

GEOHERMAL ENERGY
in
OREGON
2015

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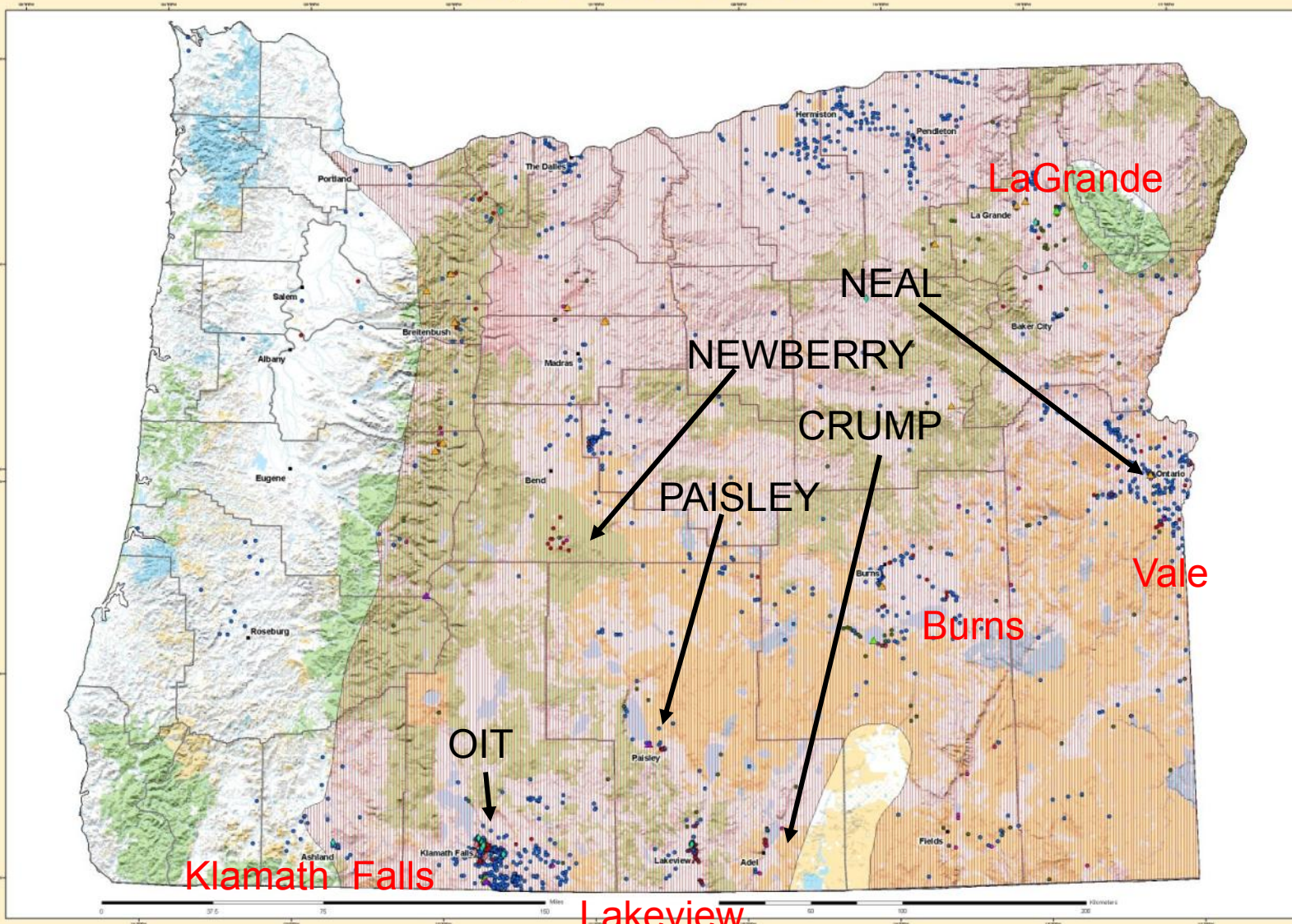
Use of Geothermal Energy in the U.S.

- 2,800 megawatts of **electricity** supplying 4 million people in western U.S. and Hawaii
- 500 thermal megawatts of **direct uses**
- 400,000 **heat pumps** nationwide, providing 1,500 thermal megawatts of heating and cooling

GEOTHERMAL RESOURCES

- ◆ Geothermal water has been used directly in Oregon for >100 years & making power in Oregon since 2010.
- ◆ Geothermal steam is generating power in Italy for >100 years & California for >50 years.

Oregon Geothermal Resources



Legend	Geothermal Categories	Ownership
<ul style="list-style-type: none"> • Cities/Towns — County Boundaries — Rivers/Streams — Lakes/Reservoirs 	<ul style="list-style-type: none"> ▲ Greenhouse ◆ Space Heating ◆ District Heating ▲ Aquaculture ▲ Spas/Resorts/Recreation Sites Regions of Known or Potential Geothermal Resources 	<ul style="list-style-type: none"> Private Lands Bureau of Land Management and Other Federal Lands State Lands Native American Lands U.S. Forest Service Lands

Geothermal Categories
• Wells > 50 Degrees C
• Springs > 50 Degrees C
• Wells > 20 and < 50 Degrees C
• Springs > 20 and < 50 Degrees C

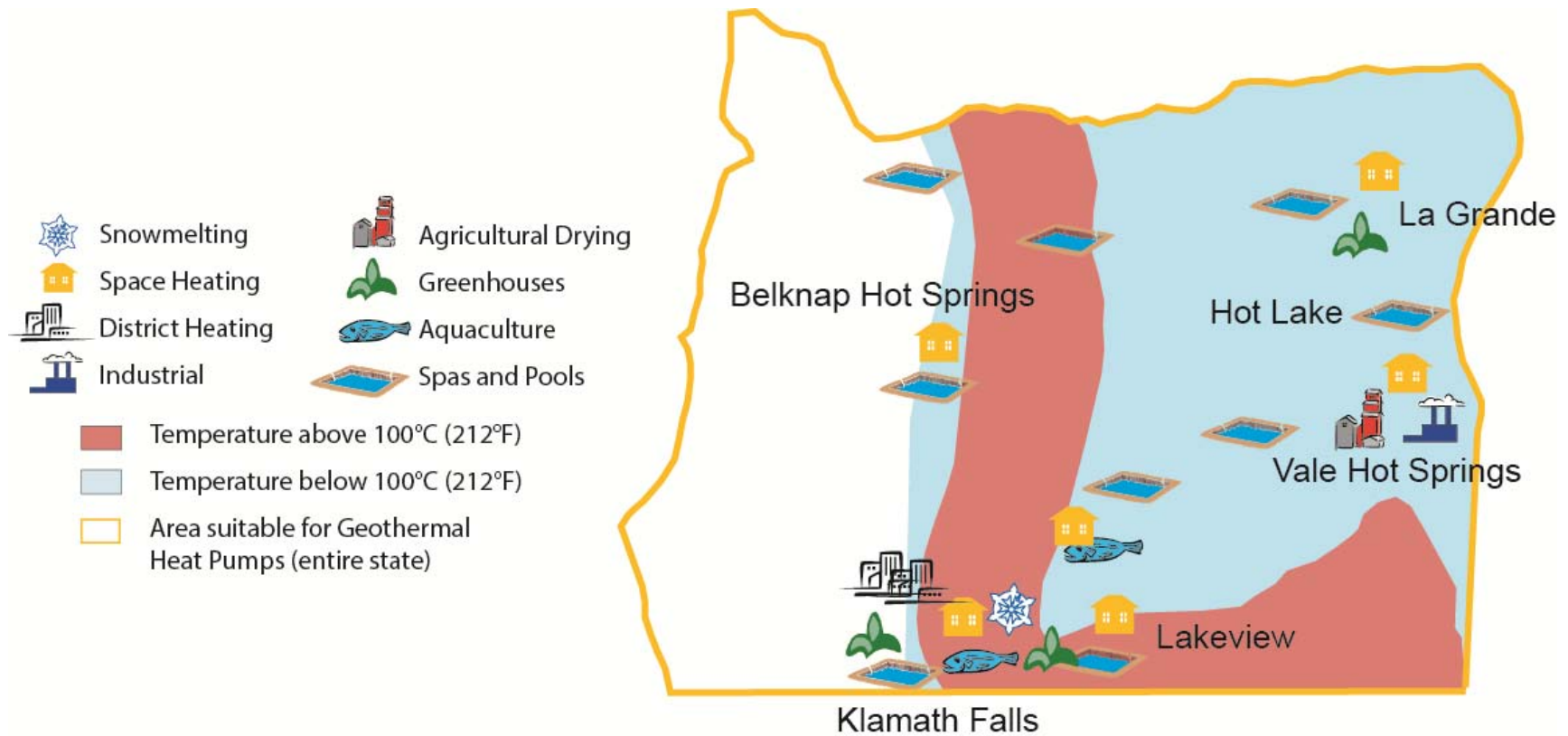
Ownership
Private Lands
Bureau of Land Management and Other Federal Lands
State Lands
Native American Lands
U.S. Forest Service Lands

Map prepared by	Oregon Geothermal Resources
Patrick Loney and Julie Ehrlich at the State National Engineering and Environmental Laboratory	Publication No. - INEELMIS-2002-1621 Rev. 1 November 2003
For The U.S. Department of Energy Office of Energy Efficiency and Renewable Energy Geothermal Technologies Program	Map Projection Information: Projected: Lambert Conformal Conic Units: Meters Central Meridian: 121.00 Standard Parallel 1: 33.00 Standard Parallel 2: 45.00 Latitude Of Origin: 42.00 Datum: North American 1927
Geothermal Data Provided by:	
1. Geo-Heat Center State Geothermal Database, [Compact Disk], February 2002	
2. National Geophysical Data Center, National Oceanic and Atmospheric Administration, 1983, Geothermal Resources of Oregon, Prepared for the Division of Geothermal Energy, United States Department of Energy, Map 1:500,000	

DIRECT USE

- ◆ Hot spring water piped to
 - pools, buildings, greenhouses.
- ◆ Wells in Klamath Falls Oregon supply hospital, schools, college, downtown business core, brewpub, and funeral parlor.

DIRECT USE



KLAMATH FALLS



Klamath Falls – Oregon Institute of Technology



KLAMATH FALLS

- OIT uses (3) 90°C wells to heat the campus and now generate power
- In-line 280 kW power plant started operating Feb. 5, 2010
- 1.2 MW power plant added 2014
- With solar, all campus energy needs met

NEAL HOT SPRINGS



U.S. GEOTHERMAL

- \$140M project ~22 MW Net
- Production well examples:
 - NHS-1 is 700 meters deep with 135°C
 - NHS-5 is 850 m & 141°C
- Idaho Power purchases power & built transmission line
- 2012 Commercial Operation

Source: www.usgeothermal.com

OREGON GEOTHERMAL POWER PLANTS

<u>Date of Operation</u>	<u>Location</u>	<u>Developer</u>	<u>Gross MW</u>
12-Nov-12	Neal HS	US Geo.	30.1
October 14	Paisley	SVEC	3.4
30-Apr-14	OIT	OIT	1.75
<u>1-Apr-10</u>	<u>OIT</u>	<u>OIT</u>	<u>0.28</u>
		TOTAL	35.53

Sources: OIT Geo-Heat Center, Surprise Valley Electrification Corp., US Geothermal Inc.

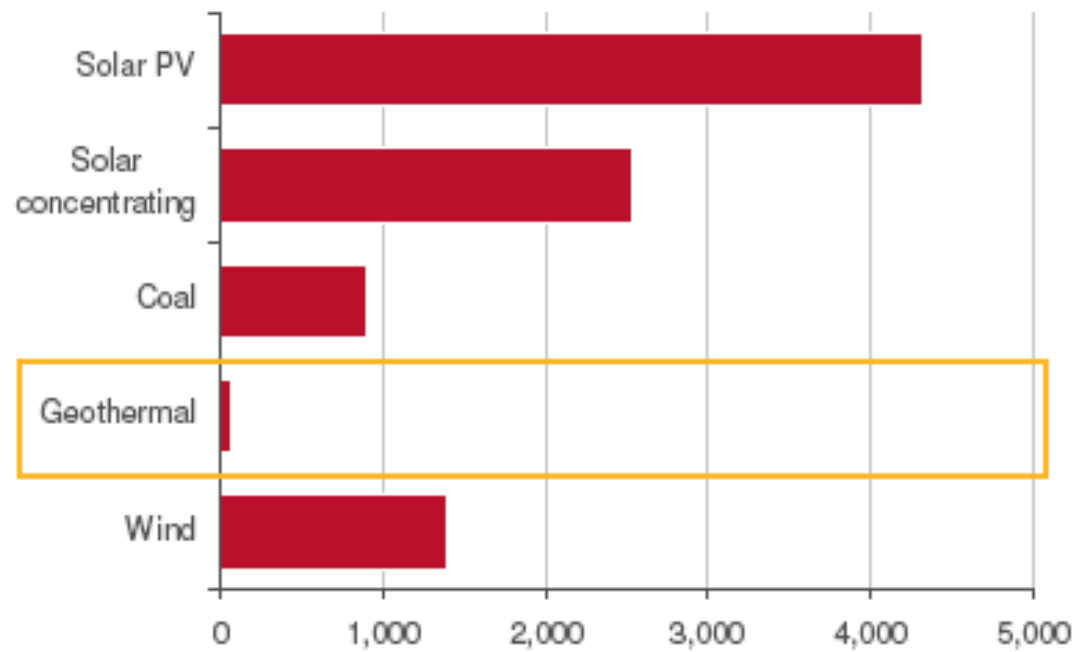
ENVIRONMENT

lbs/ per megawatt hour	Nitrogen oxide (Nox)	Sulphur Dioxide (SO2)	Carbon Dioxide (CO2)	Particulates (PM)
Coal	4.31	10.39	2191	2.23
Coal, life cycle emissions	7.38	14.8	na	20.3
Oil	4	12	1672	na
Natural Gas	2.96	0.22	1212	0.14
Geothermal (flash)	0	0.35	60	0
Geothermal (binary)	0	0	0	neglible
Geothermal (Geysers steam)	0.00104	0.000215	89	neglible
<i>source: GEA, 2007</i>				

ENVIRONMENT

Land Use

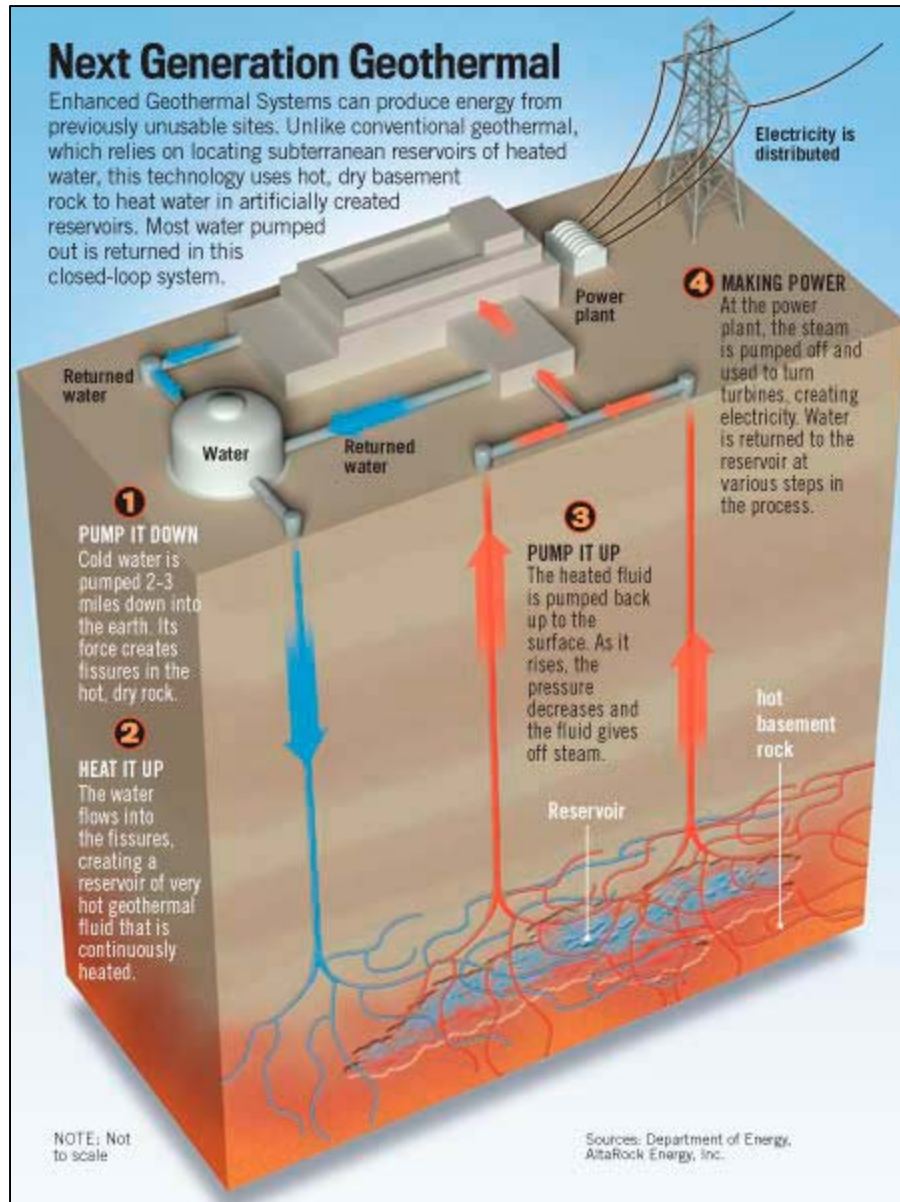
in acres/ 1 billion kWh (1 GWh, Source: NREL, AWEA and others)



Energy Trust Renewable Energy Program

- Projects 20 MW and under
- Power sale to Pacific Power or Portland General Electric
- **Project Development Assistance**
- **Project incentives**

Newberry



- Past well drilling
- High Temps 250°C (+500°F)
- Bleeding edge technology
- Public & private backing
- <http://blog.newberrygeothermal.com>

GEOHERMAL SUMMARY

- ▶ Substantial direct use on-line
- ▶ 35.53 MW Power on-line
- ▶ 40 MW Power in development
- ▶ 120+ MW near term potential

SOURCES

- Geo-Heat Center geoheat.oit.edu/
- ODOE oregon.gov/ENERGY
- US DOE www1.eere.energy.gov/geothermal
- Geothermal Resources Council
www.geothermal.org
- Geothermal Education Office
geothermal.marin.org/
- Companies active in Oregon
- <http://blog.newberrygeothermal.com/>