U.S. DEPARTMENT OF ENERGY
Northwest Clean Energy Application Center

Promoting CHP, District Energy, and Waste Heat Recovery

Alaska • Idaho • Montana • Oregon • Washington

State of Washington Clean Energy Opportunity: Technical Market Potential for CHP

August 2010

Introduction

The state of Washington has significant clean energy technical market potential including clean heat and power (CHP)/cogeneration, waste heat recovery for power and heat, and district energy. This brief white paper by the Northwest Clean Energy Application Center (NW CEAC) presents the technical market potential for CHP and waste heat recovery for power and heat. A separate and more complex white paper will explore the economic potential for CHP with a focus on the seventeen utilities subject to Revised Code of Washington 19.285 (voter initiative 937).

The analysis in this paper shows the total technical potential to be well over 4,000 MW. This is too large to be ignored. It is part of a broader context of developing the state's distributed generation potential. CHP provides significant energy efficiency improvements and economic benefits as compared to stand-alone power generation. It can also reduce pressure on the electrical grid's transmission and distribution systems.

CHP Market Characterization Summary

Washington has more CHP opportunity than shown as "technical potential" in the 2004 study for Oakridge National Laboratory, *Combined Heat and Power in the Pacific Northwest: Market Assessment*, by Energy & Environmental Analysis, Inc. (now a subsidiary of ICF International): http://chpcenternw.org/NwChpDocs/Chp_Market-Assessment_In_PNW_EEA_08_2004.pdf. This study (hereafter referred to as "Oakridge") mainly focused on natural-gas-based CHP.

Additional technical potential is available from waste heat recovery and opportunity fuels such as biomass. Table 1 provides a summary overview of this technical potential and the information sources. Additions to the base Oakridge total of 3,321.1 MW are made only when double counting does not occur. Subsequent studies and analysis have helped to confirm or expand the data in the Oakridge report.

Table 1. WA State Industrial On-site Technical Potential by Industry[1]

Industry	Update of the ORNL 2004 study (MW)
Petroleum Refineries	672
Pulp and Paper	225
Waste Heat to Power	235 (new category)
Wood Products/Forest Products	268
Dairy Digesters with co-digestion	88.8 (new category)
Landfill Gas (LFG) with CHP, high solids digesters – compost facilities, other opportunity fuels	20 (new category)
Food Processing	534
Textile Mill Products	37
Furniture and Fixtures	8
Chemicals	292
Rubber and Plastic	45
Primary Metals	335
Fabricated Metals	46
Machinery	40
Transportation Equipment	202
Instruments	36
Miscellaneous Manufacturing	40
TOTALS	3123.8

Table 2. CHP Technical Potential in Washington State[2]

MW[3]	Industries	Information Source
3,321.1	All Industrial & Commercial	Oakridge (*Combined Heat and Power in the Pacific Northwest: Market Assessment)*
672.0	Petroleum Refineries	738 MW at BP refinery (permitted) minus Oakridge on-site and export potential of 66 MW
0	Pulp & Paper	University of Washington study & NW CEAC detailed database of Washington mills – does not exceed Oakridge of 792 MW
235.0	Waste Heat to Power	Sean Casten e-mail. Not included in Oakridge 2004 study
0	Wood Products/Forest Products	The NW CEAC forest products database under development contains 78 mills, with CHP operating at 8. The Oakridge study on on-site and export potential shows an additional 704 MW at approximately 10 MW per mill. Concur with Oakridge potential.
88.8	Dairy Digesters with Co-Digestion	Dairy database and Washington Department of Ecology Agriculture Carbon Offsets study of 2008 – 135 dairies. Not included in Oakridge study
20.0	Landfill Gas (LFG) with CHP, High Solids Digesters – Compost Facilities, Other Opportunity Fuels	NW CEAC Manager's conservative estimate
4,336.9	**Total Technical Potential**	

[1] *State of Washington Clean Energy Opportunity*: Technical Market Potential for CHP – August 2010
[2] For additional information, see item 3 below.
[3] Specific industry/target market figures are in addition to the Oakridge report

CHP Market Characterization Details

The following information is from ICF International (Bruce Hedman/Anne Hampson) with additional information in item 3 below from the Northwest Clean Energy Application Center.

1. Existing Washington CHP at a Glance

- Existing CHP Installations – 34 Sites, 1,264.8 MW
- 96% of capacity is industrial, 4% is commercial
- Average System Size – 37.2 MW
- Median System Size – 7.5 MW

Table 3. Washington Existing Industrial CHP Sites and Capacity (through 2009)

Application	# Sites	Capacity (MW)
SIC 02: Livestock	4	2.9
SIC 24: Wood Products	9	268.7
SIC 26: Paper	8	512.2
SIC 29: Petroleum Refining	2	436.8
Total	**23**	**1,220.6**

Table 4. Washington Existing Commercial CHP Sites and Capacity (through 2009)

Application	# Sites	Capacity (MW)
SIC 4939: Utilities	1	7.5
SIC 4952: Wastewater Treatment	5	14.2
SIC 4953: Solid Waste Facilities	2	6.7
SIC 4961: District Energy	1	7.0
SIC 8220: Colleges/Universities	2	8.9
Total	**11**	**44.3**

Table 5. Washington Existing CHP by Size Range (through 2009)

Size Range	# Sites	Capacity (MW)
<1 MW	7	2.4
1 - 4.9 MW	6	19.7
5 - 19.9 MW	11	118.2
20 - 49.9 MW	1	28.0
50 - 99.9 MW	4	229.2
100 - 499 MW	5	867.3
Total	**34**	**1,264.8**

2. CHP Technical Potential – EEA-IFC Baseline

- Additional CHP Technical Potential – 3,321.1 MW
- 64% of tech potential capacity is in industrial applications, 36% in commercial

Table 6. Washington State Industrial Onsite Technical Potential by Industry

SIC	Industry	100 kW to 1 MW (MW)	1 to 5 MW (MW)	5 to 20 MW (MW)	> 20 MW (MW)	Total MW
20	Food Processing	81	200	252	0	534
22	Textile Mill Products	6	2	29	0	37
24	Wood Products	55	164	49	0	268
25	Furniture and Fixtures	8	0	0	0	8
26	Paper	16	44	68	97	225
28	Chemicals	26	62	58	146	292
29	Petroleum Refining	2	10	10	0	22
30	Rubber and Plastic	10	27	9	0	45
33	Primary Metals	3	10	39	284	335
34	Fabricated Metals	20	21	5	0	46
35	Machinery	16	11	13	0	40
37	Transportation Equip.	17	41	26	118	202
38	Instruments	8	13	16	0	36
39	Misc. Manufacturing	22	18	0	0	40
	Total	**289**	**624**	**573**	**644**	**2,130**

Table 7. Washington State Commercial Onsite Technical Potential by Facility type

SIC	Industry	100 kW to 1 MW (MW)	1 to 5 MW (MW)	5 to 20 MW (MW)	> 20 MW (MW)	Total MW
4222	Refrigerated Warehouse	13	9	0	0	22
4952	Water Treatment/Sanitary	9	9	6	0	23
5411	Food Sales	10	1	0	0	11
5812	Full Service Restaurants	45	7	0	0	52
7011	Hotels/Motels	52	82	38	0	171
7211	Laundries	4	0	0	0	4
7542	Carwashes	9	0	0	0	9
7991	Health Clubs	15	1	0	0	16
7992	Golf Clubs	13	0	0	0	13
8051	Nursing Homes	35	19	0	0	54
8060	Health Care	13	78	15	0	106
8220	Colleges and Universities	10	29	30	25	94
8211	Schools	78	22	14	0	114
8412	Museums	4	0	0	0	4
9223	Prisons	3	12	10	0	25
6513	Apartments	44	53	53	25	175
6512	Office Buildings	128	70	75	25	299
	Total	**485**	**392**	**239**	**75**	**1,191**

Table 8. Washington State Industrial Export Technical Potential

SIC	Industry	100 kW to 1 MW (MW)	1 to 5 MW (MW)	5 to 20 MW (MW)	> 20 MW (MW)	Total MW
20	Food Processing	0	20	174	0	194
22	Textile Mill Products	0	0	5	0	5
24	Wood Products	0	282	154	0	436
25	Furniture and Fixtures	0	0	0	0	0
26	Paper	0	61	179	327	567
28	Chemicals	0	18	57	201	276
29	Petroleum Refining	0	16	28	0	44
30	Rubber and Plastic	0	0	0	0	0
33	Primary Metals	0	0	0	0	0
34	Fabricated Metals	0	0	0	0	0
35	Machinery	0	0	0	0	0
37	Transportation Equip.	0	0	0	0	0
38	Instruments	0	0	0	0	0
39	Misc. Manufacturing	0	6	0	0	6
	Total	**0**	**402**	**598**	**528**	**1,528**

3. CHP Market Penetration

Several technical potential market penetration studies have been completed and are described here with comments:

- The 738 MW BP Cherry Point Refinery updated its Energy Facility Site Evaluation Site Certification Agreement and permits in 2008. EPA Region 10 permit and project are on hold pending completion of a major refinery upgrade of approximately $400 million. Per discussion between the NW CEAC Manager and BP, the refinery views the CHP project as a major way to reduce its carbon footprint. Washington law has established a greenhouse gas registry in harmony with EPA requirements.
- *Washington State Pulp and Paper Mill Boilers: Current and Potential Renewable Energy Production* (University of Washington September 2009 study with funding from the Washington Legislature). If modern boiler systems were installed at Washington's 13 pulp and paper mills, an increase from 220 MW to at least 520 MW could be anticipated (see page 29 of report). Note: Not all mills participated in the study. Therefore Oakridge data is used. http://www.chpcenternw.org/NwChpDocs/Pulp_and_Paper_EE_Boilers_and_CHP_092009.pdf.
- Waste heat to power: Turbosteam (Sean Casten) provided the NW CEAC and others a state-by-state spreadsheet of the waste heat to power potential for the following categories: 1) Steam pressure drop; 2) Flared tail and stack gas; 3) Pipeline compressor stations; and 4) Natural gas pressure drop. Casten's e-mail is dated July 26, 2005.
- Dairy digesters with co-digestion: Through separate funding, the NW CEAC has enhanced Washington dairy databases. Approximately 135 dairies have over 500 cows (minimum size for CHP with co-products). Dairy CHP systems generally range from 450 kW to 1.2 MW with the largest up to 5 MW. Co-digestion can increase size by another 50%. A conservative technical market size calculation is as follows: 135 dairies x 500 kW x 1.3 for co-digestion = 87.75 MW. The Washington Department of Ecology stakeholder report titled *Recommendations for the Development of Agricultural Sector Carbon Offsets in Washington State*, (October 2008, pages 24-33) provides additional information: http://www.northwestcleanenergy.org/NwChpDocs/Agriculture_Carbon_Offsets_WA%20Final.pdf.
- The major technical potential study (Oakridge 2004) is now dated and should be expanded to include both opportunity fuels/biomass-based CHP and waste heat recovery for power and heat. The technical opportunity is larger than shown in the Oakridge study.

4. References

- Energy and Environmental Analysis, Inc., *Combined Heat and Power in the Pacific Northwest: Market Assessment, Task One Final Report*, August 2004 Revised (Ken Darrow is principal author) submitted to Oakridge National Laboratory, Report No. B-REP-04-5427-004r: http://chpcenternw.org/NwChpDocs/Chp_Market-Assessment_In_PNW_EEA_08_2004.pdf.

- Gustafson, Richard, and Natalia Raffaeli (University of Washington, School of Forest Resources), *Washington State Pulp and Paper Mill Boilers: Current and Potential Renewable Energy Production, Final Report*, Washington Department of Ecology, September 2009, Publication No. 09-07-048: http://www.chpcenternw.org/NwChpDocs/Pulp_and_Paper_EE_Boilers_and_CHP_092009.pdf.

- *Recommendations for the Development of Agricultural Sector Carbon Offsets in Washington State*, October 2008, Agriculture Sector Carbon Market Work Group, Washington Department of Ecology, et al.: http://www.northwestcleanenergy.org/NwChpDocs/Agriculture_Carbon_Offsets_WA%20Final.pdf.

- *Combined Heat and Power White Paper*, Clean and Diversified Energy Initiative, Western Governors' Association January 2006: http://chpcenternw.org/NwChpDocs/WGA_CHP-WhitePaper_2006_01.pdf.

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