Portland Deep Direct-Use Thermal Energy Storage (DDU-TES) Feasibility Study

Project Officer: Arlene Anderson

Total Project Funding: $720,000

November 13, 2017

John Bershaw, PI

Portland State University

Deep Direct-Use Feasibility Studies Technical and Economic Working Group Kick-Off Meeting

This presentation does not contain any proprietary confidential, or otherwise restricted information.

Heat Flow Map of the USA

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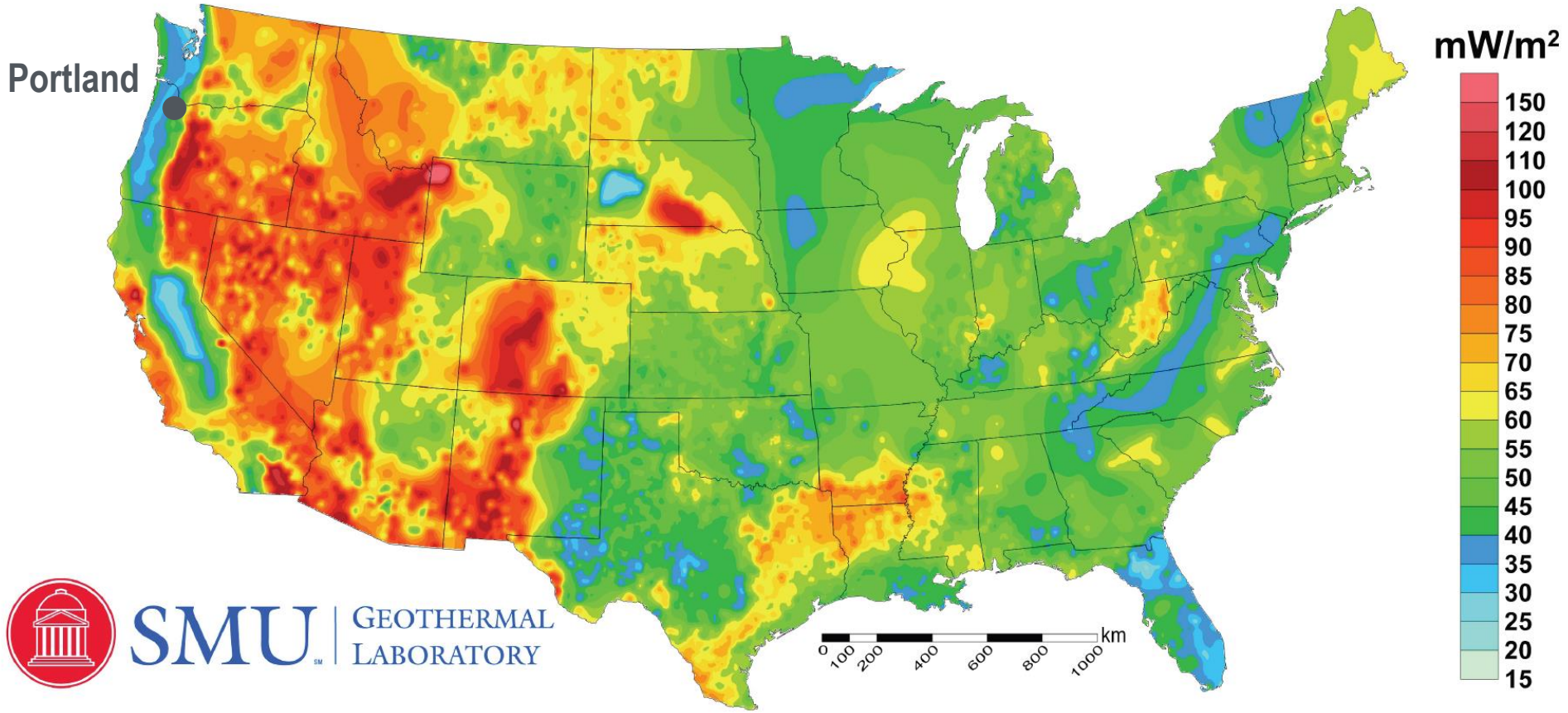

Reference: Blackwell, D.D., Richards, M.C., Frone, Z.S., Batir, J.F., Williams, M.A., Ruzo, A.A., and Dingwall, R.K., 2011, "SMU Geothermal Laboratory Heat Flow Map of the Conterminous United States, 2011". Supported by Google.org. Available at http://www.smu.edu/geothermal.

Climate for Portland, Oregon

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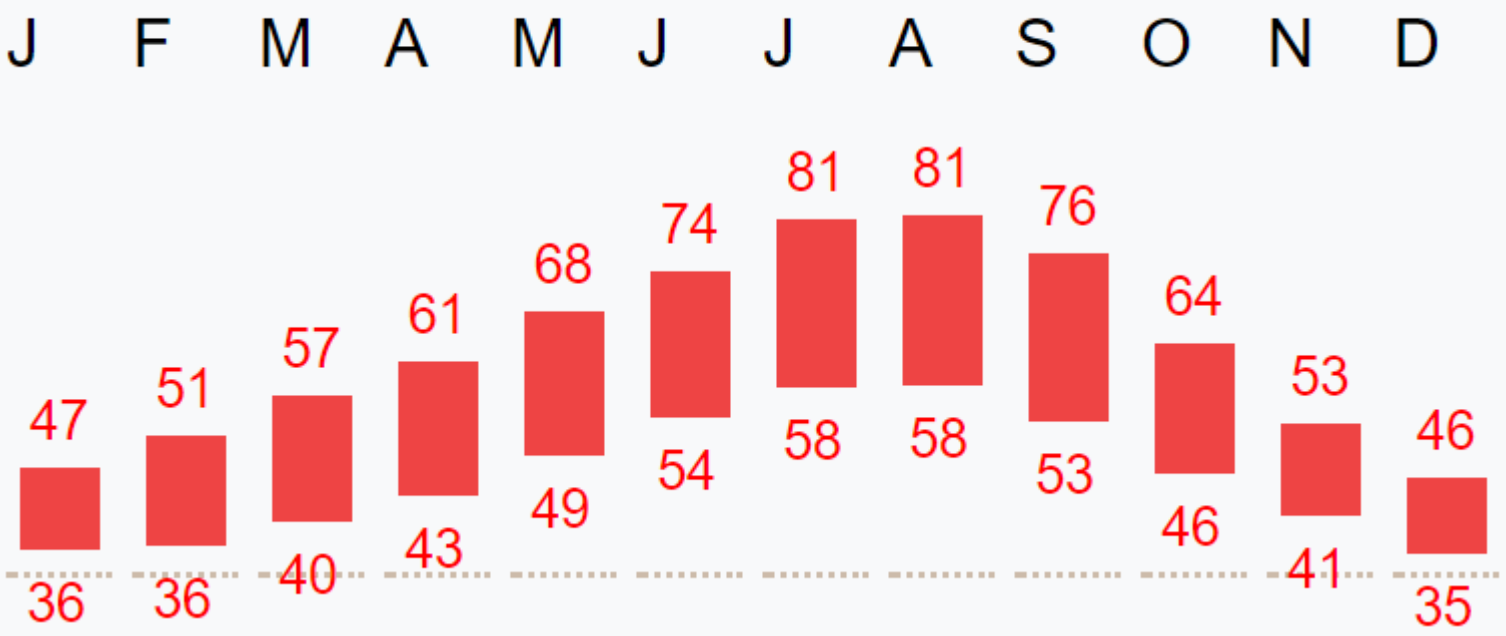
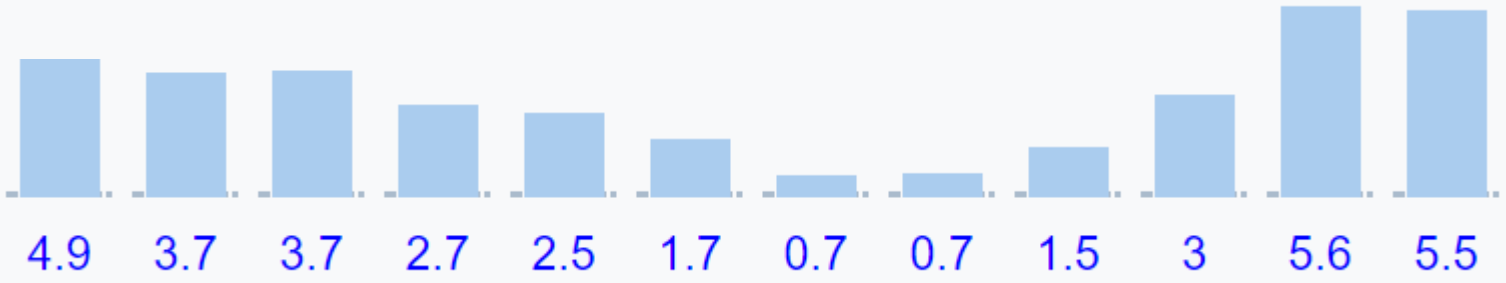
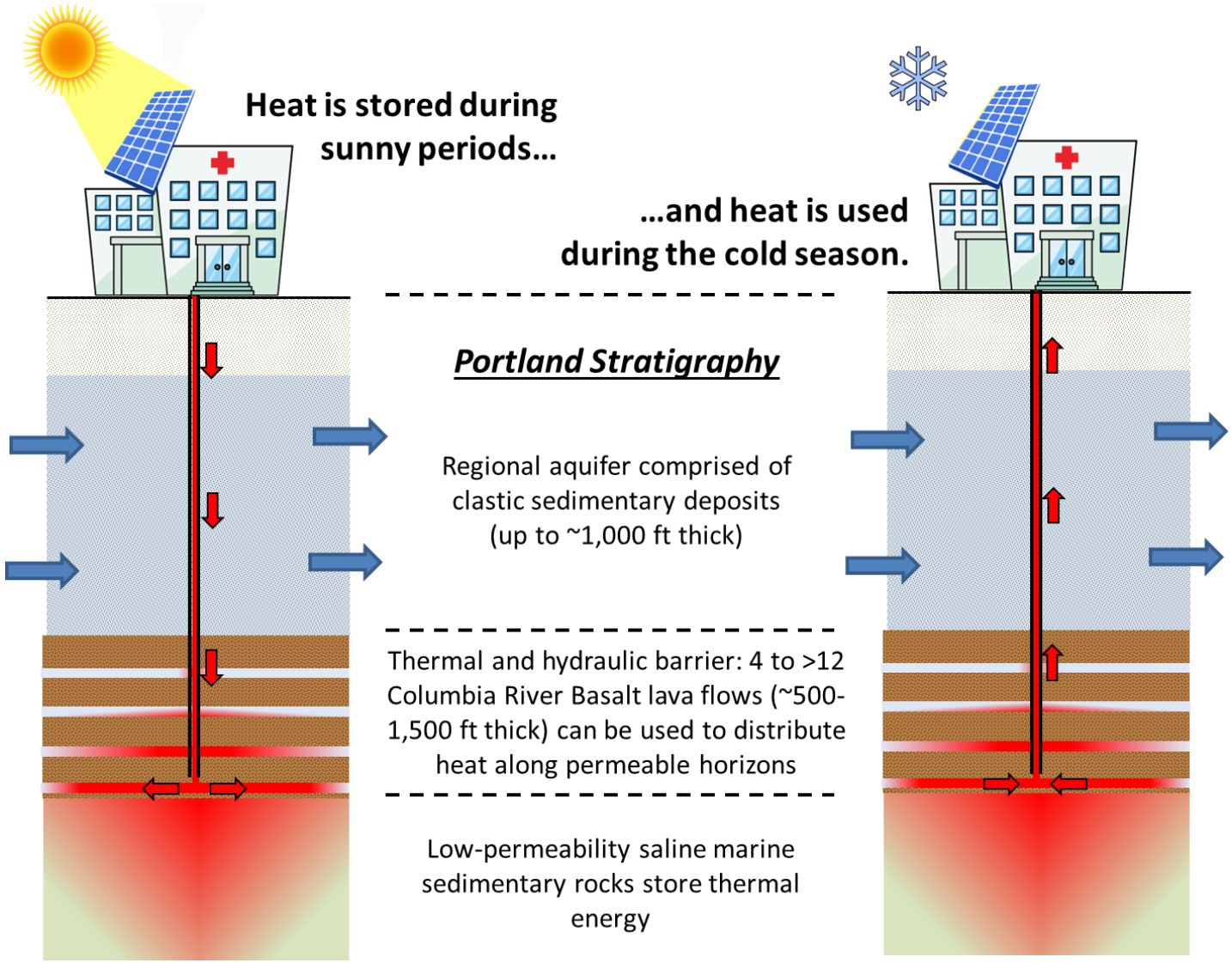


Average max. and min. temperatures in F



Precipitation totals in inches

Direct Deep Use Thermal Energy Storage

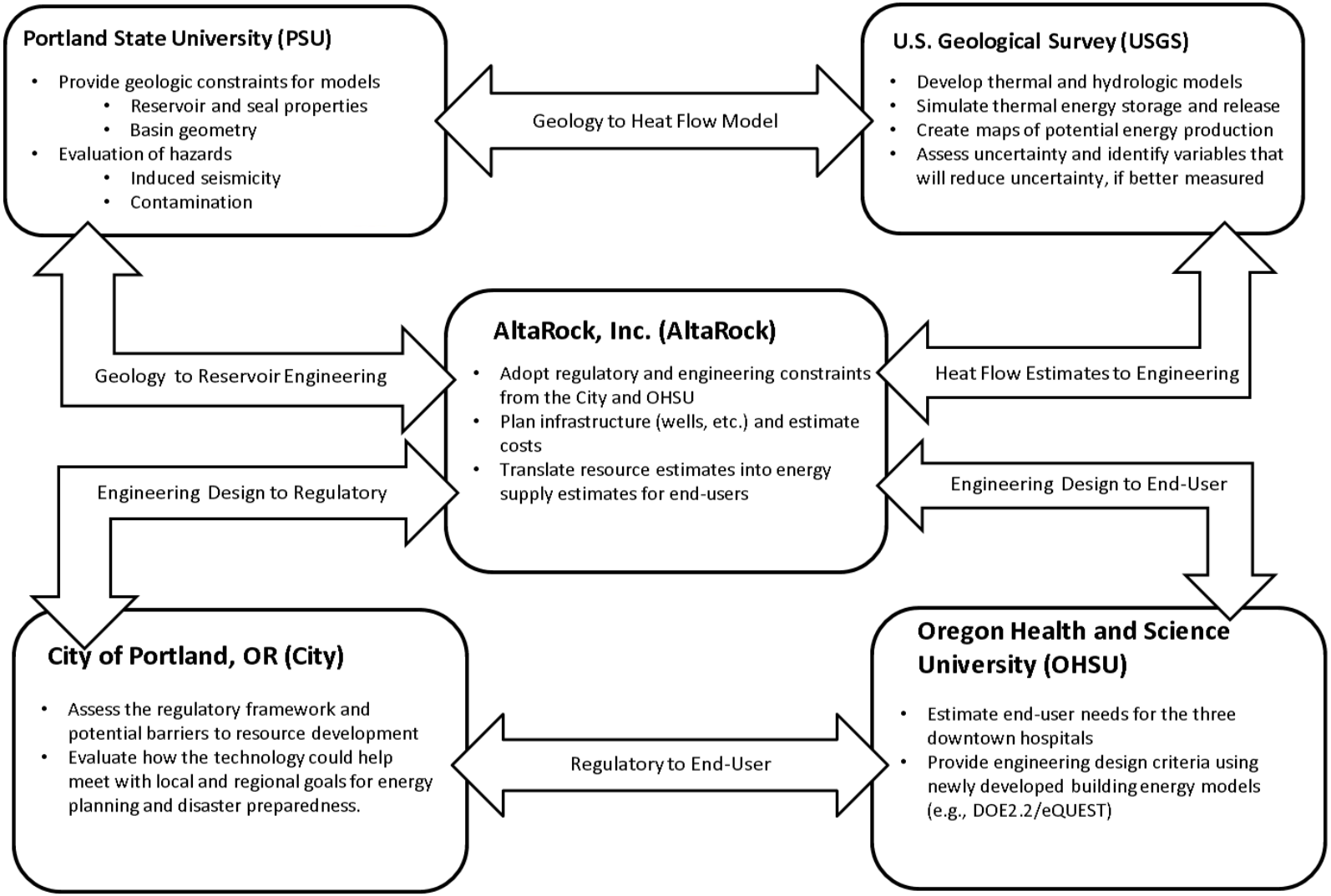


Project Objectives

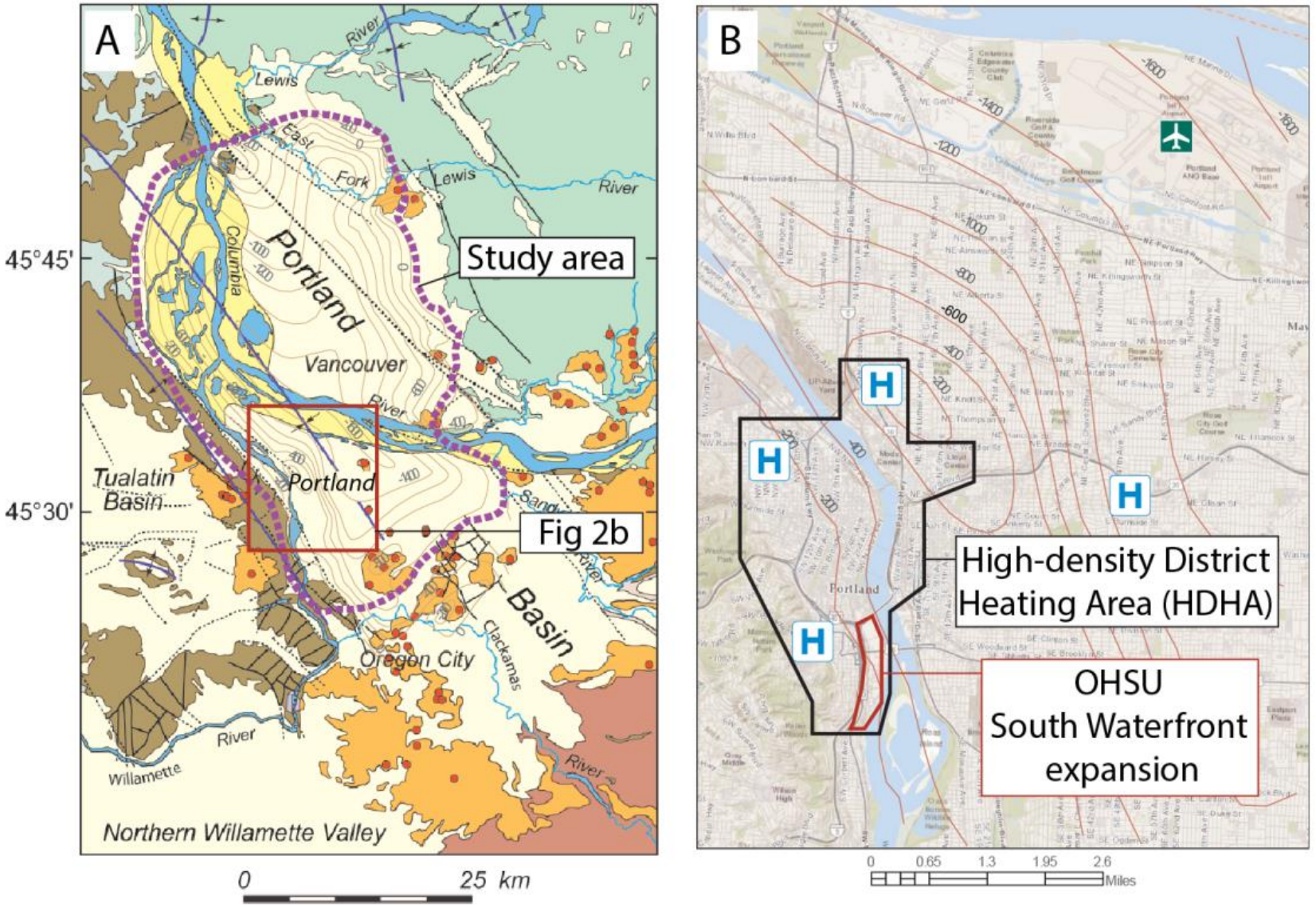
- Determine “feasibility” of DDU-TES for critical infrastructure in the Portland Metro Area
  - Geological/Technical Assessment
  - Resource Modeling
  - Regulatory Framework
  - Infrastructure Characterization
  - Hazard Assessment
  - End-User Demands and Market Transformation

- Develop tools for resource assessment that can be used elsewhere in the United States
  - Modeling tools may be applied to other low temperature systems throughout the United States

Collaborative and Multi-Disciplinary

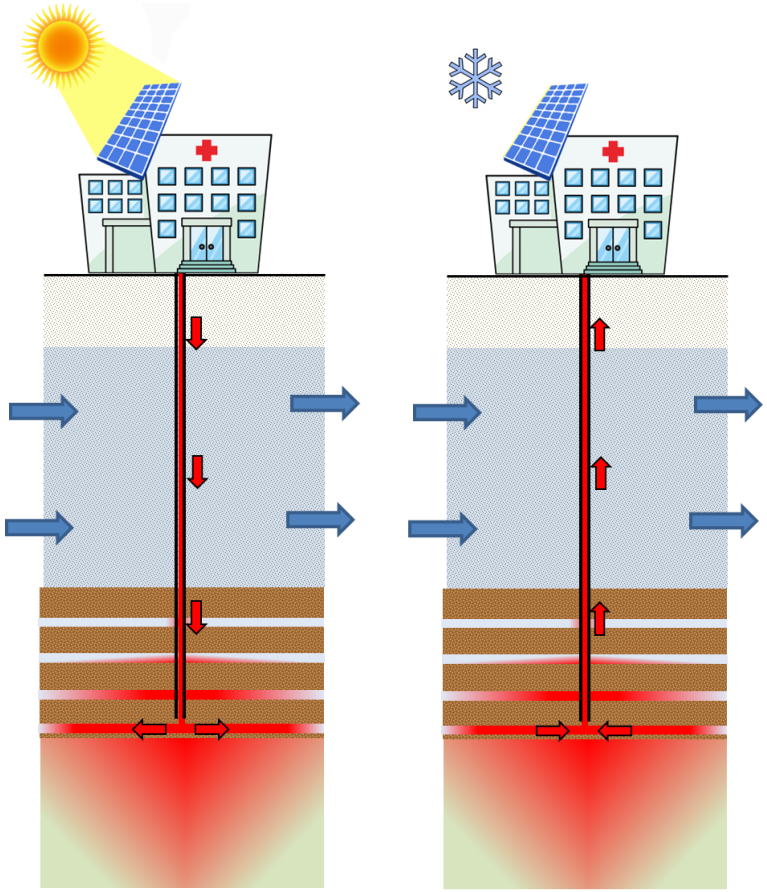


Portland Basin Geology



Flow Modeling

- Goal is to produce an estimate of recoverable heat (resource) at OHSU
- SUTRA will be used to model groundwater flow and heat transport
- Example output: 5-year recoverable heat based on 500 meter injector/producer well spacing



Regulatory Framework

- Goal is to understand the regulatory framework for DDU-TES in the Portland Metro Area
  - Can we secure all necessary permits to implement this technology?

- The City of Portland will engage all relevant public regulatory agencies
  - Oregon Dept. of Environmental Quality *(pollution safeguards)*
  - Oregon Dept. of Water Resources *(well construction and permitting of water use)*
  - Oregon Dept. of Energy *(construction exemptions for energy industry wells)*
  - City of Portland Bureau of Development Services *(land use and permitting)*
  - Oregon Dept. of Geology and Mineral Industries *(oil, gas, and geothermal wells)*

Oregon Health Sciences Expansion

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Oregon Health Sciences Expansion

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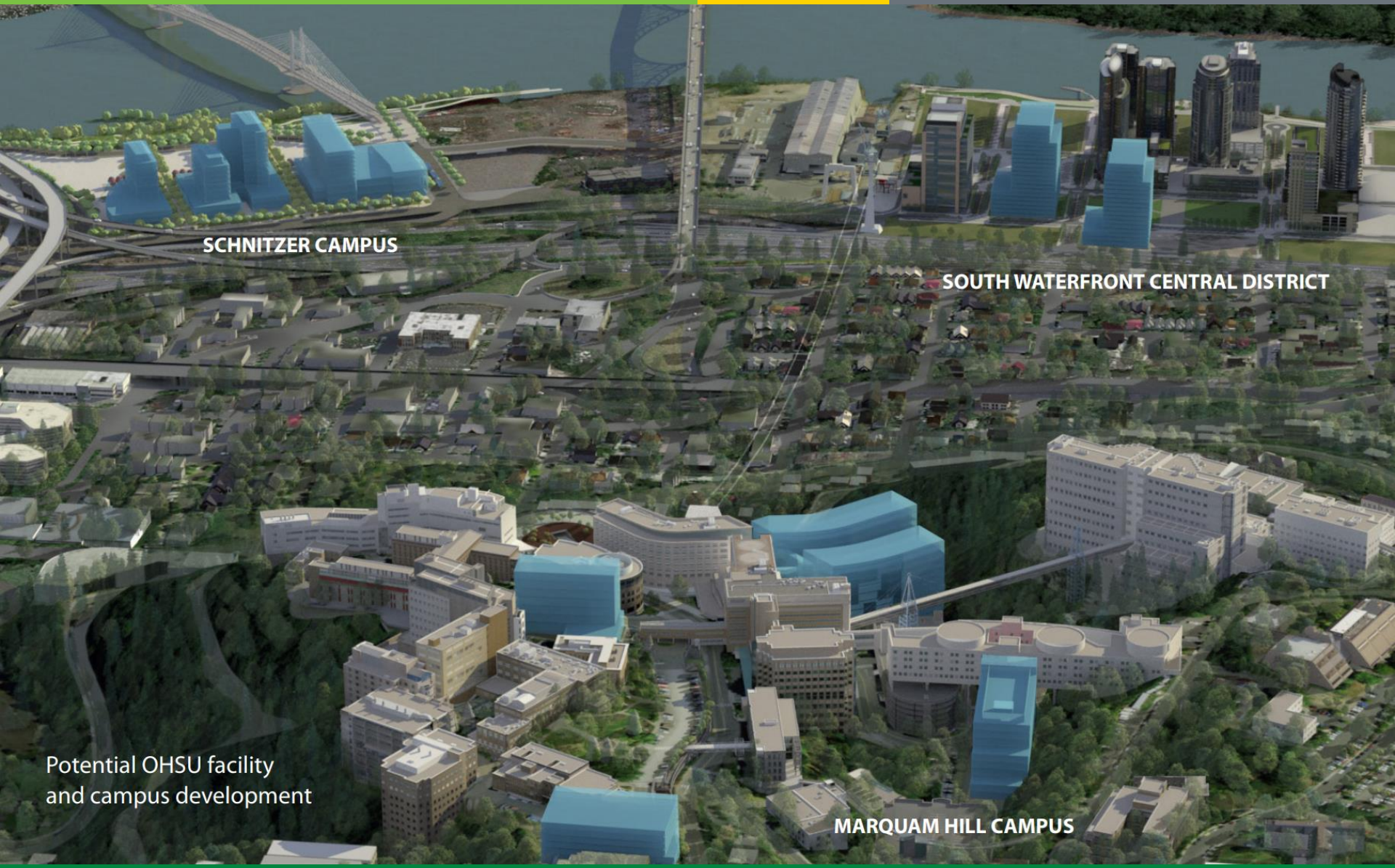


Current Energy Use on Marquam Hill Campus

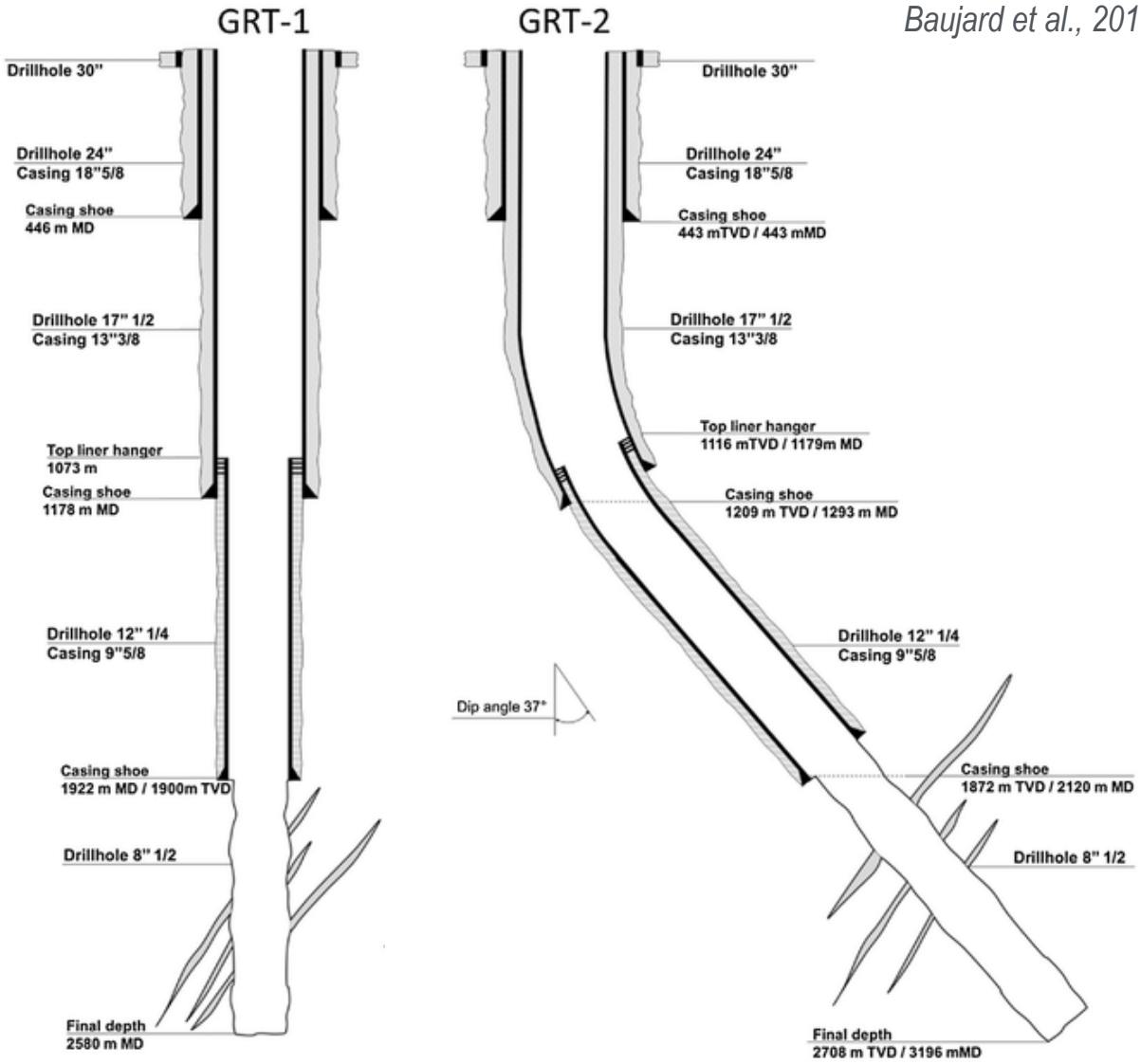
Annual electric use: 16.5 MWa

Annual Natural gas use: 6.7 million Therms

OHSU 20-Year Facilities Master Plan

- Achieve a high level of environmental sustainability with all campus development and facility projects.
- Create buildings that maximize conservation of water and energy use
- Monitor and commission energy conserving systems through the life of each building
- Plan for the expansion and upgrade of generation and distribution infrastructure
- Enable modular expansion of capacity and efficient, staged operation.
- Means for financing energy improvements on the OHSU campuses are currently under study.
- Marquam Hill has district heating (centralized). There are currently no plans for district heating on the lower campus, though this project may introduce a viable option.

Project Infrastructure



Baujard et al., 2017

Project Milestones

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	Quarter 1			Quarter 2			Quarter 3			Quarter 4			Quarter 5			Quarter 6			Quarter 7			Quarter 8		
Task	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*	*19*	*20*	*21*	*22*	*23*	*24*
1.0 Constrain Basin Geometry and Hazards																								
1.1 Develop Basin and Play Geometry Maps																								
1.1.1 Create Preliminary Basin Geometry											**MS 1.1.1.1**													**MS 1.1.1.2**
1.1.2 Incorporate Structure Into 3D Basin Model											**MS 1.1.2.1**													**MS 1.1.2.2**
1.2 Seismic and Structural Hazards Analysis																								**MS 1.2.1**
1.2.1 Assess Risk for Infrastructure																	**MS 1.2.1.1**							
1.2.2 Assess Risk for Induced Seismicity																								**MS 1.2.2.1**
1.3 Geochemical Analysis											**MS 1.3.1**													**MS 1.3.2**
2.0 Heat and Fluid Flow Simulation																								
2.1 Develop Tools for Rapid Update of Model Input											**MS 2.1.1**													
2.2 Preliminary Modeling to Assess Data Value																								
2.2.1 Estimate Thermal Properties				**MS 2.2.1.1**																				
2.2.2 Estimate Hydrogeological Properties				**MS 2.2.2.1**																				
2.3 Model Subsurface Fluid and Thermal Flux																	**MS 2.3.1**							
2.4 Assess Resource for OHSU and PDX																								
2.4.1 Estimate the Heat Source at OHSU and PDX																								**MS 2.4.1.1**
2.4.2 Evaluate Uncertainty in the Estimated Resource																								**MS 2.4.2.1**
3.0 Resource Engineering																								
3.1 Resource Extraction Design					**MS 3.1.1**						**MS 3.1.2**													
3.2 Estimate End-User Needs and Convert to Resource Criteria																	**MS 3.2.1**							
4.0 Market Transformation Plan																	**MS 4.0.1**							
4.1 Regulatory Review and Evaluation																								
4.1.1 Regulatory Agency Engagement																								
4.2 Evaluation of Market Potential and Implementation Feasibility																								
5.0 Manage the Project Effectively																								
5.1 Quarterly Team Meetings																								
5.2 Summary and Recommendations																								**MS 5.2.1**

Color-coded by Responsible Party	PSU
	USGS
	Altarock
	City of Portland / OHSU
	All

Project Milestones

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4th Quarter: Basin Geometry *(PSU)*
Geochemical Analysis *(PSU)*
Infrastructure Design *(AltaRock)*

6th Quarter: Seismic Hazard Analysis *(PSU)*
Resource Estimates *(USGS)*
Regulatory Review *(City of Portland)*

8th Quarter: Market Transformation Plan *(City of Portland)*
Recommendations *(All)*

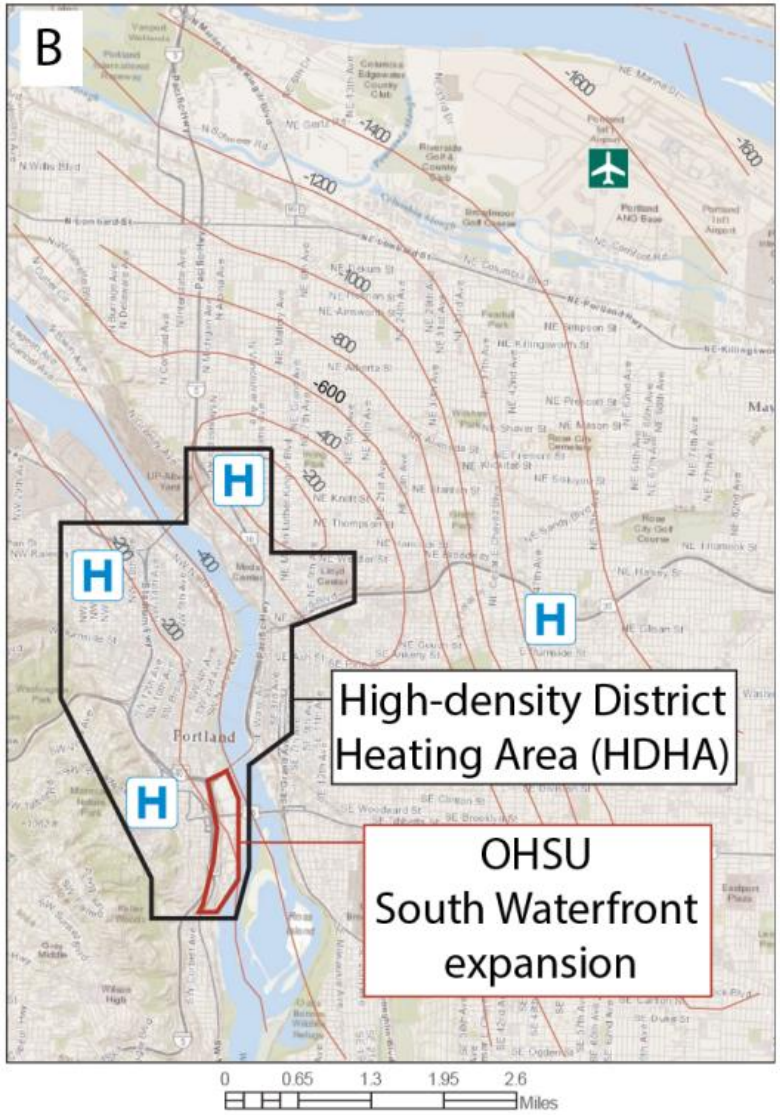
What is “Feasibility”?

Cost-Benefit Analysis:

- Heating resource available
- Hospital needs
- Energy security
- Cost of implementation

Market Transformation

- Greater Portland metro area
- Portland International Airport (PDX)



Collaboration & Data Sharing

- We value working group feedback on our plan and milestone deliverables
- Hope to learn from working group “best practices” regarding technology and project management

Data Management Plan

- End products include three master’s theses and summary reports by sub-awardees
- We will create tools that can be used to estimate DDU-TES resources elsewhere so reproducibility is critical
- Products and data will be made publicly available by uploading to the Geothermal Data Repository (DOE-GDR) using applicable templates no later than one quarter after generation using appropriate standards