regional Resource Adequacy Studies**

1. npcc rESOURCE ADEQUACY ASSESSMENT

2. pnucc NORTHWEST REGIONAL FORECAST

3. BPA 2014 PACIFIC NORTHWEST LOADS AND RESOURCE STUDY

**G: Wholesale Market Risk**

G-2. EXECUTIVE SUMMARY

G-4. REGIONAL RESOURCE BALANCE IS CHANGING

* The Origins of the Surplus
* The Origins of the Deficit
* Regional Load/Resource Forecasts
* Questions Raised by the Regional Forecasts

G-12. PSE’S MARKET RELIANCE

* Time to Re-evaluate Strategy
* Growing Risks
* Mechanisms for Reducing Risk

G-16. HOW THE PACIFIC NORTHWEST POWER MARKETS WORK

* General Market Structure
* Spot and Forward Markets
* Key Market Characteristics
* The WSPP Agreement
* Price Caps

G-22. WHOLESALE MARKET RELIABILITY ANALYSIS

* Modeling Physical Supply Risk
* The GENESYS Model
* The PSE Wholesale Purchase Curtailment Model (WCPM)
* Calculating the Capacity Contribution of Wholesale Market Purchases
* Other Modeling Considerations and Uncertainties

**H: Operational Flexibility**

H-2. OVERVIEW

H-3. SYSTEM BALANCING

* The PSE Balancing Authority
* Impact of Variability and Uncertainty on System Volatility
* Managing Volatility

H-11. FLEXIBILITY SUPPLY AND DEMAND

* Flexibility Supply
* Flexibility Demand
* Procuring and Deploying Balancing Reserve Capacity

H-16. MODELING METHODOLOGY

* Hour-ahead Methodology
* Intra-hour Methodology
* Modeling Assumptions and Limitations

H-20. RESULTS

* Demand - Hour-ahead Capacity
* Supply - Hour-ahead Capacity
* Intra-hour Flexibility Results

H-28. CONCLUSION & NEXT STEPS

**I: Regional Transmission Resources**

I-2. OVERVIEW

I-3. THE PACIFIC NORTHWEST TRANSMISSION SYSTEM

* Regional Constraints
* PSE Westside Transmission Constraints

I-7. PSE TRANSMISSION EFFORTS

* Puget Sound Area / North of Echo Lake / Northern Intertie
* West of Cascades North

I-8. BPA TRANSMISSION EFFORTS

* Network Open Season
* Wind Curtailments
* BPA Transmission Planning and Attachment K Projects

I-11. REGIONAL TRANSMISSION EFFORTS

* Major Proposed Projects
* ColumbiaGrid Efforts
* Order 1000

I-17. OUTLOOK AND STRATEGY

**J: Demand-side Resources**

CADMUS Comprehensive Assessment of Demand-side

Resource Potentials (2016-2035) for PSE

* Appendix A: Methodological Consistency with the 6th Northwest Power Plan
* Appendix B.1 Detailed Results
* Appendix B.2: Measure Descriptions
* Appendix B.3: Measure Details

**K: Colstrip**

K-2. Facility Description

* Governance
* Requirements after Operations Cease
* The History of Colstrip
* Plant Operations

 K-12. Rules & Proposed Rules

* Mercury and Air Toxics Rule
* Regional Haze Rule
* Coal Combustion Residuals Rule
* Clean Water Act
* Clean Air Act

**L. Electric Energy Storage**

L-2. OVERVIEW

* Recent Industry Developments

L-6. Potential electricity Storage Services

L-11. Energy Storage Technologies

* Chemical Storage (Batteries)
* Mechanical Storage
* Thermal Storage
* Bulk Gravitational Storage

L-28. Development Considerations

* Siting Storage
* Development Timelines

L-31. PSE Storage Analysis

* Technologies Modeled
* Sizing Assumptions
* Performance Metrics
* Generic Costs
* Battery System Cost Assumptions
* Methodology
* Pilot Project

**M. Distributed Solar**

M-2. OVERVIEW

M-3. DISTRIBUTED SOLAR PV IMPACT AT THE CIRCUIT LEVEL

* Study Design and Assumptions
* Findings
* Summary

M-23. Distributed Photovoltaic Technical and Market Potential

* Cadmus Group Report

**N. Electric Analysis**

*N-2: PORTFOLIO ANALYSIS METHODS*

* *Developing Wholesale Power Prices*
* *Deterministic Portfolio Optimization Analysis*
* *Stochastic Risk Analysis*

*N-6: PORTFOLIO ANALYSIS MODELS*

* *The AURORA Dispatch Model*
* *Portfolio Screening Model III*
* *Stochastic Portfolio Model*

*N-25: Key Inputs and Assumptions*

* *AURORA Inputs*
* *PSM III Inputs*
* *Planning Standard*

*N-52: Outputs*

* *AURORA Electric Prices and Avoided Costs*
* *Electric Integrated Portfolio Results – 2013 Planning Standard*
* *Electric Integrated Portfolio Results – 2015 Optimal Planning Standard*
* *Candidate Resource Strategies*

*N-126. Incremental Cost of Renewable Resources*

**O. Gas Analysis**

O-2. ANALYTICAL MODEL

* SENDOUT
* Resource Aternatives Assumptions
* Scenarios and Sensitivities Analyzed

O-7. ANALYSIS RESULTS

O-22. PORTFOLIO DELIVERED GAS COSTS