Load Forecast
2019
For use in Resource Adequacy

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Northwest Power and Conservation Council

In today's presentation

- Review of loads in 2012
- Resource adequacy needs
  - Load forecast methodology
  - Drivers of the forecast
  - Treatment of conservation
  - Incorporating impact of weather
  - Forecast for 2019

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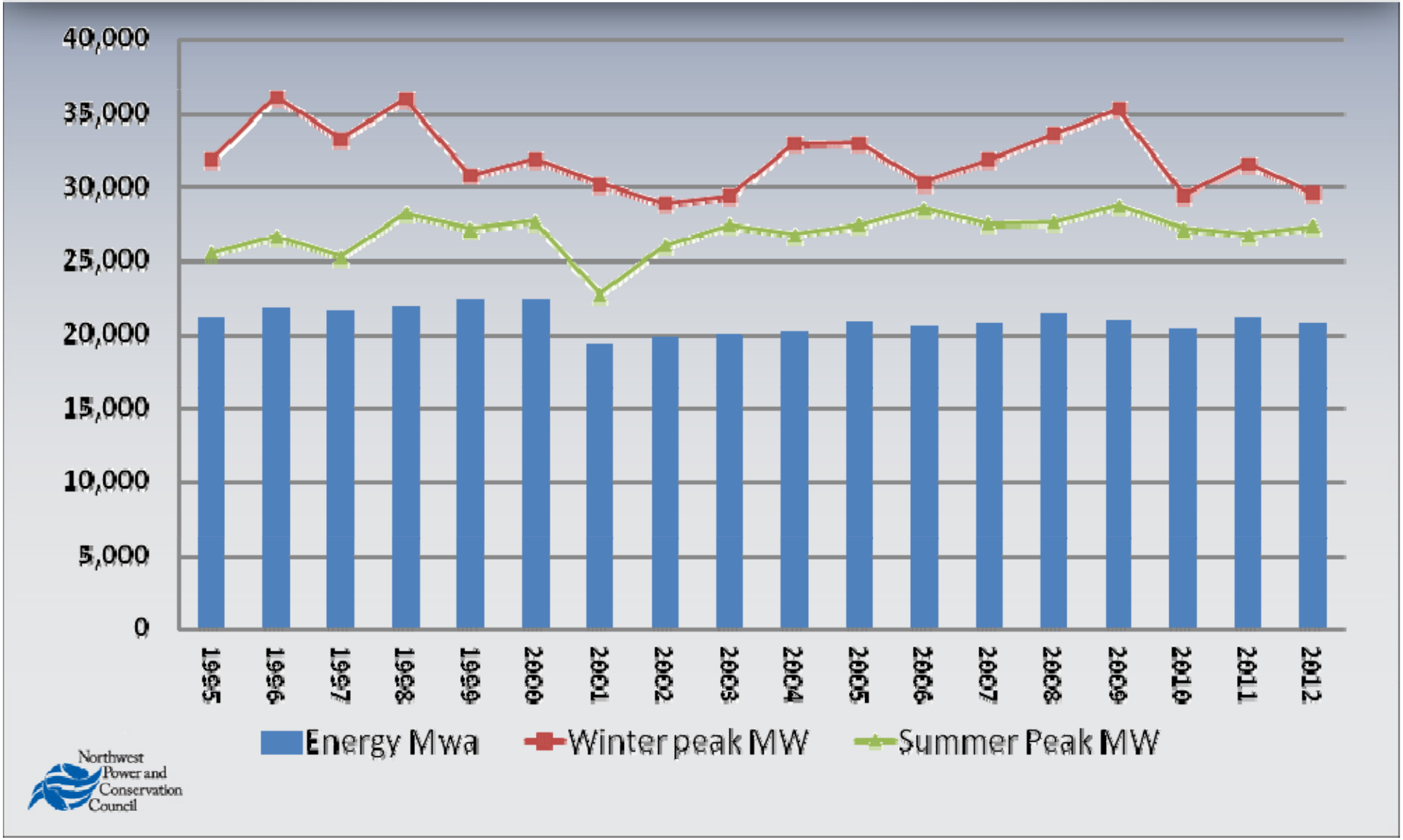
Regional Loads (MWA and MW)



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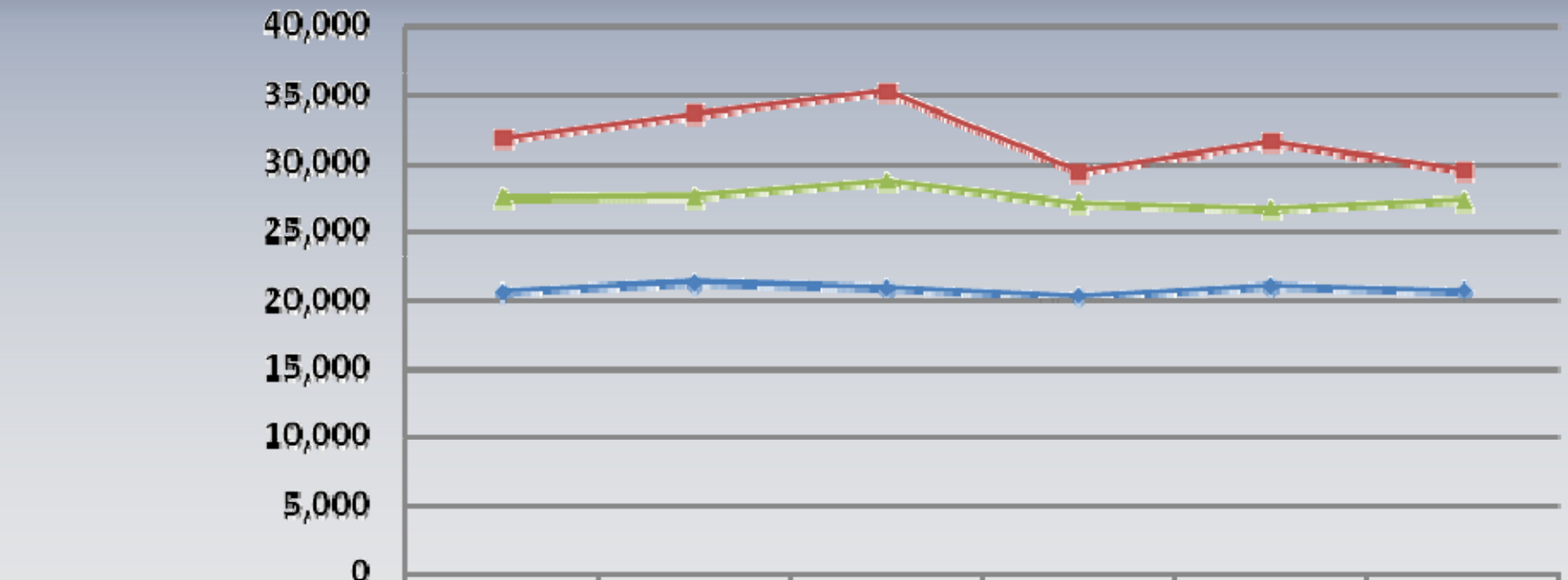
More Recent Regional Loads



	2007	2008	2009	2010	2011	2012
Energy Mwa	20,666	21,350	20,925	20,348	21,096	20,747
Winter Peak MW	31,855	33,633	35,316	29,440	31,577	29,570
Summer Peak MW	27,521	27,595	28,728	27,148	26,737	27,317

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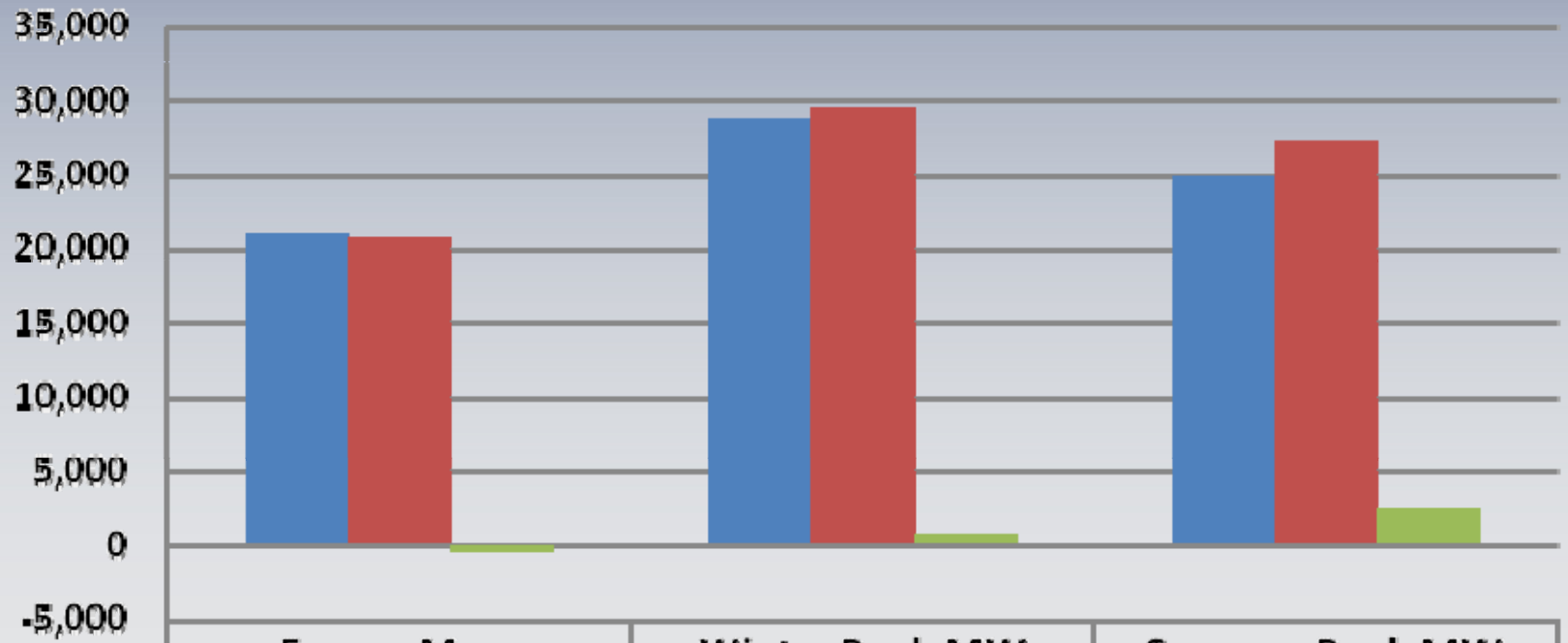
2012 Regional Loads Actual and weather Normalized



	Energy Mwa	Winter Peak MW	Summer Peak MW
2012 WN	20,972	28,770	24,893
2012 Actual	20,747	29,570	27,317
Difference	(225)	800	2,424

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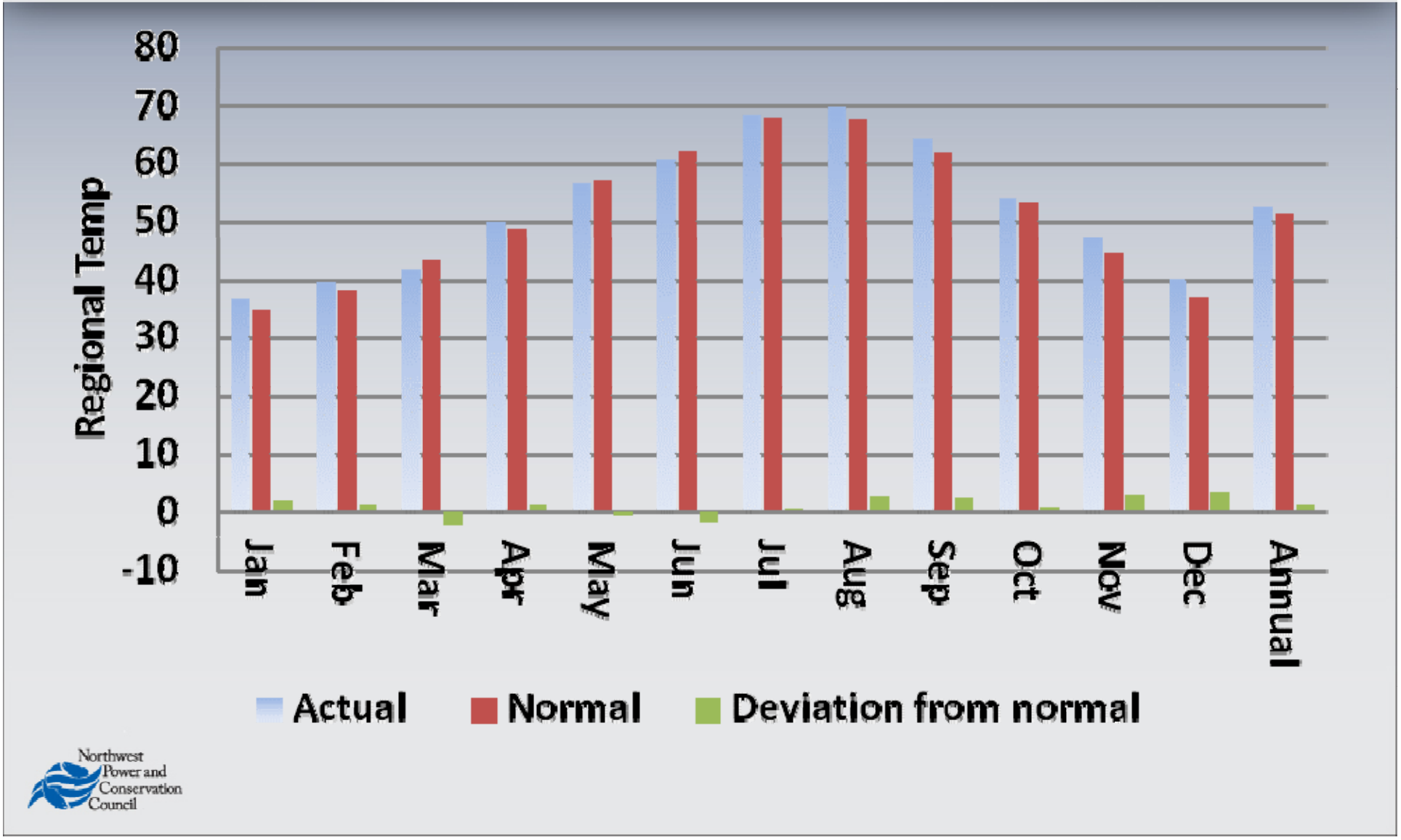
2012 Actual and Normal Average Monthly Temperatures in the Northwest



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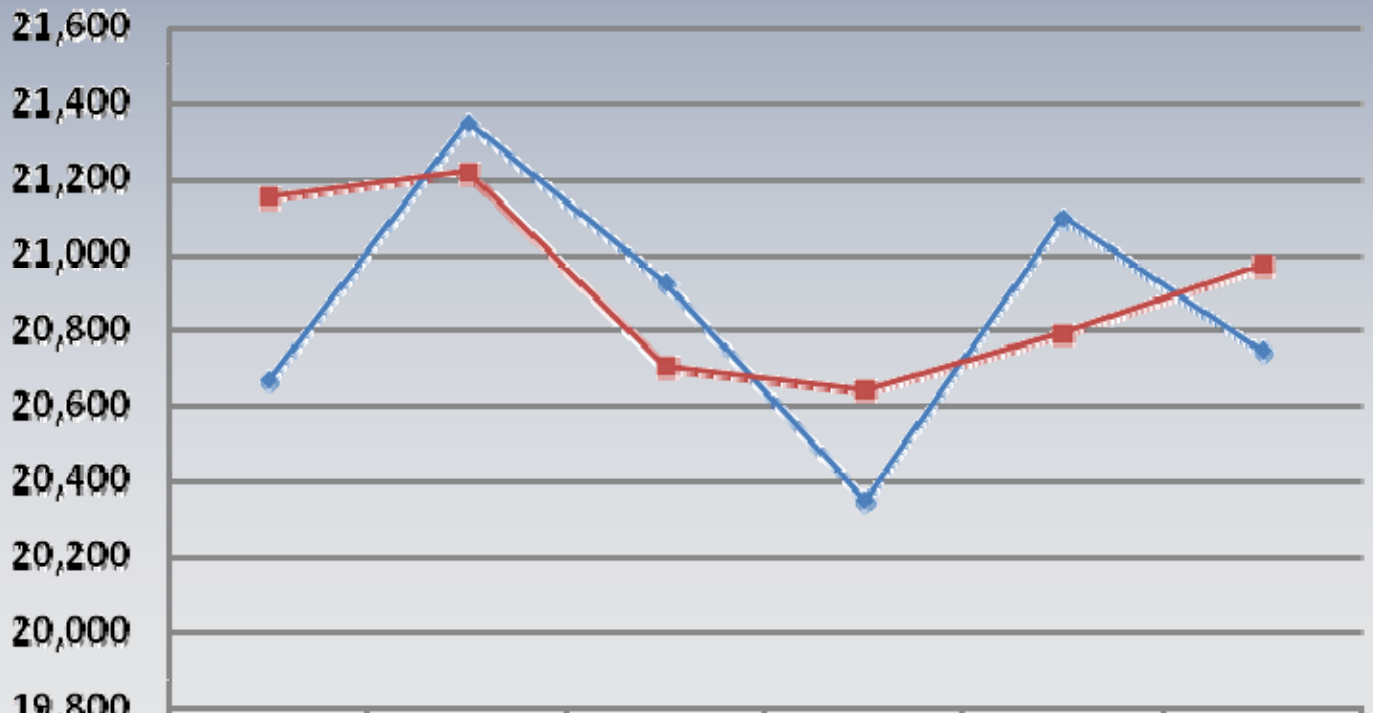
Actual and Temperature- Normalized NW Annual Energy Loads – 2007-2012



	2007	2008	2009	2010	2011	2012
Actual Load	20,666	21,350	20,925	20,348	21,096	20,747
Load After Adj for temp	21,152	21,219	20,704	20,640	20,791	20,972

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Resource Adequacy Needs

- Hourly loads projected 5 years from current year
- Projected loads under 1928-2012 Regional temperature conditions
- Treatment of conservation
  - Add Embedded conservation
  - Subtract 6th Power Plan conservations targets

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Information flow for Short-term Electricity Demand Forecasting System

1) Obtain Daily Regional Temperatures 1928-2012

2) Obtain hourly Loads by Balancing Authority and calculate daily regional load Model 1995-2012

3) Obtain actual monthly and annual forecast of regional employment

4) Calculate Hourly Load Allocation Factor s for each day

5) Estimate Structural Load Model using
1928-2012 daily Temps
1995-2012 daily Loads
1995-2012 employment

6) Estimate Daily Weather Normalized Loads for 2019

7) Estimate 84 sets of Daily Temperature Sensitive Loads Using 1928-2012 daily Temperatures

8) Adjust for Embedded and Target Conservation amounts

9) Loads for Resource Adequacy work

Create 84 sets of 8760 hourly Load Forecasts for 2019 For use in RA analysis

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Input Data Sets

- **Hourly load data for 1995-2012 (from WECC)**
- **Hourly temperatures data for 1990-2012 from Western Regional Climate Center**
- **1928-2012 Daily temperature from 4 sites in the region**
- **Monthly employment data for 1995-2012 from Bureau of Labor Statistics.**
- **Hourly Direct Service Industry load data for 1993-2012 from Bonneville Power Administration**
- **Forecast of regional employment 2013-2019**
- **Forecast of DSI load from BPA 2012 WhiteBook**
- **Estimates of past (1978-2009) efficiency acquisition levels**
  (Utility Programs, NEEA, State Codes, Federal Appliance Standards)

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Calculating Daily Average Regional Temperature

- Start with hourly temperature for the four sites (Portland PDX, SeaTac, Boise and Spokane airports)
- Weight the site temperature to calculate a weighted regional average for each day.
- Monthly weights (load weighted) were developed by BPA for each site.

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Short-term Model Structure

- A structural time series model is adopted to represent the load for electricity in the region as a function of cyclical, weather and economic variables.

- The general specification of the demand model is represented by .
  - where: L=f(S, W,DE,I)
- *L* = net average daily electricity load in the region (net of Direct Service Industries)
- *S* = variables depicting seasonal variations in load,
- *W* = deviation in temperature variables generated via a regression model
- *DE* = economic variables, and
- *I* = indicator variables.

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Structural Equation

Dependent Variable: LOG(LOAD-DSI_LOAD)
Method: Least Squares
Date: 06/28/13 Time: 12:38
Sample: 1/01/1928 12/31/2020 IF @YEAR>1994
Included observations: 6573
Convergence achieved after 8 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C1	0.089824	0.001543	58.19550	0.0000
C2	0.067007	0.001520	44.07623	0.0000
S1	0.016865	0.001541	10.94548	0.0000
S2	0.029775	0.001535	19.39757	0.0000
S3	-0.019903	0.001492	-13.33863	0.0000
C1_W	-0.038630	0.000345	-111.9580	0.0000
C2_W	-0.017592	0.000251	-70.15685	0.0000
S1_W	0.020302	0.000345	58.91746	0.0000
S2_W	0.017245	0.000253	68.11050	0.0000
C1_W*C1	0.010379	0.000488	21.24912	0.0000
C2_W*C1	0.005245	0.000355	14.76415	0.0000
S2_W*C1	-0.002946	0.000359	-8.214112	0.0000
C1_W*S1	0.001965	0.000488	4.026406	0.0001
S1_W*S1	-0.001555	0.000488	-3.187891	0.0014
D_JUL4	-0.082779	0.004219	-19.62218	0.0000
D_LBD	-0.068119	0.004273	-15.94221	0.0000
D_MEMD	-0.075623	0.004287	-17.63877	0.0000
D_NYD	-0.050983	0.004322	-11.79513	0.0000
D_TG	-0.076196	0.004289	-17.76664	0.0000
D_XMAS	-0.061184	0.004227	-14.47552	0.0000
RESILOG	-0.066734	0.004781	-13.95821	0.0000
RESILOG*C1	-0.351150	0.006617	-53.06978	0.0000
RESILOG*C2	0.136517	0.005512	24.76765	0.0000
RESILOG*S1	-0.157783	0.006238	-25.29388	0.0000
RESILOG*S2	0.166701	0.006400	26.04880	0.0000
RESILOG(-1)	-0.036032	0.004547	-7.925153	0.0000
RESILOG(-1)*C1	-0.075148	0.006235	-12.05294	0.0000
RESILOG(-1)*S2	0.014906	0.006052	2.462783	0.0138
RESILOG^2*S2	-0.095047	0.016704	-5.690214	0.0000
LOG(REGION_EMP)	0.453160	0.020259	22.36800	0.0000
@YEAR=1998	-0.028335	0.004610	-6.145850	0.0000
@YEAR=2001	-0.024008	0.004592	-5.228011	0.0000
C	5.958600	0.175738	33.90623	0.0000
AR(1)	0.446731	0.011927	37.45500	0.0000
AR(2)	0.323359	0.011867	27.24940	0.0000

R-squared	0.963322	Mean dependent var	9.882323
Adjusted R-squared	0.963131	S.D. dependent var	0.106007
S.E. of regression	0.020355	Akaike info criterion	-4.945701
Sum squared resid	2.708779	Schwarz criterion	-4.909542
Log likelihood	16289.05	Hannan-Quinn criter.	-4.933201
F-statistic	5050.470	Durbin-Watson stat	1.973489
Prob(F-statistic)	0.000000		

Inverted AR Roots	.83	-.39

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<u>Model structure</u>

Log format

Fourier series to capture cyclical behavior

Accounting for holidays

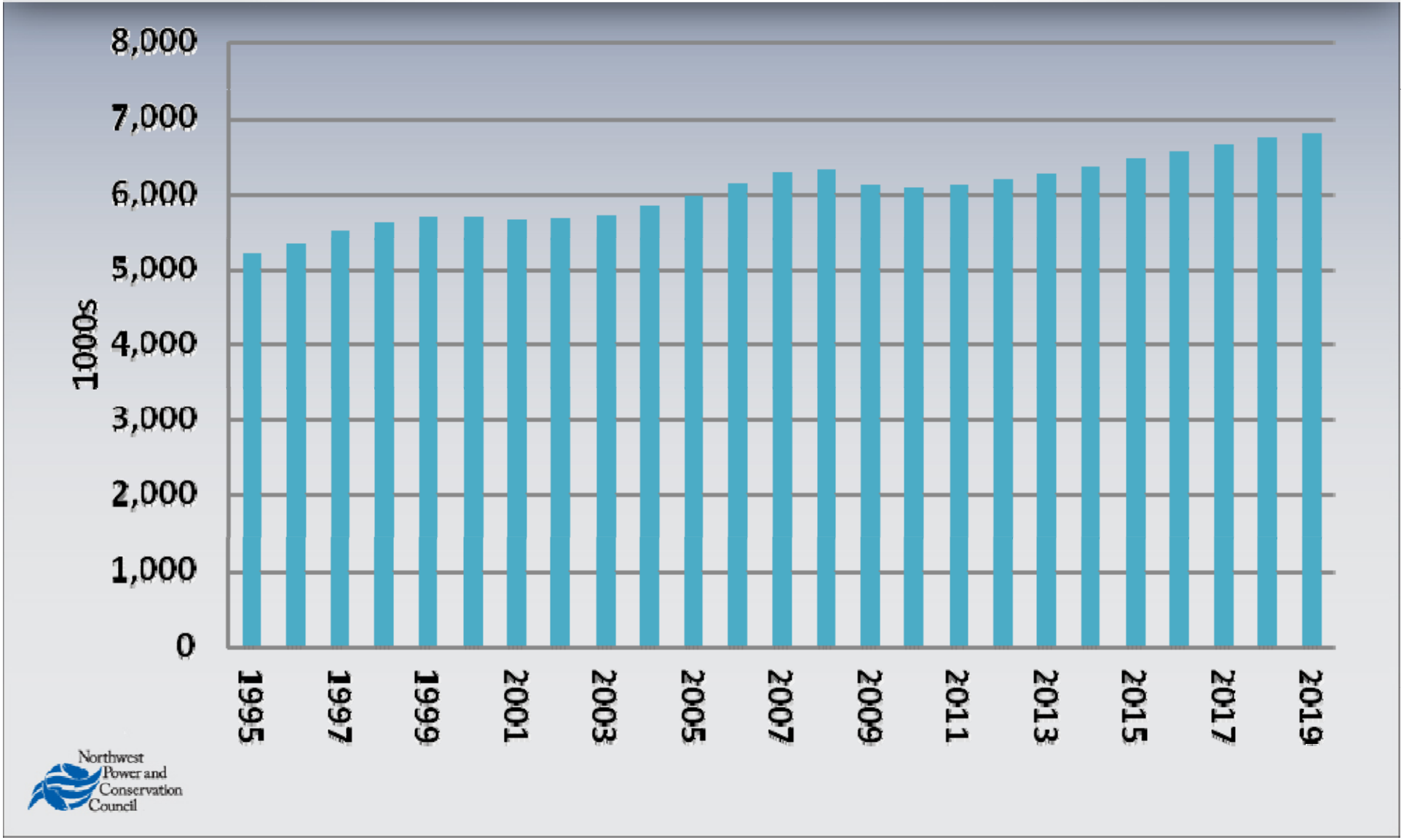
Accounting for load response to temperature

Captures limits to load growth as temperature increases

Driven with regional employment

Explains 96% of variations in daily historic load

Economic Driver of Short-term Forecast
1995-2019 Regional Employment



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Treatment of Conservation (Avoiding Double Counting)

- Resource Adequacy analysis requires that:
  1. Amount of conservation that is embedded in load be calculated and added back into the load forecast, to create a gross load forecast
  2. The 6th Power Plan conservation targets be subtracted from the gross load.
  3. Conservation targets are given the same hourly profile as the load.

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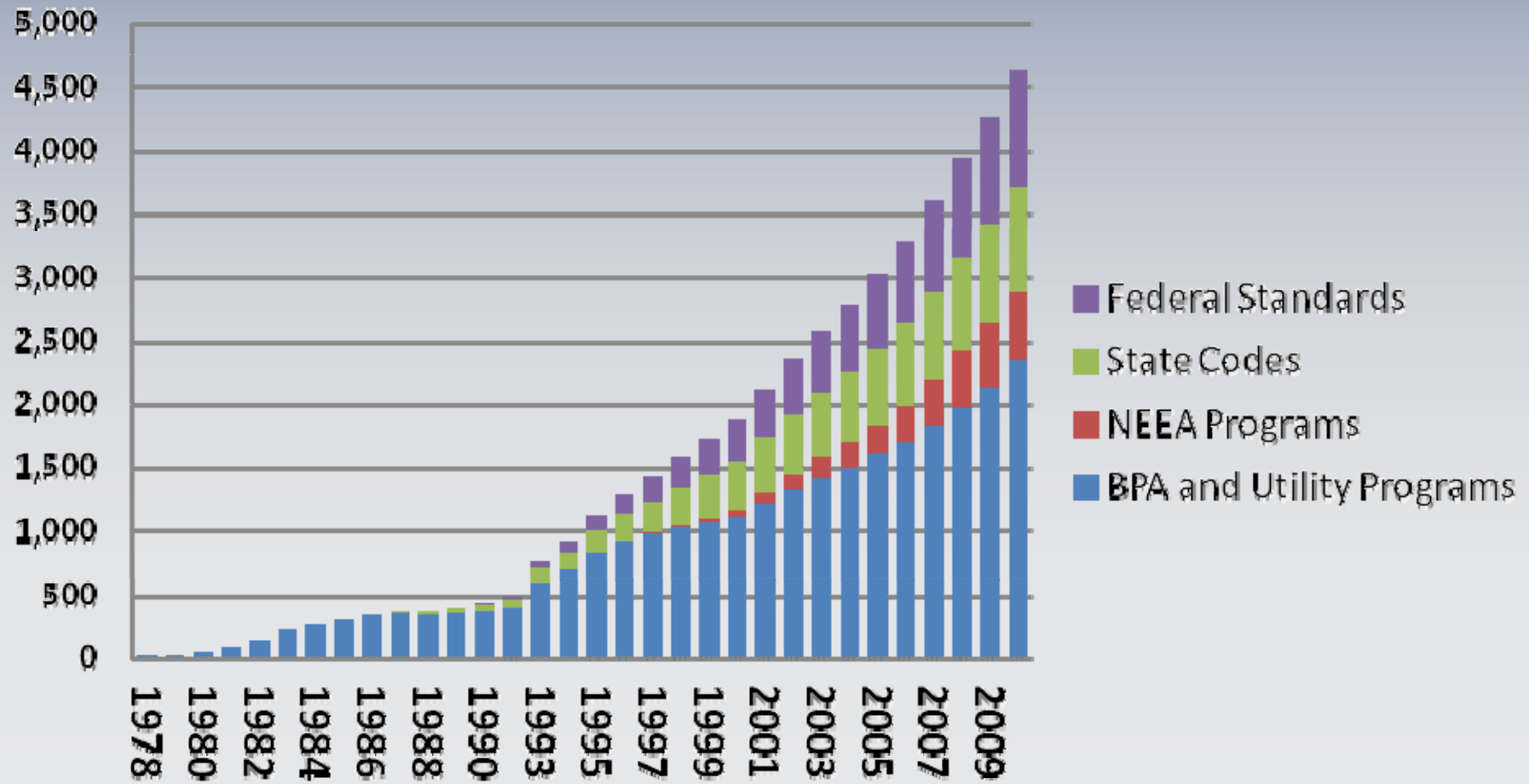
NW Energy Efficiency Acquisitions (Cumulative MWA)



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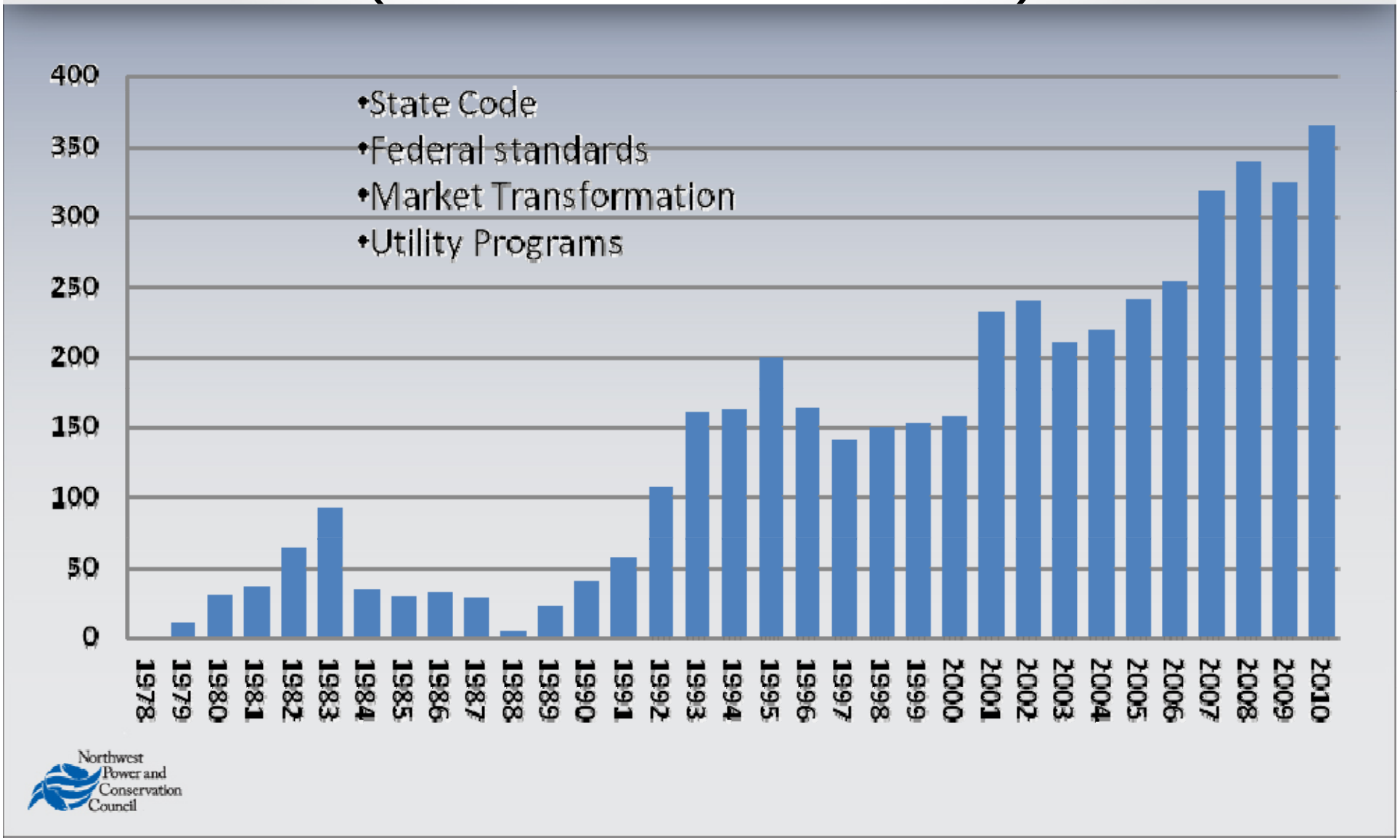
NW Energy Efficiency Acquisitions (Incremental MWA)



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Structural Equation For Forecast of Incremental Conservation Embedded in the loads

Dependent Variable: CONSERVATION_ACTUAL_INC
Method: Least Squares
Date: 06/28/13 Time: 11:40
Sample (adjusted): 1977 2011
Included observations: 35 after adjustments
Convergence achieved after 29 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EMPLOYMENT	0.111749	0.033989	3.287784	0.0025
C	-405.5139	184.4397	-2.198625	0.0353
AR(1)	0.833971	0.114340	7.293812	0.0000

R-squared	0.936914	Mean dependent var	142.8993
Adjusted R-squared	0.932971	S.D. dependent var	115.2499
S.E. of regression	29.83815	Akaike info criterion	9.711269
Sum squared resid	28490.08	Schwarz criterion	9.844585
Log likelihood	-166.9472	Hannan-Quinn criter.	9.757289
F-statistic	237.6214	Durbin-Watson stat	1.443456
Prob(F-statistic)	0.000000		

Inverted AR Roots	.83

- Incremental Conservation achievement 1977-2011
  - Code and standards
  - Market Transformation
  - Programmatic
- Historic conservation is regressed against employment (as an indicator of economic condition)
- 94% of historic variations is explained.

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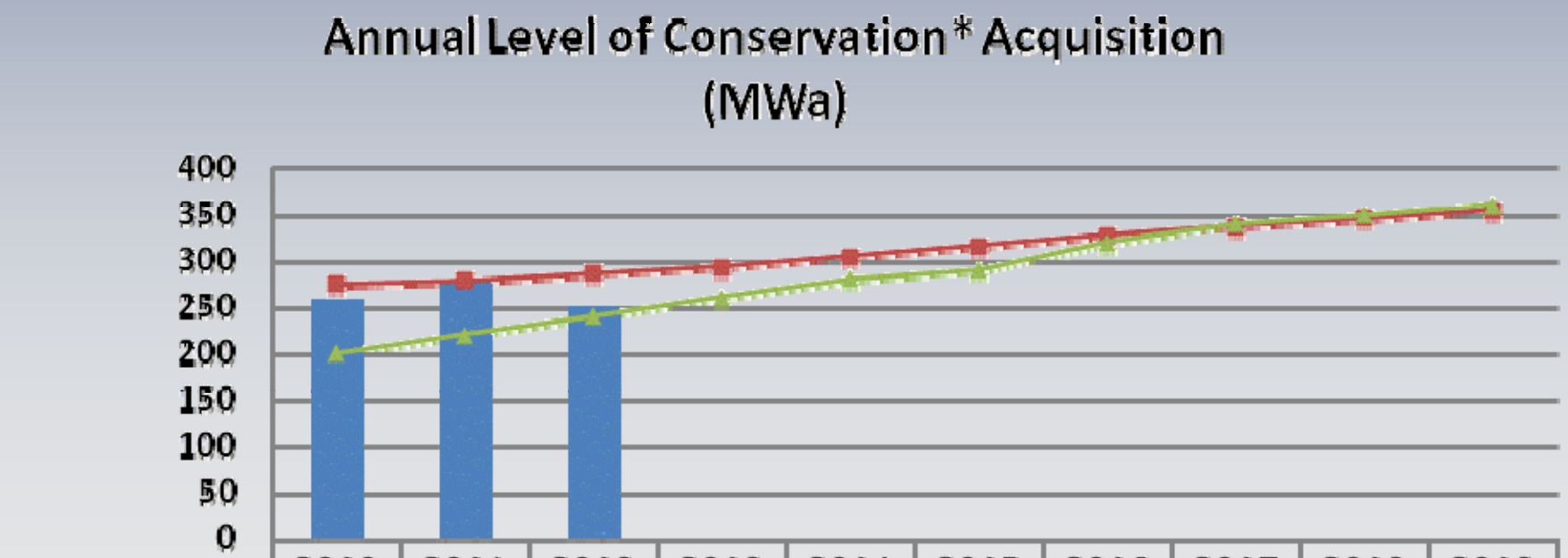
Treatment of Conservation for Resource Adequacy Analysis



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Actual	258	278	250							
Embedded	275	278	286	293	305	316	327	337	346	354
6th Plan	200	220	240	260	280	290	320	340	350	360

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Treatment of Conservation

	Cumulative Embedded conservation	Cumulative targeted	Increase in Load	Simluation June 2013	used in hourly load adj.
	Simluation June 2013	6th plan targets	Delta Mwa to be Added	WN Load net of DSI load	percent of total load
2013-2013	293	260	33	20,389	0.16%
2013-2014	598	540	58	20,540	0.28%
2013-2015	914	830	84	20,690	0.41%
2013-2016	1,242	1,150	92	20,829	0.44%
2013-2017	1,579	1,490	89	20,954	0.42%
2013-2018	1,925	1,840	85	21,069	0.40%
2013-2019	2,279	2,200	79	21,174	0.37%
2013-2020	2,640	2,565	75	21,271	0.35%

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Caveats to the Forecast

- Adjustment to BPA loads for 2009-2011
  - increased BPA BA load by 5%~250 MWa
- Conservation achievements in 2012
  - We assumed 280MWa- actual seems to be closer to 250
  - Embedded Conservation estimated
  - Load shape for conservation resource is assumed to be same as the Load.
- Past and Future Impact of Solar Rooftop and Demand Response are not explicitly modeled.
- Future Federal appliance standards are not modeled

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Caveats to the Methodology

- An econometric Load forecast beyond 3-5 year is risky.
- Actual shape of conservation is not knowable.
- Estimating embedded conservation is that, an estimate.
- Impact of weather on daily and hourly loads far exceed uncertainty about conservation.

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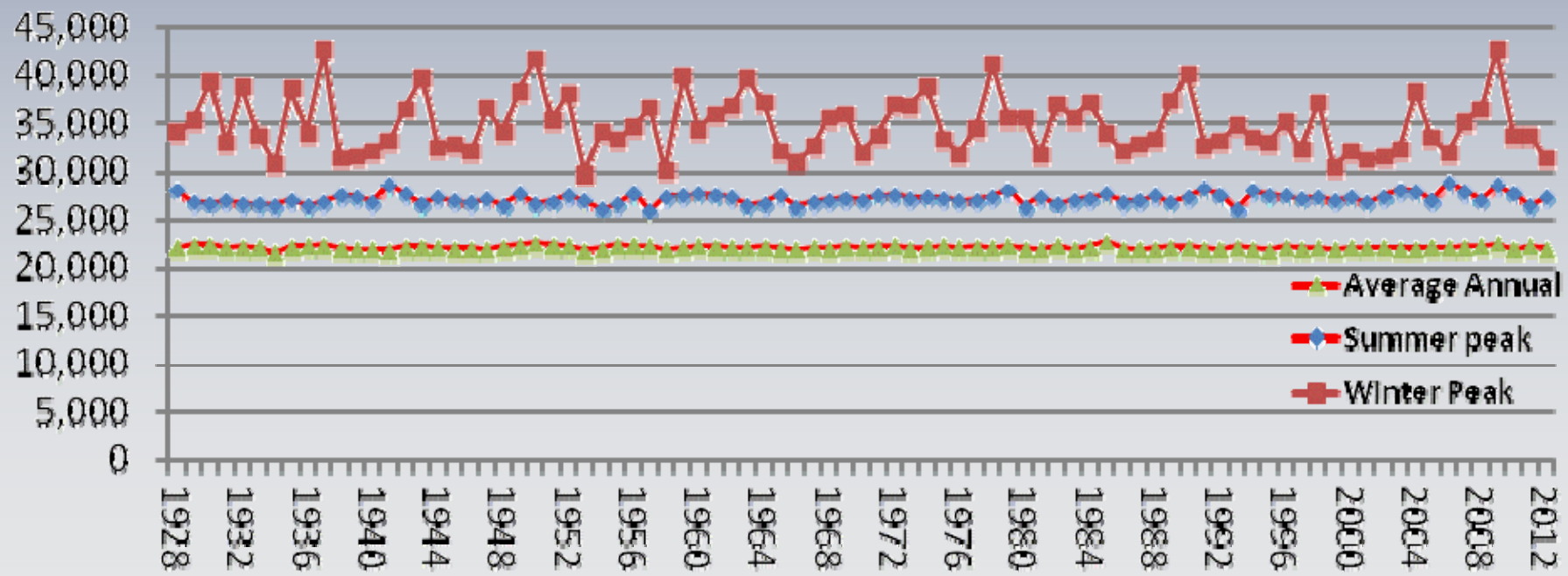
2019 Regional Net load Forecast Average, and Peak Loads



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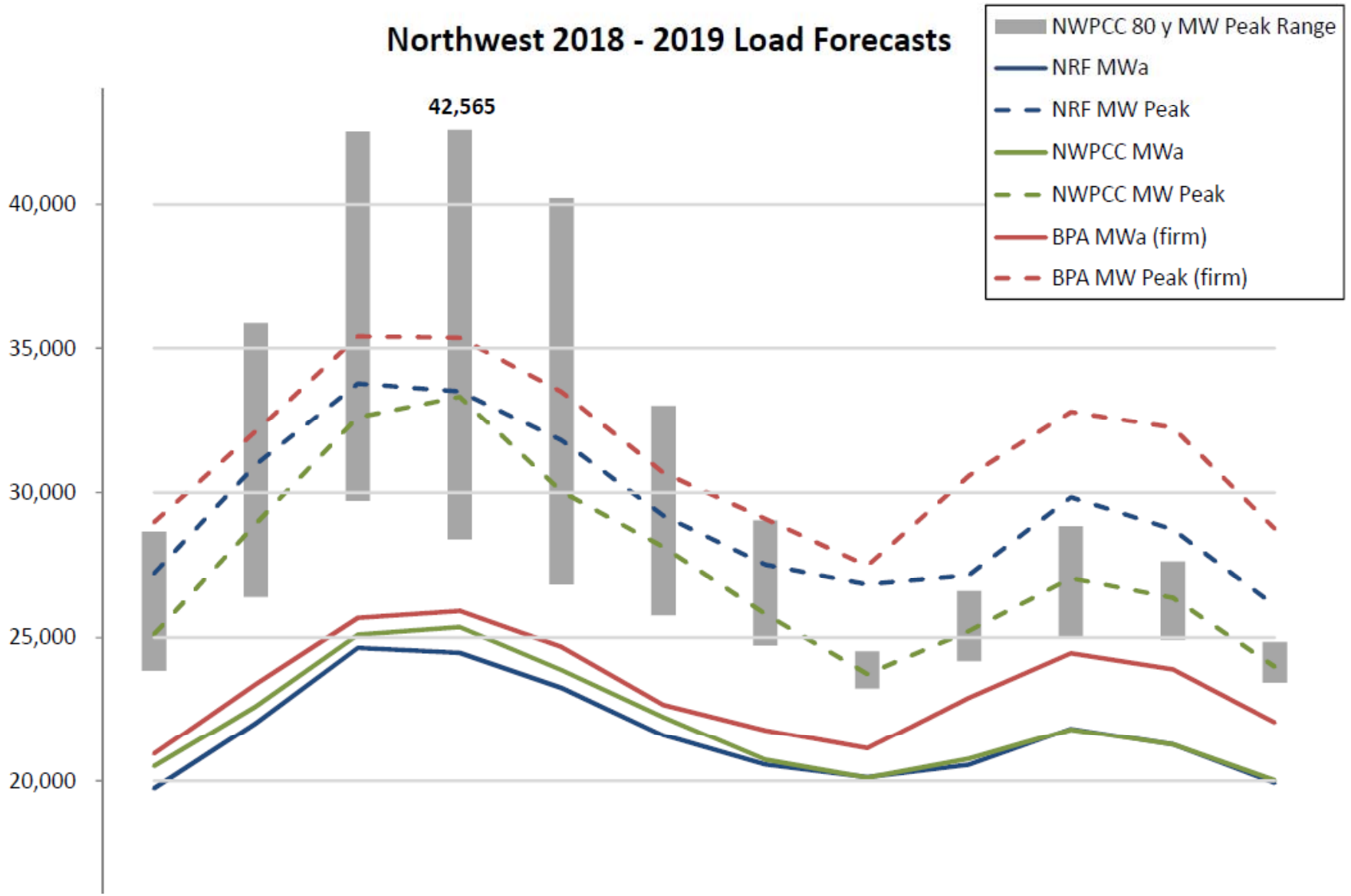
Comparison of Range of load Forecasts (as prepared by PNUCC – Dick Adams)



Limits to the RA Analysis

- Given the above caveats regarding the methodology and the data, it is my recommendation to:
- 1) Take the econometrically forecasted loads (3-5 years forward look, under the 84 temperature-year condition) without any further adjustments - the reference case.
- 2) Do sensitivity (+/- 2.5%) on reference case.

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Parsing Regional Loads

- We are currently working on developing the forecast of load for Southern Idaho.
- This forecast will be used to parse regional loads into:
- PNW West
- PNW East
- Southern Idaho

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