

TABLE OF CONTENTS

VOLUME 1

<u>SUBJECT</u>	<u>PAGE</u>
CHAPTER 1 – PLAN OVERVIEW	1-1
The 2015 Electricity Supply Resource Procurement Plan	
• Portfolio Transformation.....	1-1
• Reducing Resource Deficits since 2002.....	1-2
• Capacity Needs and Planning	1-2
• Preferred Resources	1-4
• Hydro Potential	1-7
• Demand Side Management.....	1-8
• Renewable Portfolio Standards.....	1-9
• Resource Adequacy	1-10
• Market Operations	1-12
• Regional Electricity Market Development	1-13
○ Energy Imbalance Markets.....	1-13
○ Regional Transmission Organizations / Independent System Operators.....	1-14
○ Participation in Organized Markets	1-14
• Colstrip Unit 4 Value	1-15
• Introduction to 2015 Plan Document	1-15
○ Volume 1	1-16
○ Volume 2.....	1-16

<u>SUBJECT</u>	<u>PAGE</u>
CHAPTER 2 – LOAD FORECAST	2-1
NorthWestern’s 2015 Forecast of Customer Loads	
• Peak Demand Forecast	2-1
• Energy Usage and Needs	2-3
• Customer Forecast.....	2-7
• Retail Load Shape	2-8
• Energy Load – Balance	2-9
• Conclusion.....	2-12
CHAPTER 3 – DEMAND SIDE MANAGEMENT	3-1
DSM Acquisition Plan and Programs	
• DSM Goals.....	3-1
• DSM Budget and Spending.....	3-3
• DSM Programs.....	3-5
• DSM Program Costs & Lost Revenue Recovery.....	3-7
CHAPTER 4 – KEY MODEL INPUTS	4-1
Commodity Price Forecasts Used in the 2015 Resource Plan	
• Commodity Forward Prices	4-1
• Natural Gas Price Forecast.....	4-1
• Electricity Price Forecast.....	4-3
• Colstrip Coal Price Forecast.....	4-5
• Renewable Energy Credits	4-6

<u>SUBJECT</u>	<u>PAGE</u>
CHAPTER 5 - ENVIRONMENTAL.....	5-1
Environmental Trends that Influence the 2015 Plan	
• Introductory Statement.....	5-1
• Greenhouse Gas Emissions.....	5-1
Summary of Key Colstrip Environmental Risks	
• Regional Haze Rule.....	5-6
• Mercury and Air Toxics.....	5-7
• Coal Combustion Residuals.....	5-8
• New Source Review (“NSR”) / Prevention of Significant Deterioration (“PSD”).....	5-8
• National Ambient Air Quality Standards (“NAAQS”).....	5-9
• Wastewater.....	5-10
Summary of Key Hydro Risks	
• Hydroelectric License Compliance.....	5-10
• Relicensing.....	5-11
• River Flow and Reservoir Management.....	5-12
• Hydrologic Uncertainty.....	5-13
Other Environmental Considerations	
• Wind Generation.....	5-13
• Dave Gates Generating Station (“DGGS”).....	5-14
• Basin Creek.....	5-15
• Transmission Line Permitting.....	5-15
CHAPTER 6 – CARBON IMPACTS	6-1
Carbon Scenarios Included in Modeled Portfolios	

<u>SUBJECT</u>	<u>PAGE</u>
<ul style="list-style-type: none"> • Carbon Costs6-1 	
CHAPTER 7 – RESOURCE ADEQUACY –	
REGIONAL MARKET 7-1	
Resource Adequacy and the Regional Market Impacts	
<ul style="list-style-type: none"> • Background.....7-1 • NERC Resource Adequacy7-2 • Regional Resource Adequacy7-3 	
Regional Market Development and Regulatory Change	
<ul style="list-style-type: none"> • Energy Imbalance Markets7-6 • Regional Transmission Organizations / Independent System Operators7-7 • Participation in Organized Markets.....7-8 • Real Power Balancing and Reliability Based Control7-9 	
CHAPTER 8 – EXISTING RESOURCES 8-1	
Existing Resources Included in Modeled Portfolios	
<ul style="list-style-type: none"> • Introduction.....8-1 • Utility Hydroelectric Resources8-2 <ul style="list-style-type: none"> ○ Licenses and Agreements8-4 ○ Hydroelectric Operations8-5 • Thermal Generation Resources8-7 <ul style="list-style-type: none"> ○ Colstrip Unit 48-8 ○ Dave Gates Generating Station8-13 ○ Basin Creek Equity Partners, LLC.....8-13 ○ Thermal QF Resources.....8-14 	

<u>SUBJECT</u>	<u>PAGE</u>
• Wind Generation.....	8-14
• Small Hydroelectric Generation	8-17
• Qualifying Facility Power Purchase Agreements	8-17
• Renewable Portfolio Standards.....	8-19
• CREP Resources	8-21
• Distributed Energy Resources	8-21
 CHAPTER 9 – NEW RESOURCES	 9-1
New Resources Evaluated for the 2015 Plan	
• New Resources Overview.....	9-1
• Thermal Resources	9-1
○ Internal Combustion Engines.....	9-2
○ Combined Cycle Combustion Turbines.....	9-2
○ Simple Cycle Combustion Turbines.....	9-2
○ Defining New Gas-Fired Resources	9-3
○ Natural Gas-Fired Resource Siting.....	9-4
• Renewable Resources	9-7
○ Hydroelectric Upgrades	9-7
○ Optimization	9-7
○ Utility Scale Solar PV.....	9-9
○ Wind.....	9-11
○ Small Hydroelectric	9-11
• Research and Development.....	9-12
○ Demand Response.....	9-12
○ Microgrid	9-13

<u>SUBJECT</u>	<u>PAGE</u>
CHAPTER 10 – INTEGRATED GENERATION SYSTEM.....	10-1
• Background.....	10-1
• Hydro Optimization	10-3
 CHAPTER 11 – ANCILLARY SERVICES	
LOSS OF LOAD PROBABILITY	11-1
• Introduction.....	11-1
• Contingency Reserves	11-1
• Ancillary Services.....	11-2
• Regulation Requirements for Wind and Solar PV.....	11-4
• Flexibility Requirements for Wind and Solar PV	11-9
• Cost of Regulation.....	11-13
• Loss of Load Probability.....	11-15
 CHAPTER 12 – RESULTS AND CONCLUSIONS.....	12-1
• Introduction.....	12-1
• Options for Capacity Expansion	12-2
• Portfolio Analysis	12-5
• Capacity Expansion Charts	12-7
• Valuation of Risk	12-9
• Net Present Value of Portfolio Costs	12-12
• Carbon Footprint	12-18
• Conclusions	12-20

<u>SUBJECT</u>	<u>PAGE</u>
CHAPTER 13 – RESPONSES TO MPSC COMMENTS	
ON 2013 PLAN.....	13-1
• Commission 2013 Plan Comments	13-1
CHAPTER 14 – ACTION PLAN.....	14-1
Implementation and Next Steps	
• Moving Forward	14-1
APPENDIX 1 ABBREVIATIONS	A1-1
APPENDIX 2 GLOSSARY.....	A2-1

<u>Tables</u>	<u>PAGE</u>
1-1 Utility Owned and Controlled Resources in Montana	1-2
1-2 Economically Optimal Portfolio Resources	1-5
1-3 Estimated EOP Costs	1-7
2-1 Historical Peak Demand	2-2
2-2 Peak Demand 1 in 2	2-2
2-3 Actual and Expected Population Growth	2-7
3-1 DSM Acquisition Plan and Budget	3-4
4-1 Base Case Electricity and Natural Gas Price Forecasts (Including base case carbon price for electricity)	4-5
4-2 Colstrip Coal Price Forecast	4-6
4-3 Renewable Energy Credit Price Forecast	4-8
4-4 Fundamental Inputs to PowerSimm Analysis	4-9
4-5 Weighted Average Cost of Capital	4-9
5-1 Estimated EOP Carbon Emissions with CPP Regulated Sources	5-5
6-1 CO ₂ Cost Forecasts	6-4
6-2 2015 Plan Carbon Price Forecast	6-6
7-1 NERC Reference Reserve Margin Levels	7-3
8-1 NorthWestern Owned Hydro Resources	8-4
8-2 NorthWestern Thermal Generation	8-8
8-3 Colstrip Generation, Ownership	8-9
8-4 Renewable Wind Resources	8-15
8-5 Small Hydro Resources	8-17

<u>Tables</u>	<u>PAGE</u>
8-6 Future Renewable Resources	8-18
8-7 RPS Eligible Renewable Resources.....	8-19
9-1 Resource Cost Summary (2015\$)	9-3
9-2 CBI Study Potential Locations	9-4
9-3 CBI Study Scoring.....	9-5
9-4 Hydroelectric Capacity Expansion Potential	9-9
11-1 2015 Contingency Reserve Requirements	11-1
11-2 2022 Ramp Requirements with Additional Wind and Solar PV	11-12
11-3 2016 Reserve Margins and LOLP with Capacity Resource Additions.....	11-18
12-1 Summary of Resource Inputs for Capacity Expansion Planning	12-4
12-2 Resource Plan Portfolio Assumptions.....	12-6
12-3 Description of New Units by Portfolio.....	12-7
12-4 Net Present Value of Portfolio Costs by Scenario and Category ..	12-12
12-5 Carbon Footprint (20-Year Average Annual)	12-19

<u>Figures</u>	<u>PAGE</u>
1-1 Winter Peak Demand and Available Resources	1-3
1-2 EOP Resource Mix 2025	1-6
1-3 Planning Reserve Margins for Selected Power Companies	1-11
2-1 2014 Actual Retail Load Energy Usage by Rate Class.....	2-3
2-2 NorthWestern Service Territory Total Degree Day Range and Average 1989-2014.....	2-4
2-3 Retail Load and DSM Program Savings Forecast	2-6
2-4 2014 Retail Load Shape	2-8
2-5 Current plus Market 5 Year HL MWh.....	2-11
2-6 Current plus Market 5 Year LL MWh	2-12
4-1 Natural Gas Price Forecast Comparisons	4-3
4-2 Electricity Price Forecast Comparisons	4-4
5-1 Implications of the CPP.....	5-4
6-1 2013 Plan Carbon Price Trajectories	6-2
6-2 CO ₂ Cost Forecast Comparison	6-5
7-1 NERC Reliability Assessment Areas	7-2
7-2 Planning Reserve Margins for Selected Power Companies	7-5
8-1 2016 Electricity Supply Portfolio (Based on nameplate capacity) ...	8-1
8-2 NorthWestern Energy Hydro Facilities.....	8-2
8-3 Hydros Locations	8-3
8-4 2015 Owned Hydro Average Hourly Output by Week	8-6
8-5 Electric Generation (Non-Hydros).....	8-7
8-6 Net Wind Generation Hourly Output – Daily Examples	8-16

<u>Figures</u>	<u>PAGE</u>
8-7 Forecast RPS Compliance.....	8-20
8-8 Forecast Growth in Net Metering.....	8-22
10-1 Integrated System Economic Sharing of Contingency Reserves and Regulating Requirements.....	10-3
11-1 Illustration of Regulation Compared to Load Following	11-3
11-2 NorthWestern Load, Intermittent Renewable Generation, and Regulation Requirements.....	11-4
11-3 Impact of Adding 100 MW of Wind Generation on Regulation Requirements	11-5
11-4 Regulation Requirements for 2022 with Additional Wind Generation (Excludes Load Following Component)	11-6
11-5 Impact of Adding 100 MW of Solar PV Generation on Regulation Requirements	11-7
11-6 Regulation Requirements for 2022 with Additional Solar PV Generation (Excludes Load Following Component)	11-8
11-7 One-hour Ramp Requirements with Current Resources	11-9
11-8 One-hour Ramp Requirements with Additional 100 MW Wind	11-10
11-9 One-hour Ramp Requirements with Additional 100 MW Solar	11-11
11-10 DGGs Regulation vs. 50/50 Regulation	11-14
11-11 Cost of Supply Regulation 50% Hydros – 50% DGGs.....	11-15
11-12 LOL Days in Ten Years – Economically Optimal Portfolio.....	11-19
12-1 Current Plus Market Portfolio.....	12-8

<u>Figures</u>	<u>PAGE</u>
12-2 EOP Capacity Expansion.....	12-9
12-3 Illustration of Risk Premium Concept.....	12-10
12-4 Values of Risk Premium for Select Portfolios	12-11
12-5 Net Present Value of Portfolio Cost plus Carbon Footprint.....	12-13
12-6 Net Present Value Costs of Current + Market, Frame CT and EOP	12-14
12-7 Net Present Value Cost of EOP Costs under Alternative Load Growth Scenarios	12-15
12-8 Net Present Value Cost of EOP and Price Sensitivities.....	12-16
12-9 Net Present Value Cost of EOP, and EOP with Additional Wind..	12-18
12-10 Carbon Emission Rates by Portfolio (lbs CO ₂ /MWh)	12-20

TABLE OF CONTENTS

VOLUME 2

CHAPTER 1 BACKGROUND

- **Commission Comments on 2013 Plan.....1 to 10**
- **2014 - 2016 ETAC Meeting Minutes & Materials.....1 to 271**
- **NWE Motion for Extension.....1 to 4**
- **MPSC Notice of Commission Action 1**

CHAPTER 2 FORECASTS

- **20-Year Load Forecasts1 to 6**
- **Peak Forecast 2015 1**
- **Customer History and Forecast1 to 10**
- **Residential and GS-1 Secondary Load Forecast Metrics.....1 to 8**
- **Weather Ended 20161 to 2**
- **Commodity Prices1 to 26**
- **Wind Resource Pricing1 to 2**
- **RPS Compliance Forecast.....1 to 2**

CHAPTER 3 DEMAND SIDE MANAGEMENT

- **Smart Grid Demonstration Project.....1 to 6**
- **Battery Storage Project.....1 to 3**
- **NWE CFL Lighting Market Study.....1 to 64**
- **PNW SGDP Annual Report Technology Performance1 to 32**
- **Large Customer Demand Response Survey1 to 7**
- **Behavior Based DSM and Price Elasticity of Demand1 to 4**

CHAPTER 4 CARBON

- **CPP NWE Motion to Stay1 to 6**
- **UM BBER Report1 to 75**
- **CPP EPA Transmission Impact1 to 11**
- **CPP Final Goals Summary & Table.....1 to 2**

CHAPTER 5 RESOURCE DEFINITIONS & OPTIMIZATION

- **Basin Creek Dispatch Study1 to 47**
- **NWE Hydropower Operational Plan1 to 14**
- **Thermal Operating Characteristics and Cost.....1 to 2**
- **Wartsila Report1 to 58**
- **DNV-GL Solar PV Study1 to 31**
- **Microgrid Project1 to 2**
- **NWE CHEOPS Hydro Report1 to 192**
- **NWE CHEOPS Hydro Peaking Report1 to 21**
- **Ancillary Service Modeling1 to 6**

CHAPTER 6 RESOURCE SITING

- **CBI Site Selection Report1 to 29**
- **New Generation Pre-Feasibility-Level Infrastructure and Costs1 to 11**

CHAPTER 7 POWERSIMM AND TECHNICAL DESCRIPTIONS

- **Example of Resource Selection Process 1**
- **Capacity Expansion Area Charts 1**
 - **Frame CT 1**

- **High Load** 1
- **Low Load** 1
- **Double Wind and Solar**..... 1
- **Triple Wind and Solar** 1
- **RPS Compliance** 1
- **Net Position Reports -- Around the Clock (ATC)**
 - **ATC Current + Market**.....1 to 20
 - **ATC Economically Optimal Portfolio**1 to 20
 - **ATC Frame CT**.....1 to 20
 - **ATC High Load**.....1 to 20
 - **ATC Low Load**.....1 to 20
 - **ATC High Carbon**1 to 20
 - **ATC Low Carbon**.....1 to 20
 - **ATC High Gas**.....1 to 20
 - **ATC Double Wind and Solar**1 to 30
 - **ATC Triple Wind and Solar**.....1 to 30
 - **ATC RPS Compliance**.....1 to 20
- **Net Position Reports – Heavy Load (HL)**
 - **HL Current + Market**1 to 20
 - **HL Economically Optimal Portfolio**.....1 to 20
 - **HL Frame CT**1 to 20
 - **HL High Load**1 to 20
 - **HL Low Load**1 to 20
 - **HL High Carbon**1 to 20
 - **HL Low Carbon**1 to 20
 - **HL High Gas**1 to 20
 - **HL Double Wind and Solar**1 to 30
 - **HL Triple Wind and Solar**1 to 30
 - **HL RPS Compliance**1 to 20

- **Net Position Reports – Light Load (LL)**
 - **LL Current + Market**.....1 to 20
 - **LL Economically Optimal Portfolio**1 to 20
 - **LL Frame CT**.....1 to 20
 - **LL High Load**.....1 to 20
 - **LL Low Load**.....1 to 20
 - **LL High Carbon**.....1 to 20
 - **LL Low Carbon**.....1 to 20
 - **LL High Gas**.....1 to 20
 - **LL Double Wind and Solar**1 to 30
 - **LL Triple Wind and Solar**.....1 to 30
 - **LL RPS Compliance**.....1 to 20
- **Generating Stations Reports**
 - **Current + Market**1 to 36
 - **Economically Optimal Portfolio**.....1 to 72
 - **Frame CT**1 to 72
 - **High Load**1 to 84
 - **Low Load**.....1 to 84
 - **High Carbon**1 to 72
 - **Low Carbon**1 to 72
 - **High Gas**.....1 to 72
 - **Double Wind and Solar**.....1 to 120
 - **Triple Wind and Solar**1 to 108
 - **RPS Compliance**1 to 72
- **Supply Cost Report**.....1 to 15
- **Methods to Model and Calculate Capacity Contributions of Variable Generation for Resource Adequacy Planning**1 to 63
- **Discussion of Models Used in 2015 Plan**1 to 8