Northwest Power and Conservation Council

February 24, 2011

MEMORANDUM

TO: Power Committee

FROM: Tom Eckman and Michael Schilmoeller

SUBJECT: Status of Direct Use of Natural Gas Analysis

The 6th Plan Action Item ANLYS-16 called for a review of the Council's Policy on the direct use of natural gas. Preliminary studies have been completed. Staff is evaluating the results and making arrangements for RTF review. This presentation will briefly discuss the status of the analysis.

851 S.W. Sixth Avenue, Suite 1100
Portland, Oregon 97204-1348
www.nwcouncil.org

Steve Crow
Executive Director

503-222-5161
800-452-5161
Fax: 503-820-2370

Status Report on Direct Use of Natural Gas

Power Committee

March 3, 2011

Web Conference

Terry Morlan and Michael Schilmoeller

Northwest Power and Conservation Council

Aliases

- Direct use of natural gas
- Fuel conversions
- Fuel switching
- Fuel choice
- Total energy efficiency

All relate to using natural gas directly for end-use energy service rather than generating electricity for electric heating

Northwest Power and Conservation Council

History: Council Issues About Direct Use of Natural Gas

- Are Council's electricity efficiency incentives influencing fuel choice?
- Is conversion to natural gas "electricity conservation"? Is it a "resource" under the Act?
- How is thermal efficiency different from economic efficiency, and which the objective?
- Potential savings estimates
- Need for Council policy or utility programs?

The last Council study performed in 1994

Northwest Power and Conservation Council

What the 1994 Study Showed

- Thermodynamic efficiency is not same as economic efficiency
  - Economic efficiency depends on energy used and equipment and conversion costs
- Regional, cost-effective potential for switching from electricity to gas was about 730 aMW
- Conversion would
  - Increase carbon monoxide (CO) and oxides of nitrogen (NO_X)
  - Decrease CO_2 and oxides of sulfur (SO_X)
- Where it made sense to convert electric appliances to gas, customers were already doing so

Northwest Power and Conservation Council

Adopted Council Policy

- Monitor direct use of gas as an alternative to conservation and generation
- Let prices in the market continue to direct the selection
- Take actions consistent with market-based approach
  - *Provide information and analysis*
  - *Encourage efficient pricing of electricity*
  - *Help remove other market distortions*
  - *Work through the Natural Gas Advisory Committee*
  - *Participate in gas and electric IRP processes*

Northwest Power and Conservation Council

RTF Study Initiated 2008

- A Regional Technical Forum (RTF) advisory group scoped the study
  - e.g., study confined to existing residential conversions
- Northwest Gas Association, Puget Sound Energy, and the RTF provided funding
- Global Energy Partners, LLC, (GEP) won the contract January 2009 for data preparation. Work finished in September 2009.
- Staff began Regional Portfolio Model (RPM) analysis May 2010 to assess risk and system effects
- Study completed and results presented to the RTF in June 2010 and to the Power Committee in July 2010

Northwest Power and Conservation Council

An Updated Analysis

- Changes required a new look at the issue
  - New federal and state efficiency codes and standards
  - New fuel prices, appliance costs
- The GEP work provided paths to pursue
  - More complete consideration of customer segment groups and conversion opportunities
  - Description of daily and seasonal energy shapes
  - Recognition for air conditioning costs
  - More consistent treatment of house size and type with the energy requirements and costs

Northwest Power and Conservation Council

The Fine Print

- Ignored some space and water heating fuels and appliances
  - Only natural gas and electricity considered (no propane, oil, solar thermal, etc.)
  - Some small segment groups (e.g., central hot-water heating) excluded
  - Some segment groups (gas/heat pump hybrids) excluded for lack of cost information
- Assumed use is insensitive to price, once the choice is made

Northwest Power and Conservation Council

Structure of the Study

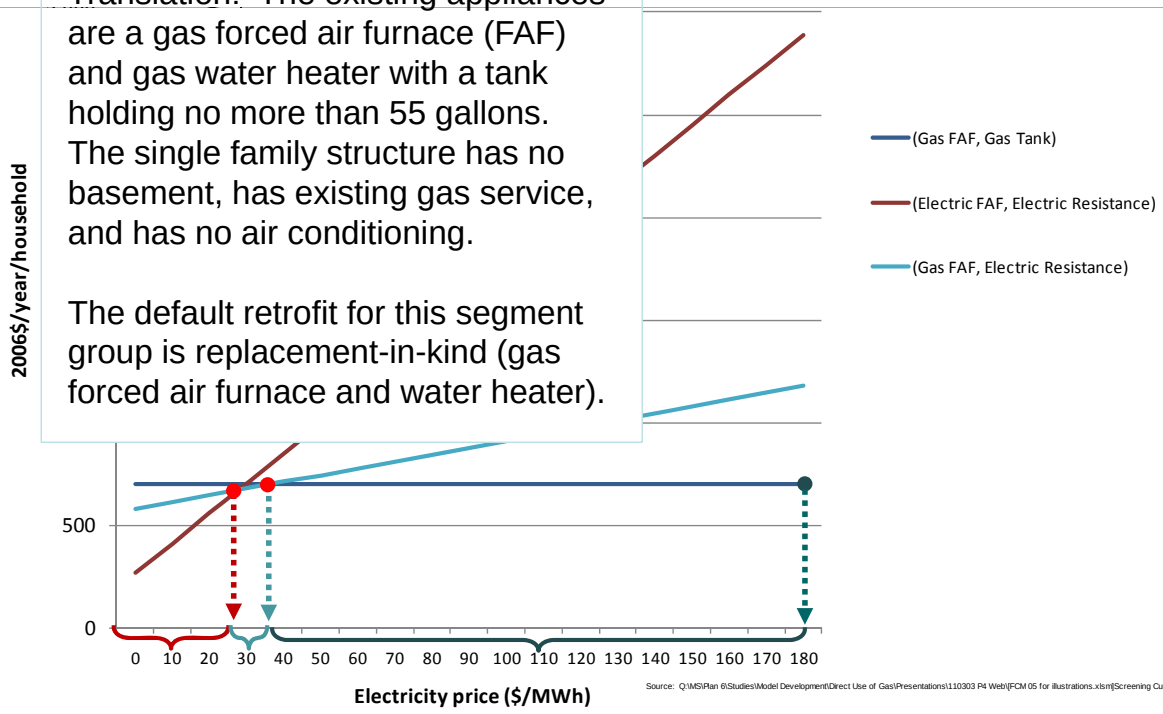
- As a space heater is nearing the end of its life, customers consider alternatives for replacement based on their best guess about future natural gas and electricity prices. They want to minimize total cost.
- They buy and install the appliance(s).
- Their actual cost depends on whatever carbon penalty, and natural gas and electricity prices occur.

Northwest Power and Conservation Council

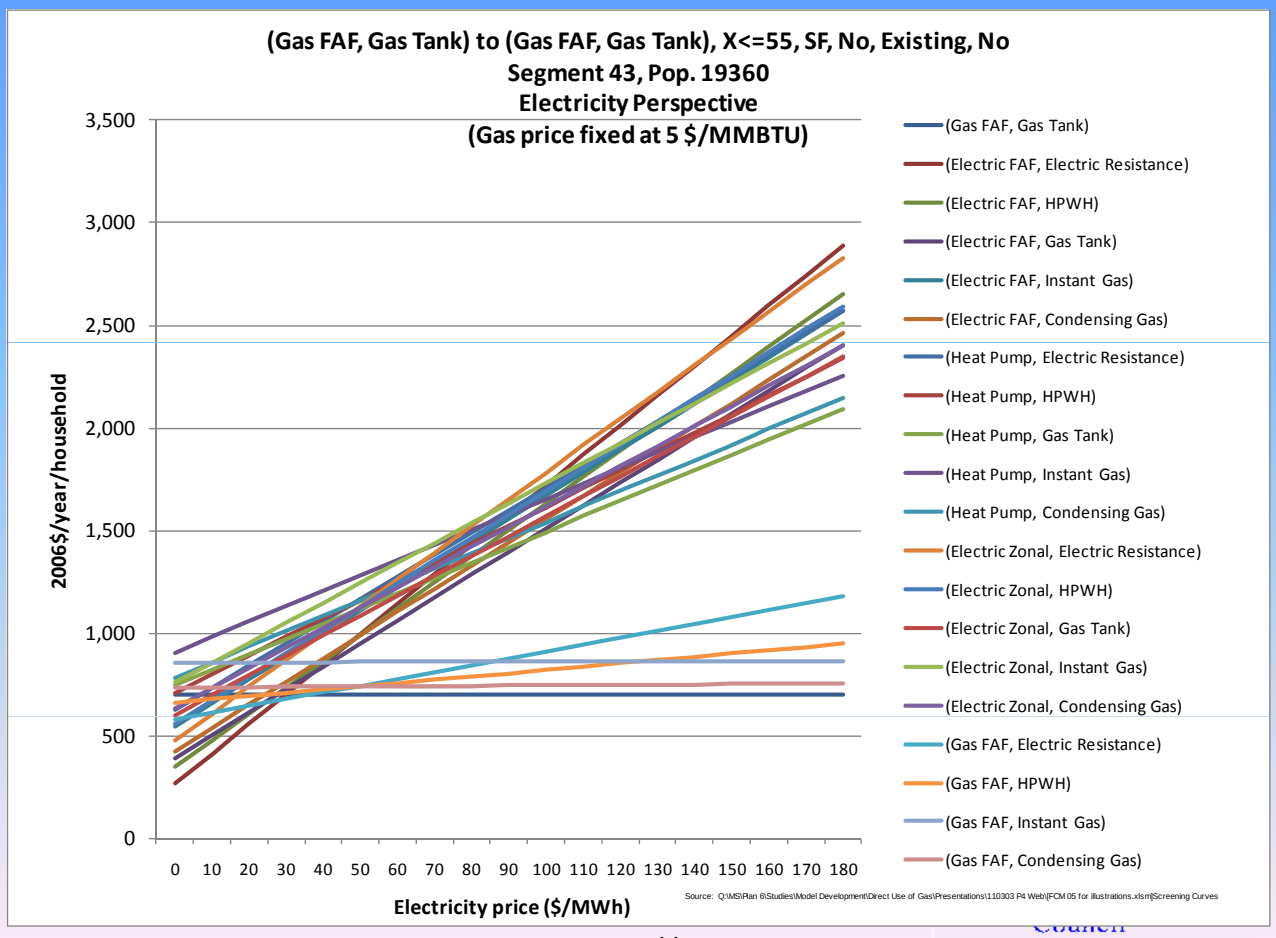
(Gas FAF, Gas Tank) to (Gas FAF, Gas Tank), X<=55, SF, No, Existing, No
Segment 43, Pop. 19360
Electricity Perspective
(Gas price fixed at 5 $/MMBTU)

Translation: The existing appliances are a gas forced air furnace (FAF) and gas water heater with a tank holding no more than 55 gallons. The single family structure has no basement, has existing gas service, and has no air conditioning.

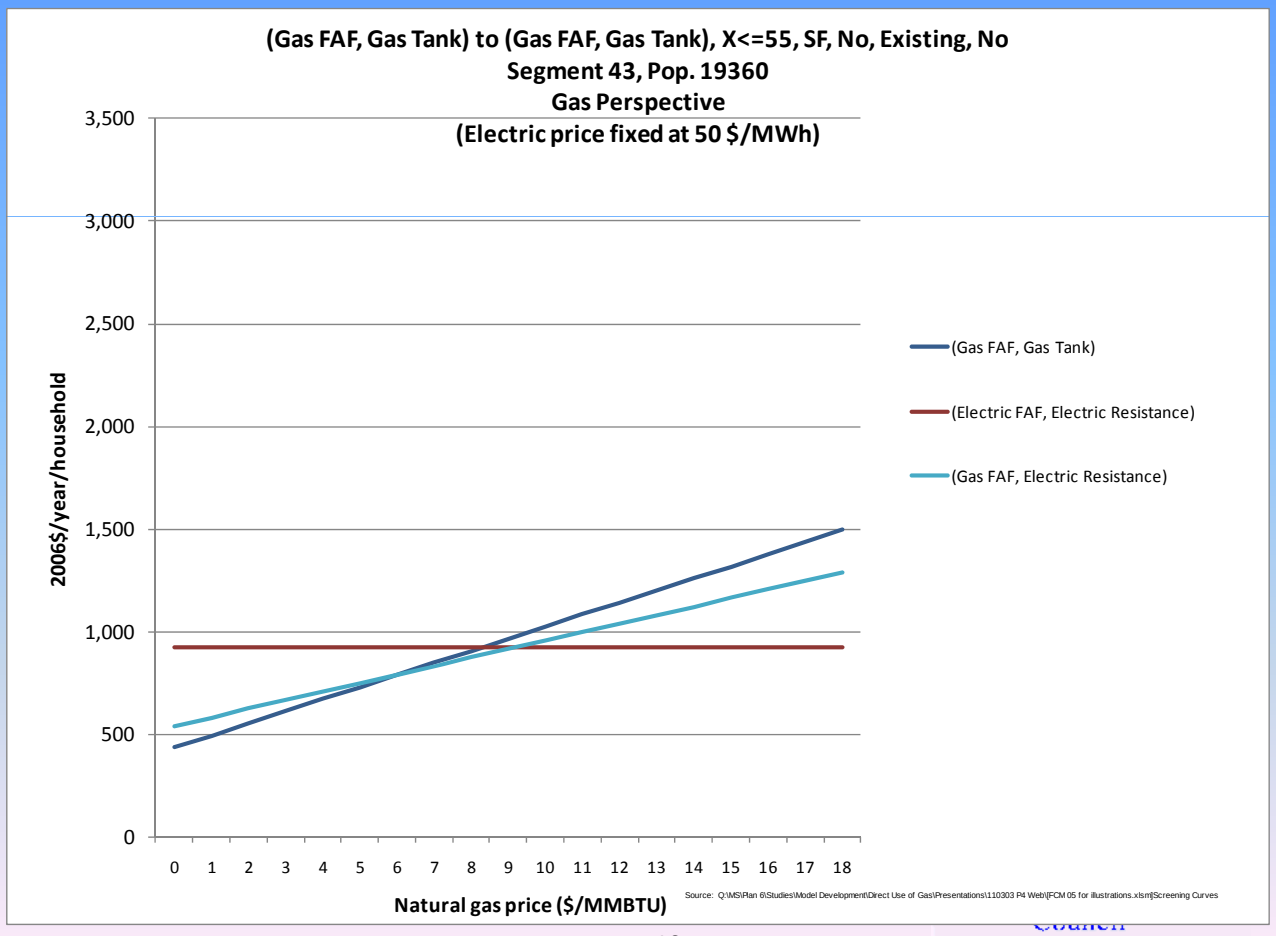
The default retrofit for this segment group is replacement-in-kind (gas forced air furnace and water heater).



Source: Q:\MS\Plan 6\Studies\Model Development\Direct Use of Gas\Presentations\110303 P4 Web\[FCM 05 for illustrations.xlsm]Screening Curves


(Gas FAF, Gas Tank) to (Gas FAF, Gas Tank), X<=55, SF, No, Existing, No
Segment 43, Pop. 19360
Electricity Perspective
(Gas price fixed at 5 $/MMBTU)
2006$/year/household
3,500
3,000
2,500
2,000
1,500
1,000
500
0
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180
Electricity price ($/MWh)
(Gas FAF, Gas Tank)
(Electric FAF, Electric Resistance)
(Electric FAF, HPWH)
(Electric FAF, Gas Tank)
(Electric FAF, Instant Gas)
(Electric FAF, Condensing Gas)
(Heat Pump, Electric Resistance)
(Heat Pump, HPWH)
(Heat Pump, Gas Tank)
(Heat Pump, Instant Gas)
(Heat Pump, Condensing Gas)
(Electric Zonal, Electric Resistance)
(Electric Zonal, HPWH)
(Electric Zonal, Gas Tank)
(Electric Zonal, Instant Gas)
(Electric Zonal, Condensing Gas)
(Gas FAF, Electric Resistance)
(Gas FAF, HPWH)
(Gas FAF, Instant Gas)
(Gas FAF, Condensing Gas)
Source: Q:\MS\Plan 6\Studies\Model Development\Direct Use of Gas\Presentations\110303 P4 Web\[FCM 05 for illustrations.xlsm]Screening Curves

11


(Gas FAF, Gas Tank) to (Gas FAF, Gas Tank), X<=55, SF, No, Existing, No
Segment 43, Pop. 19360
Gas Perspective
(Electric price fixed at 50 $/MWh)
2006$/year/household
3,500
3,000
2,500
2,000
1,500
1,000
500
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
Natural gas price ($/MMBTU)
(Gas FAF, Gas Tank)
(Electric FAF, Electric Resistance)
(Gas FAF, Electric Resistance)
Source: Q:\MS\Plan 6\Studies\Model Development\Direct Use of Gas\Presentations\110303 P4 Web\[FCM 05 for illustrations.xlsm]Screening Curves

12

Least-cost Segments for SegmentGroup * 43 *, annual households: 19360,

segment group (Gas FAF, Gas Tank) to (Gas FAF, Gas Tank), DWH tank size <=55 gal., SF, no basement, existing gas, no A/C

Electricity Price (2006$/MWh)

Gas Price (2006$/MMBTU)	0	10	20	30	40	50	60	70	80	90	100	110
0	714	714	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1	714	714	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
2	714	714	729	-1	-1	-1	-1	-1	-1	-1	-1	-1
3	714	714	714	-1	-1	-1	-1	-1	-1	-1	-1	-1
4	714	714	714	729	-1	-1	-1	-1	-1	-1	-1	-1
5	714	714	714	729	-1	-1	-1	-1	-1	-1	-1	-1
6	714	714	714	714	729	-1	-1	-1	-1	-1	-1	-1
7	714	714	714	714	729	730	-1	-1	-1	-1	-1	-1
8	714	714	714	714	714	730	730	-1	-1	-1	-1	-1
9	714	714	714	714	714	730	730	730	-1	-1	-1	-1
10	714	714	714	714	714	730	730	730	730	-1	-1	-1
11	714	714	714	714	714	715	730	730	730	732	732	732
12	714	714	714	714	714	715	730	730	730	730	732	732
13	714	714	714	714	714	715	730	730	730	730	730	732
14	714	714	714	714	714	715	715	730	730	730	730	732
15	714	714	714	714	714	715	715	730	730	730	730	730
16	714	714	714	714	714	715	715	715	730	730	730	730
17	714	714	714	714	714	715	715	715	730	730	730	730
18	714	714	714	714	714	715	715	715	730	730	730	730
19	714	714	714	714	714	715	715	715	715	730	730	730
20	714	714	714	714	714	715	715	715	715	715	720	730
30	714	714	714	714	714	715	715	715	715	715	720	720
40	714	714	714	714	714	715	715	715	715	715	720	720
50	714	714	714	714	714	715	715	715	715	715	720	720
60	714	714	714	714	714	715	715	715	715	715	720	720

Source: Q:\MS\Plan 6\Studies\Model Development\Direct Use of Gas\Presentations\110303 P4 Web\[FCM 05 for illustrations.xlsm]RPM Input

-1	gas FAF space heater, gas tank water heater (replacement in kind)	729	gas FAF space heater, electric resistance water heater
714	electric FAF space heater, electric resistance water heater	730	gas FAF space heater, heat pump water heater
715	electric FAF space heater, heat pump water heater	732	gas FAF space heater, condensing gas water heater
720	heat pump space heater, heat pump water heater		

Key Points

- Commodity prices get used in two different ways in this evaluation
  - The customer's ***forecast*** for the prices
  - The prices that actually arrive

  and these two will typically be very different
- The selection has consequences beyond heating costs: to the need for power resources and to the emission of greenhouse gases
- We ask, can we improve the outcome by influencing the selection?

Northwest Power and Conservation Council

Questions?

Northwest Power and Conservation Council

Reserve Slides

Northwest Power and Conservation Council

Northwest Power and Conservation Council

Existing Segments Groups

- Segment groups were determined primarily by existing circumstances
  - Existing space heating appliance
  - Existing water heating appliance
  - Single- or multi-family building
  - Whether or not a gas main is available, and if so, whether service already exists or an extension from the gas main is necessary
  - Whether or not there was a basement
  - Whether or not there was air conditioning

Northwest Power and Conservation Council

New Segment Groups

Existing System		
Space Heating (SH)	Water Heating (WH)	**Segment groups**
FAF Electric	Electric Resistance	20
FAF Electric	Gas Tank	10
Gas FAF	Electric Resistance	10
Gas FAF	Gas Tank	10
Heat Pump	Electric Resistance	10
Heat Pump	Gas Tank	5
Zonal Electric	Electric Resistance	20
Zonal Electric	Gas Tank	10
	Grand Total	**95**

Northwest Power and Conservation Council

20 New Segment Groups

Associated with FAF Electric and Electric DHW

Existing SH	Existing WH	Water heater size	Household	Basement	Gas Availability	Air Conditioning	Retro SH	Retro WH
							Determine retrofit baseline	
FAF Electric	Electric Resistance	X<55	SF	No	E	No	FAF Electric	Electric Resistance
FAF Electric	Electric Resistance	X<55	SF	No	E	Yes	FAF Electric	Electric Resistance
FAF Electric	Electric Resistance	X<55	SF	No	M	No	FAF Electric	Electric Resistance
FAF Electric	Electric Resistance	X<55	SF	No	M	Yes	FAF Electric	Electric Resistance
FAF Electric	Electric Resistance	X>=55	SF	No	E	No	FAF Electric	HPWH
FAF Electric	Electric Resistance	X>=55	SF	No	E	Yes	FAF Electric	HPWH
FAF Electric	Electric Resistance	X>=55	SF	No	M	No	FAF Electric	HPWH
FAF Electric	Electric Resistance	X>=55	SF	No	M	Yes	FAF Electric	HPWH
FAF Electric	Electric Resistance	X<55	SF	Yes	E	No	FAF Electric	Electric Resistance
FAF Electric	Electric Resistance	X<55	SF	Yes	E	Yes	FAF Electric	Electric Resistance
FAF Electric	Electric Resistance	X<55	SF	Yes	M	No	FAF Electric	Electric Resistance
FAF Electric	Electric Resistance	X<55	SF	Yes	M	Yes	FAF Electric	Electric Resistance
FAF Electric	Electric Resistance	X>=55	SF	Yes	E	No	FAF Electric	HPWH
FAF Electric	Electric Resistance	X>=55	SF	Yes	E	Yes	FAF Electric	HPWH
FAF Electric	Electric Resistance	X>=55	SF	Yes	M	No	FAF Electric	HPWH
FAF Electric	Electric Resistance	X>=55	SF	Yes	M	Yes	FAF Electric	HPWH
FAF Electric	Electric Resistance	X<55	MF	No	E	No	FAF Electric	Electric Resistance
FAF Electric	Electric Resistance	X<55	MF	No	E	Yes	FAF Electric	Electric Resistance
FAF Electric	Electric Resistance	X<55	MF	No	M	No	FAF Electric	Electric Resistance
FAF Electric	Electric Resistance	X<55	MF	No	M	Yes	FAF Electric	Electric Resistance

source: C:\Backups\Plan 6\Studies\Model Development\Direct Use of Gas\Presentations\110104 DUG RTF\[New Segment Groups 110104.xlsm]Illustration 2

Northwest Power and Conservation Council

New Segments

	Retrofit systems																									
space heating→	FAF Electric					Gas FAF					Heat Pump					Zonal Electric					Ductless HP					Grand Total
water heating→	Electric Resistance	Gas Tank	HPWH	Instant Gas	Condensing Gas	Electric Resistance	Gas Tank	HPWH	Instant Gas	Condensing Gas	Electric Resistance	Gas Tank	HPWH	Instant Gas	Condensing Gas	Electric Resistance	Gas Tank	HPWH	Instant Gas	Condensing Gas	Electric Resistance	Gas Tank	HPWH	Instant Gas	Condensing Gas	
Existing system																										
FAF Electric																										
Electric Resistance	12	12	20	20	20	12	12	20	20	20	12	12	20	20	20	12	12	20	20	20						336
Gas Tank	6	6	10	10	10	6	6	10	10	10	6	6	10	10	10	6	6	10	10	10						168
Gas FAF																										
Electric Resistance	6	6	10	10	10	6	6	10	10	10	6	6	10	10	10	6	6	10	10	10						168
Gas Tank	6	6	10	10	10	6	6	10	10	10	6	6	10	10	10	6	6	10	10	10						168
Heat Pump																										
Electric Resistance	6	6	10	10	10	6	6	10	10	10	6	6	10	10	10	6	6	10	10	10						168
Gas Tank	3	3	5	5	5	3	3	5	5	5	3	3	5	5	5	3	3	5	5	5						84
Zonal Electric																										
Electric Resistance						12	12	20	20	20						12	12	20	20	20	12	12	20	20	20	252
Gas Tank						6	6	10	10	10						6	6	10	10	10	6	6	10	10	10	126
Grand Total	**39**	**39**	**65**	**65**	**65**	**57**	**57**	**95**	**95**	**95**	**39**	**39**	**65**	**65**	**65**	**57**	**57**	**95**	**95**	**95**	**18**	**18**	**30**	**30**	**30**	**1470**

source: C:\Backups\Plan 6\Studies\Model Development\Direct Use of Gas\Presentations\110104 DUG RTF\[New Segment Groups 110104.xlsm]all segments - count

Northwest Power and Conservation Council

20 segments

Associated with

Electric FAF and Electric DHW ⟶ Gas FAF Electric and Instant Gas DHW

Existing SH	Existing WH	Water heater size	Household	Basement	Gas Availability	Air Conditioning	Retro SH	Retro WH
FAF Electric	Electric Resistance	X<55	MF	No	E	No	Gas FAF	Instant Gas
FAF Electric	Electric Resistance	X<55	MF	No	E	Yes	Gas FAF	Instant Gas
FAF Electric	Electric Resistance	X<55	MF	No	M	No	Gas FAF	Instant Gas
FAF Electric	Electric Resistance	X<55	MF	No	M	Yes	Gas FAF	Instant Gas
FAF Electric	Electric Resistance	X<55	SF	No	E	No	Gas FAF	Instant Gas
FAF Electric	Electric Resistance	X<55	SF	No	E	Yes	Gas FAF	Instant Gas
FAF Electric	Electric Resistance	X<55	SF	No	M	No	Gas FAF	Instant Gas
FAF Electric	Electric Resistance	X<55	SF	No	M	Yes	Gas FAF	Instant Gas
FAF Electric	Electric Resistance	X<55	SF	Yes	E	No	Gas FAF	Instant Gas
FAF Electric	Electric Resistance	X<55	SF	Yes	E	Yes	Gas FAF	Instant Gas
FAF Electric	Electric Resistance	X<55	SF	Yes	M	No	Gas FAF	Instant Gas
FAF Electric	Electric Resistance	X<55	SF	Yes	M	Yes	Gas FAF	Instant Gas
FAF Electric	Electric Resistance	X>=55	SF	No	E	No	Gas FAF	Instant Gas
FAF Electric	Electric Resistance	X>=55	SF	No	E	Yes	Gas FAF	Instant Gas
FAF Electric	Electric Resistance	X>=55	SF	No	M	No	Gas FAF	Instant Gas
FAF Electric	Electric Resistance	X>=55	SF	No	M	Yes	Gas FAF	Instant Gas
FAF Electric	Electric Resistance	X>=55	SF	Yes	E	No	Gas FAF	Instant Gas
FAF Electric	Electric Resistance	X>=55	SF	Yes	E	Yes	Gas FAF	Instant Gas
FAF Electric	Electric Resistance	X>=55	SF	Yes	M	No	Gas FAF	Instant Gas
FAF Electric	Electric Resistance	X>=55	SF	Yes	M	Yes	Gas FAF	Instant Gas

source: C:\Backups\Plan 6\Studies\Model Development\Direct Use of Gas\Presentations\110104 DUG RTF\[New Segment Groups 110104.xlsm]Illustration 2

Northwest Power and Conservation Council

Summary of Fuel Conversion Resource Findings

Study	Technical Potential	Cost-Effective Potential	Resource Potential
Lazar	1448		
Bonneville			385
Beyers	1370	854	630
Aos & Blackmon	1483	1038	845
Council Staff	1445	733	170 - 430

Northwest Power and Conservation Council

History: Council Fuel Choice Policy

- Plan is intended to be fuel neutral
  - Monitor effect of incentives on fuel choice
- Fuel conversion is not conservation and not a resource
- Preference for thermally balanced cogeneration
- Market based approach

Northwest Power and Conservation Council

1994 Study

- Growing attractiveness of natural gas-fired combined cycle combustion turbines motivated the Council to take another look at “fuel switching” or “total energy efficiency”.

Northwest Power and Conservation Council

1994 Study Addressed

- Thermal efficiency of residential end-use technologies
- Cost effectiveness of fuel switching
- Assessed recent trends in fuel choice
- Reviewed Council history on fuel choice
- Proposed a Council policy statement on fuel choice

Northwest Power and Conservation Council

What Studies Show

- Thermodynamic efficiency is not same as economic efficiency
- Economic efficiency depends on:
  - Amount of Energy Used
    - House size
    - Thermal efficiency of shell and equipment
    - Climate zone
  - Energy prices and escalation assumptions
  - Conversion costs
    - Gas service extension
    - Equipment conversion costs
    - Avoided capacity costs

Northwest Power and Conservation Council

Environmental Considerations

- The 1994 study showed that increased direct use of natural gas would:
  - Increase nitrous oxide and carbon monoxide emissions
  - Reduce carbon dioxide emissions
  - Reduce sulfur oxide emissions
  - Insignificant effects on suspended particulates and VOCs

Northwest Power and Conservation Council