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February 6, 2018

MEMORANDUM

TO: **Power Committee**

FROM: **Massoud Jourabchi**

SUBJECT: **Analysis of load Impact of reducing reliance on natural Gas and other non-electric fuels**

BACKGROUND:

Presenter: Massoud Jourabchi

Summary: In this study, we evaluated forecast of loads with reduced reliance on natural gas and other non-electric fuels. Study forecast load for two scenarios, incorporates impact of conservation and extreme temperature conditions. This study shows that to maintain reliability of the system, there is need for new resources beyond what was called for in the 7th Plan.

Relevance: Increasing electricity intensity of use has been called for as a way of reducing CO2 emissions.

Background: There has been a few regional studies investigating deep-decarbonization policies, such as switching to Electric Vehicles, using more conservation resources, pushing more electrification in buildings. In order to assess load impact of such policies, Council staff conducted a number of studies where penetration rates for new EVs was pushed to about 100% by 2050. All residential and commercial energy using appliances were pushed to electricity from natural gas, and oil and other fuels. Analysis shows winter and summer loads increase significantly to levels not seen in the region. Analysis incorporated impact of extreme weather condition on loads. Also modeled were impact of current efficiency targets and potential targets in the future.

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Analysis of Load Impact of Reducing Reliance on Natural Gas and other non-electric fuels

(For Residential and Commercial Sectors only)

Massoud Jourabchi

February 2018

Northwest Power and Conservation Council

In this presentation

- Background on regional energy consumption
- Analytical steps using Council's Modeling tools
- Impact of reducing reliance on non-electric fuel for
  - New Construction and Replacements in
    - Residential sector
    - Commercial sector
- Incorporating high EV penetration rates
- Incorporating impacts of 7th plan target conservation

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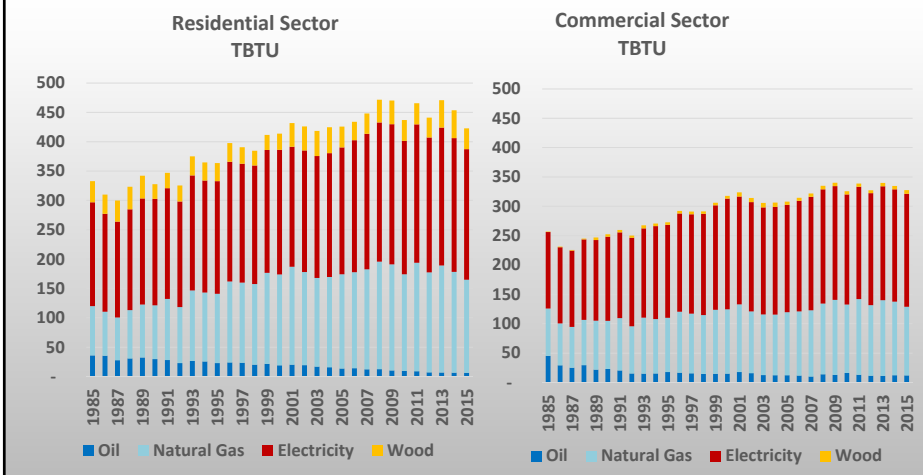
Background: Demand For Energy



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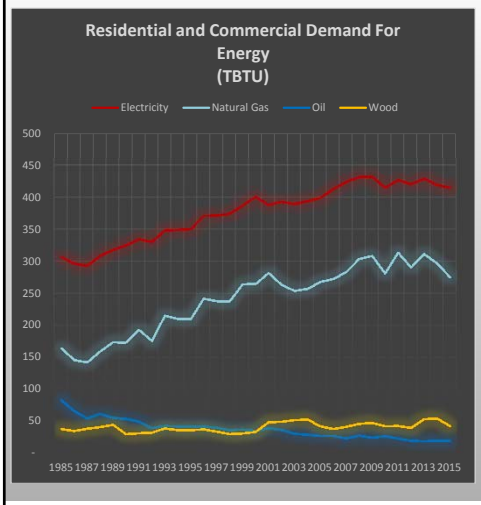
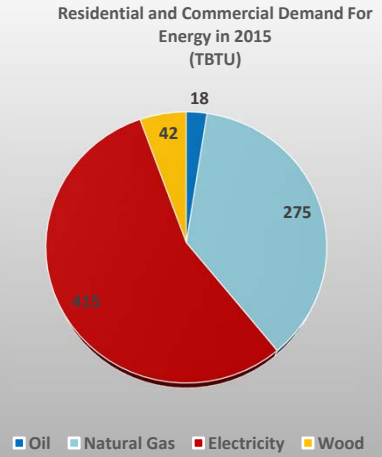
Combined Residential and Commercial Sectors Demand for Energy





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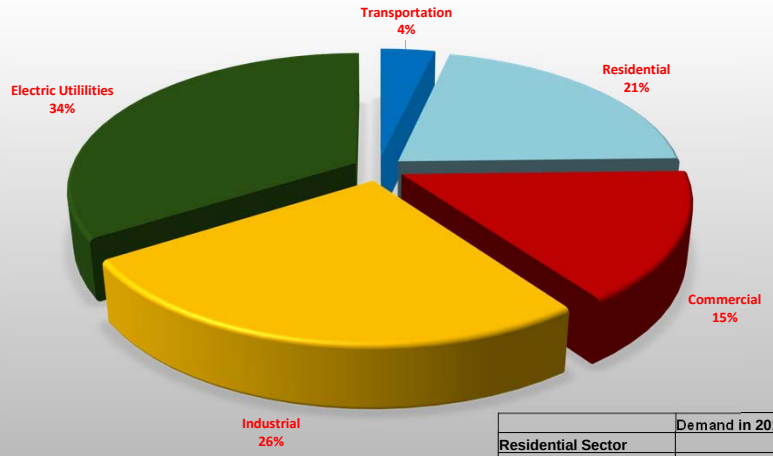
BACKGROUND: DEMAND FOR NATURAL GAS IN 2015 (SECTORS MARKET SHARE)



	Demand in 2015 (TBTU)
Residential Sector	159
Commercial Sector	117
Industrial Sector	196
Electric Utilities	257
Transportation sector	27

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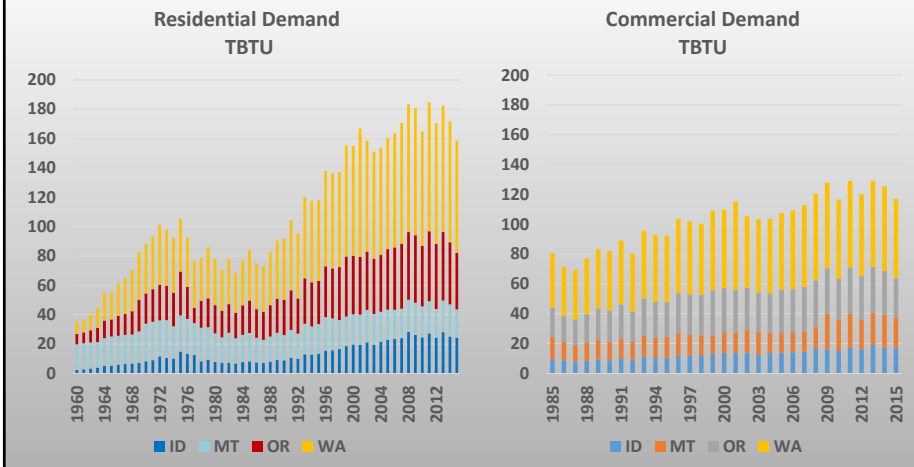
Source: State Energy Data System (SEDS)

Background: Demand for Natural Gas



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Background: Demand for Energy by Fuel type for Residential and Commercial Sectors shows that post recession, growth rates for almost all fuels have declined

	Demand in TBTU			Market Shares			Average Annual Growth Rates	
Residential Sector	1985	2007	2015	1985	2007	2015	1985-2007	2008-2015
Oil	36	12	6	11%	3%	1%	-5%	-9.2%
Natural Gas	84	171	159	25%	38%	37%	3%	-2.1%
Electricity	177	231	223	53%	51%	53%	1%	-0.9%
Wood	36	35	35	11%	8%	8%	-0.2%	-1.3%
Commercial Sector	1985	2007	2015	1985	2007	2015	AAGR 1985-2007	AAGR 2008-2015
Oil	45	10	12	18%	3%	4%	-7%	-2.3%
Natural Gas	81	113	117	31%	35%	36%	2%	-0.4%
Electricity	130	193	193	51%	60%	59%	2%	-0.2%
Wood	1	6	6	0%	2%	2%	9%	0.7%

Analytical steps in developing two scenarios

- Starting with Base Case scenario from the 7th Plan.
- Incorporated impact of high penetration rate for Electric Vehicles.
- No New Gas scenario: Prevents Consumer fuel choice for new and replacements natural gas.
- All Electric scenario: Consumer fuel choice for new and replacements was pushed to electricity.
- Both Scenarios include high EV penetration rates

Incorporating impact of higher penetration rate for EVs

- All new vehicles to be EV by 2050
- By 2035, about 35% of New vehicles are EV
- By 2035 Load impact (additional load)
  - Average ~ 640 aMW
  - Peak* ~ 32 MW
  - Off Peak ~ 1200 aMW

*Additional charging during the on peak period was added
*Peak is measured coincident with system peak

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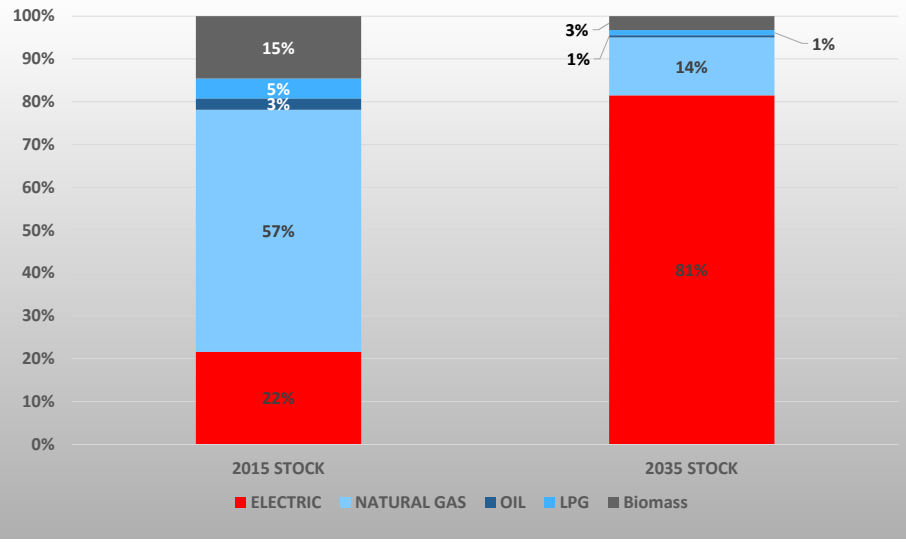
Fuel Shares in Residential Space-heating (All New Electric Scenario)



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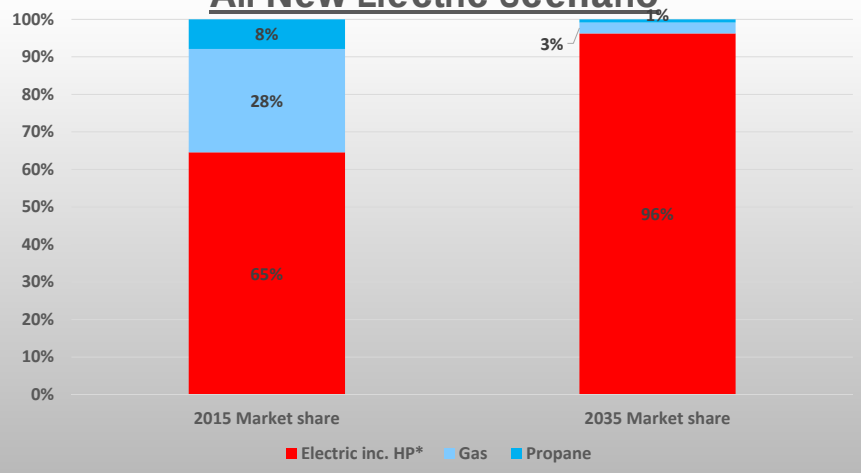
Fuel shares for Residential Water Heating

All New Electric Scenario



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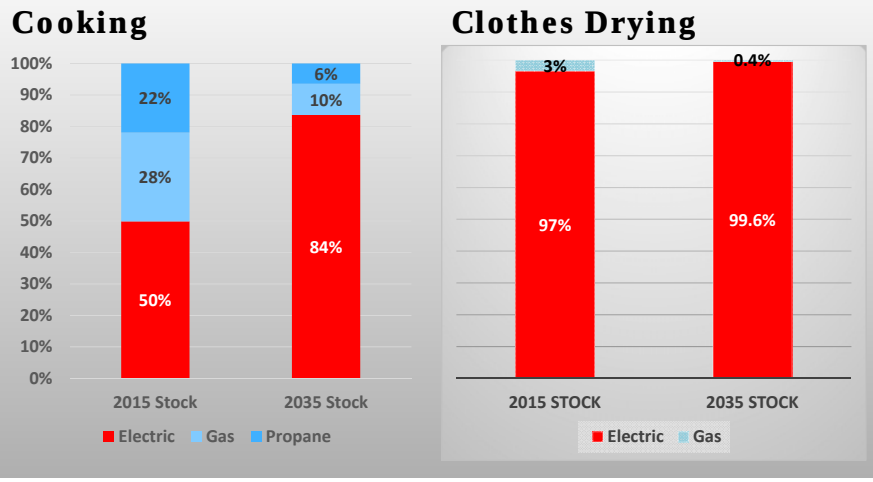
Fuel Share of Residential Cooking and Clothes Drying Fuels
All Electric Scenario



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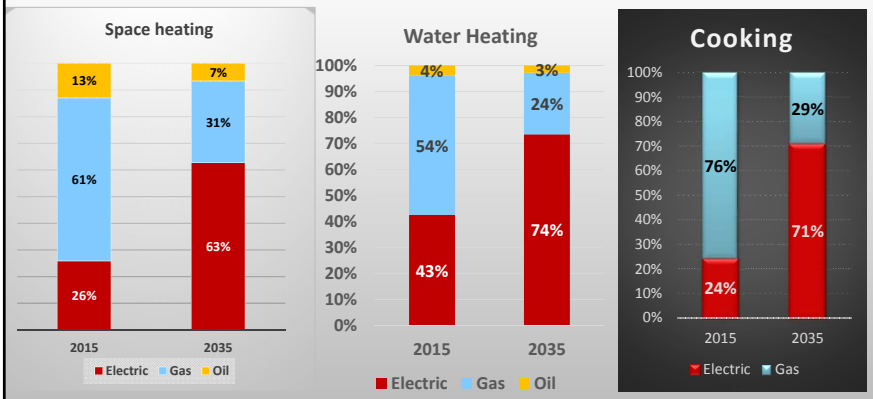
Fuel Shares Commercial Sector
All electric Scenario



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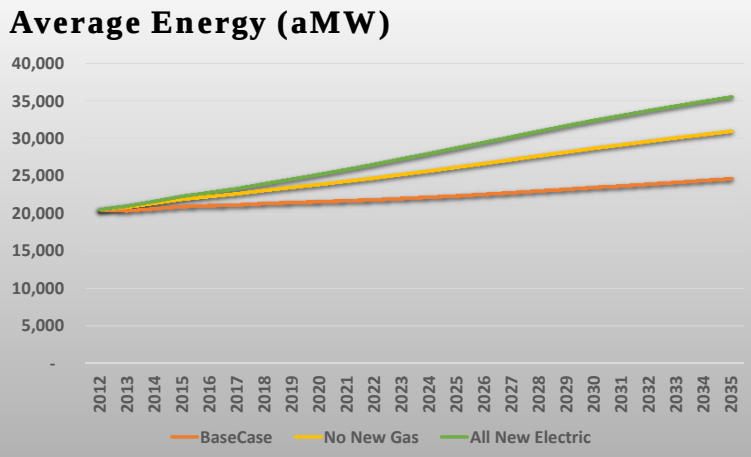
Regional Loads
(normal weather, prior to Conservation and DR)



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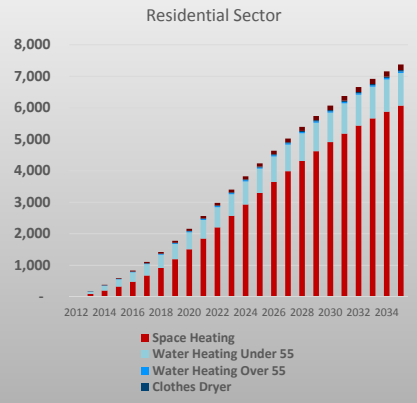
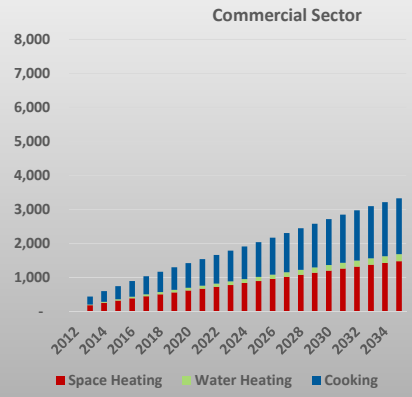
Change in demand for electricity by Sector and Enduse aMW
All Electric Compared to Base case





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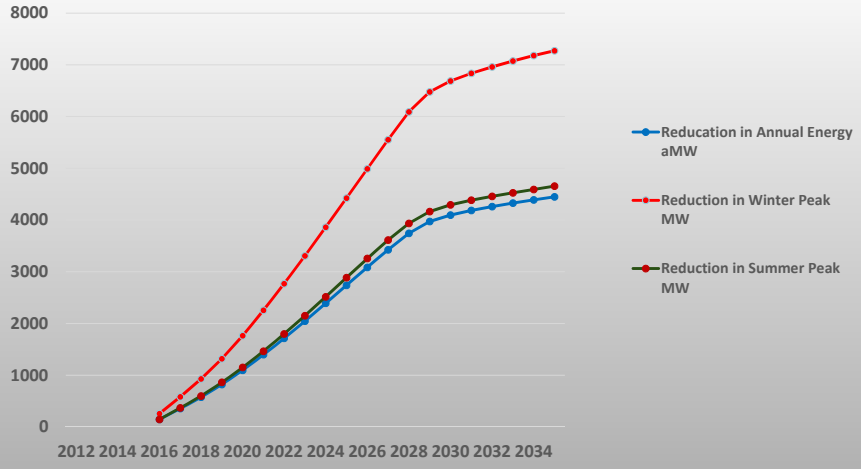
Reduction in Energy and Peaks due to 7th Plan Conservation Targets



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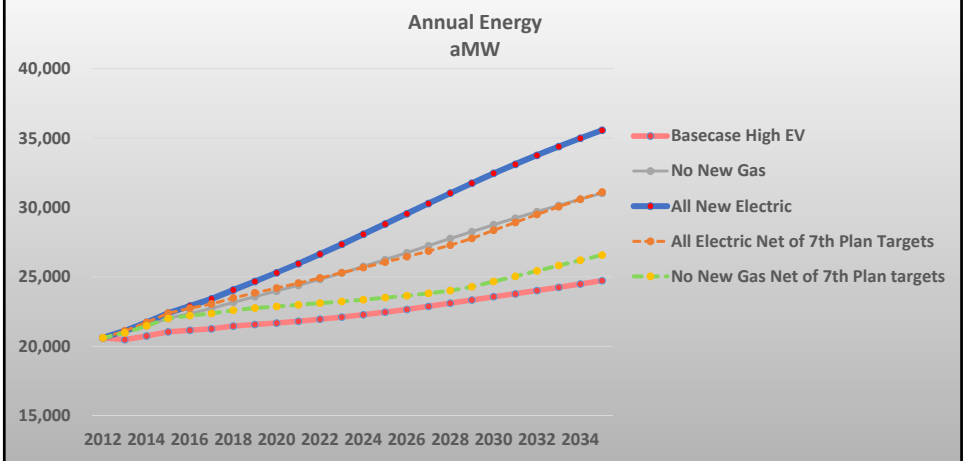
Regional Loads with and without 7th plan Conservation Targets



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2035 Range of Loads and Comparison to Base Case High EV

Scenario ID	Loads in 2035 Normal weather High EV	Annual Load (aMW)
1	Base Case	24,737
2	No New Gas	31,032
3	All Electric	35,567
4	All Electric Net of 7th Plan Conservation	31,119

Scenario ID	Comparison to Base Case High EV	Annual Load (aMW)
2	No New Gas	6,295
3	All Electric	10,830
4	All New Electric Net of 7th Plan Conservation	6,382

Scenario ID	% Change from Base Case High EV	Annual Load (aMW)
2	No New Gas	25%
3	All Electric	44%
4	All Electric Net of 7th Plan Conservation	26%

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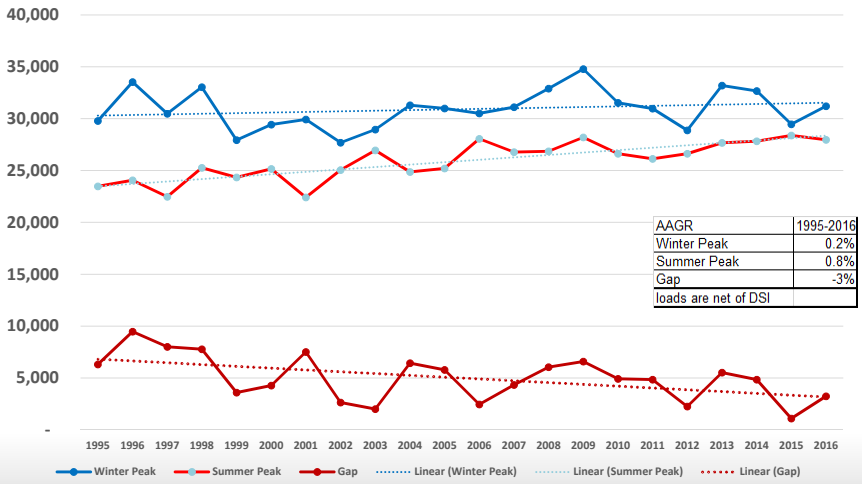
Estimating Peak Loads
Under different temperature profiles

- Peak loads are estimated by incorporating hourly Enduse profiles.
- These load profiles are estimated for "Normal" temperature conditions.
- Peak loads are impacted by deviations from Normal temperature.
- We incorporate impact of past observed temperature variations into the forecast using council's hourly model used for Resource Adequacy analysis.

Observed Trends in Regional Peak Electricity Loads for 1995-2016

adjusted for DSI shows summer peaks are growing at a faster rate



Incorporating Range of Temperatures

- Range of forecast for peak loads for the three scenario is shown below.
- These values show extremes and expected levels.
- In **All Electric scenario**, by 2035, Winter peak can increase by 85% to over 65,000 MW and summer peak can increase to about 40,000 MW.

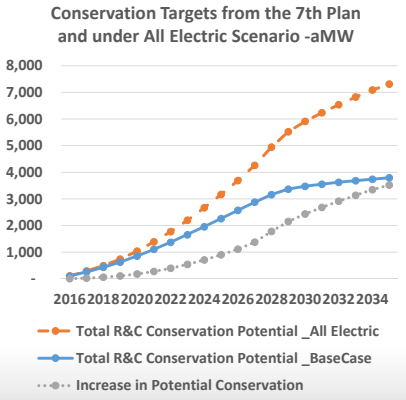
Base Case	Minimum	Expected Peak	Highest
Winter Peak	26,626	29,022	35,114
Summer Peak	26,110	26,962	28,123

No New Gas	Minimum	Expected	Highest
Winter Peak	38,973	42,481	51,398
Summer Peak	31,841	33,124	34,624

All Electric	Minimum	Expected	Highest
Winter Peak	49,577	54,040	65,382
Summer Peak	35,839	37,282	38,971

Conservation Potential with Base Case and All-Electric Case

(Caution this is a rough analysis and subject to refinement)



- **By 2035**
  - **There may be twice as much conservation potential in All-electric scenario than in Base Case**
  - **5,000 MW decline in Winter peaks**
  - **4,500 MW decrease in Summer peaks**

Range of Peak Forecasts
All Electric Scenario 2035

All Electric Scenario 2035	Winter Peak (MW)	Summer Peak (MW)
Maximum peak load under All-Electric Scenario (with expected temperatures)	54,040	37,282
Seasonal Peak Impact of 7th Plan Conservation Targets	(7,272)	(4,655)
Maximum peak load under All-Electric Scenario net of 7th Plan Targets	46,767	32,628
Seasonal Peak Impact of Additional Conservation Potential	(5,000)	(4,500)
All-Electric net of 7th plan conservation, Potetnial Additional Conservation	41,767	28,128

All Electric Scenario 2035 with extreme past temperatures	Winter Peak (MW)	Summer Peak (MW)
Maximum peak load under All-Electric Scenario and past extreme high temperatures	65,382	38,971
Seasonal Peak Impact of 7th Plan Conservation Targets	(7,272)	(4,655)
Maximum peak load under All-Electric Scenario net of 7th Plan Targets	58,110	34,316
Seasonal Peak Impact of Additional Conservation Potential	(5,000)	(4,500)
All-Electric net of 7th plan conservation, Potential Additional Conservation	53,110	29,816

All Electric Scenario 2035 with low range of expected temperatures	Winter Peak (MW)	Summer Peak (MW)
Maximum peak load under All-Electric Scenario and past extreme low temperatures	49,577	35,839
Seasonal Peak Impact of 7th Plan Conservation Targets	(7,272)	(4,655)
Maximum peak load under All-Electric Scenario net of 7th Plan Targets	42,305	31,184
Seasonal Peak Impact of Additional Conservation Potential	(5,000)	(4,500)
All-Electric net of 7th plan conservation, Potential Additional Conservation	37,305	26,684

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Summary of Findings

- **In an application of Council's load forecasting models, we limited residential and commercial consumers choice for natural gas and other fossil fuels and incorporating higher penetration rates for electric vehicles.**
- **Study shows that by 2035, comparing All-Electric and Base case scenarios:**
  - Load for electricity can increase by about 26% to over 31,000 aMW (under normal weather)
  - Incorporating range of past temperature conditions, under extreme temperature conditions:
  - Winter Peak load forecast can increase to over 65,000 MW a 85% increase.
  - Summer peak loads forecast can increase to 40,000 MW, a 40% increase.
  - These levels of load has not been experienced in the region.

After adjusting for target conservation and adding additional potential conservation

- Winter peak load forecast is in the 37,000 - 53,000 MW range
- Summer peak load forecast is in the 27,000 - 30,000 MW range

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