

A tall drilling rig with a red and white lattice structure stands on a hillside. The rig has a red section with the number '328' on it. In the background, there are various industrial components, including blue tanks and a smokestack emitting a plume of white smoke. The scene is set against a clear blue sky and a dense forest of green trees.

WHP Technologies: Transferring Success from Geothermal to Waste Heat to Power Projects

Michael Newell, Ener-G-Rotors

Loy Sneary, Gulf Coast Green Energy

Jessica Lubetsky, Pew Clean Energy Program

SMU May 19, 2015

The Heat is Power Association

The industry-led advocacy organization focused exclusively on advancing waste heat to power.

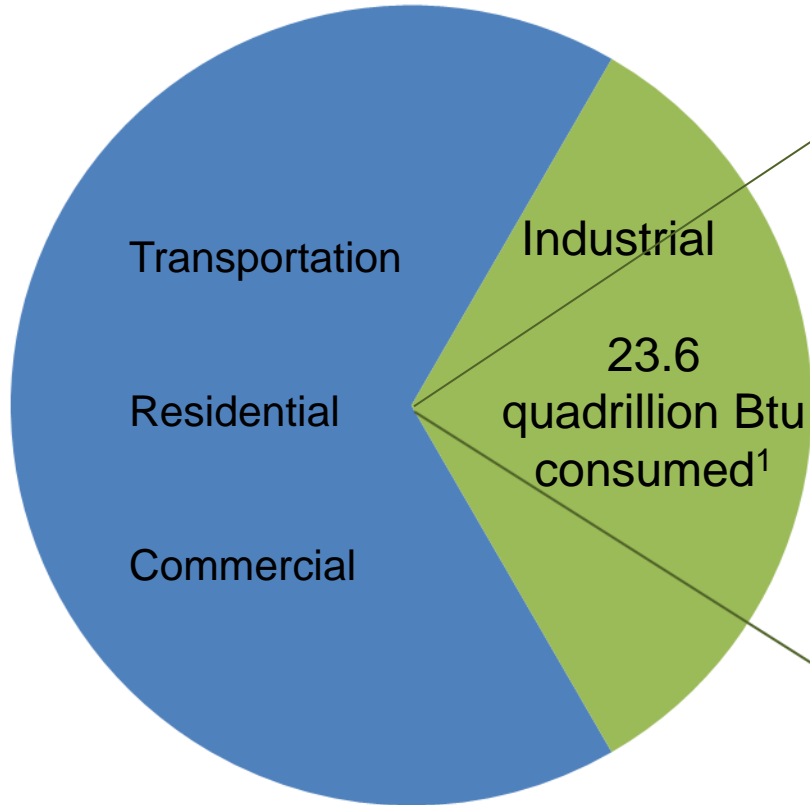
Active with federal, state and regional stakeholders including

- **Congress**
- **Federal agencies including U.S. EPA and U.S. DOE**
- **NARUC**
- **Regional industry and environmental organizations**

Through education and advocacy, HiP is working to get WHP included in federal and state legislation, regulations and programs as an energy efficient power resource that generated electricity with no additional fuel, combustion or emissions.

Waste Heat Could Generate 15,000 MW

Energy Consumption by sector (2012)



Lost Opportunity

20%-50% of energy consumed in industrial sector is lost as waste heat²

- 5-12 quadrillion Btus
- Wasted opportunity = 6,916,477 GWh

Includes manufacturing, agriculture, construction, mining

¹ http://www.eia.gov/forecasts/aeo/er/early_consumption.cfm

² Waste Heat Recovery: Technology and Opportunity in US Industry, Report for US DOE, BCS, 2008



DOE WHP Market Assessment – Key Findings

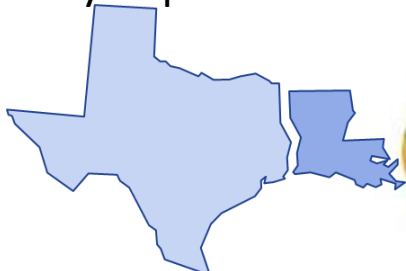
Over 14,500 MW of technical potential at over 2,900 industrial sites

Over 4,000 MW of projects with a payback of three years or less

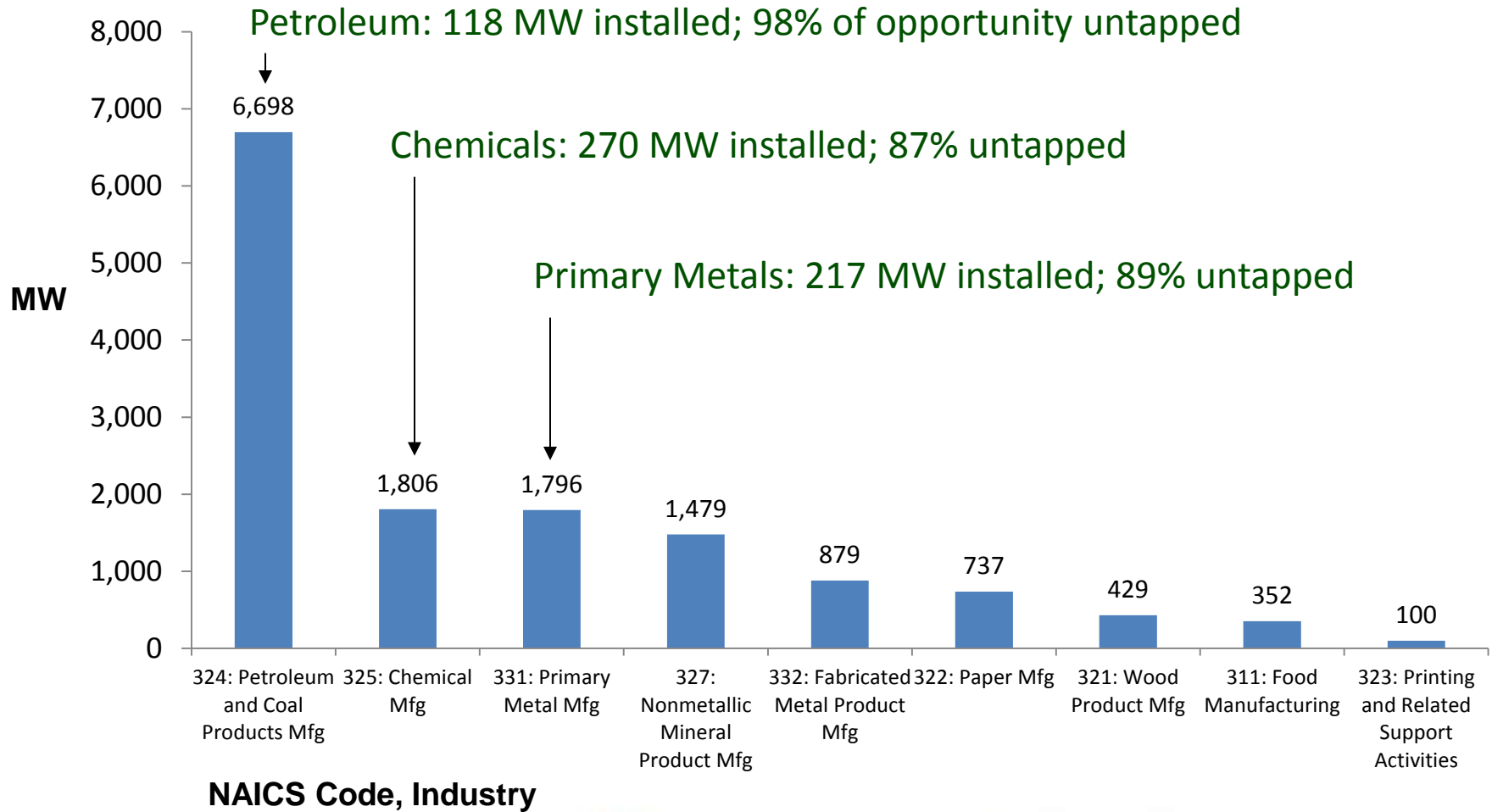


3,500 MW of potential in the petroleum refining sector, nearly 1,500 MW of which could be cost effectively implemented today

3,160 MW of potential opportunities in Texas, California and Louisiana alone, over 1,100 MW of which could be cost effectively implemented today



Potential for Additional WHP Projects



Source: ICF Waste Heat to Power Market Assessment March 2015



Waste Heat-to-Power (WHP) Fuel and Emission Free Power



Environmentally Responsible Distributed Generation



WHP Providers

Alphabet Energy: Thermoelectrics

Cool Energy: Stirling Engines

Cornerstone Sustainable Energy: Thermal hydraulic

ElectraTherm: ORC

Ener-G-Rotors: ORC

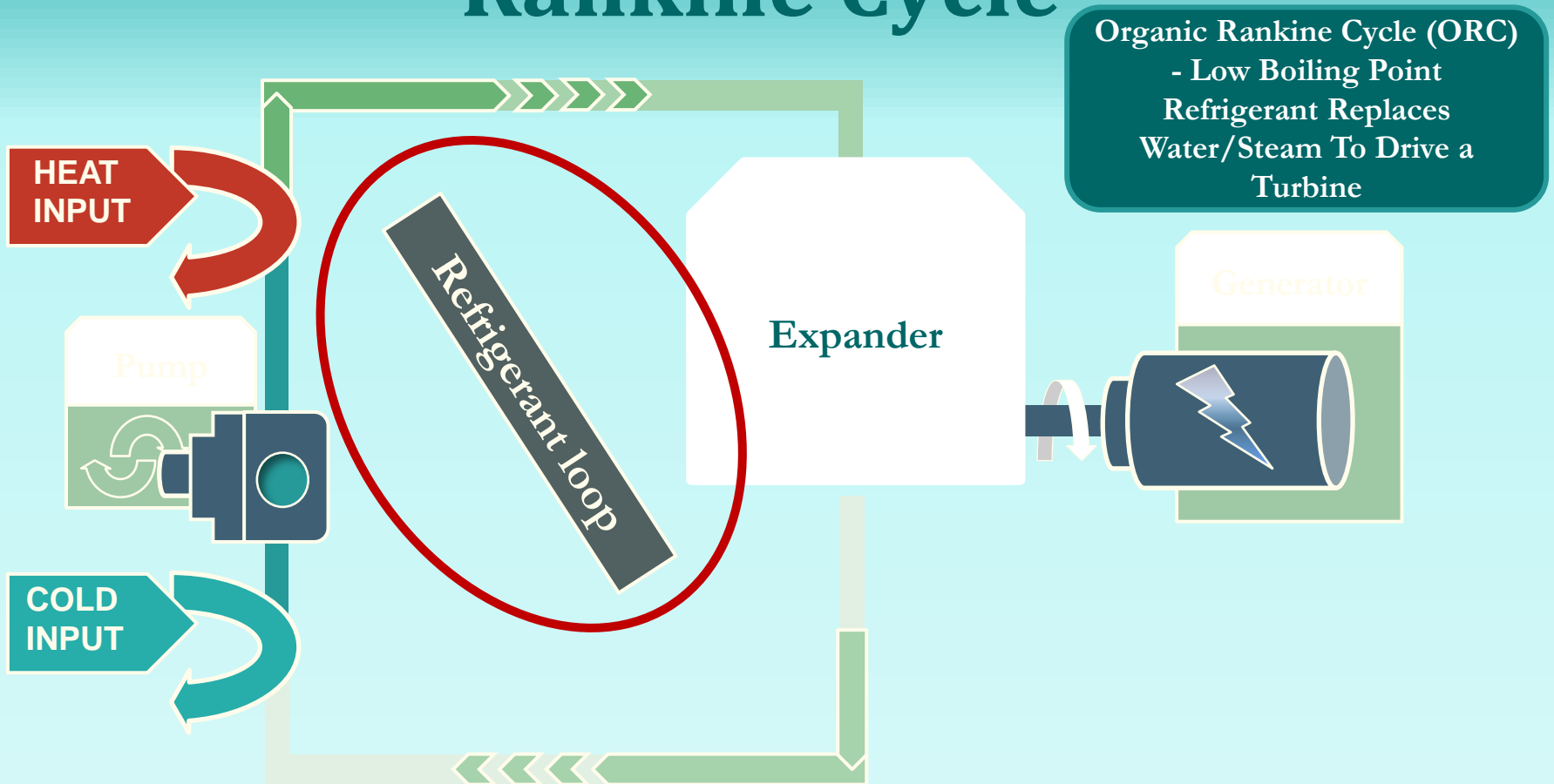
Echogen: Supercritical CO₂

Gulf Coast Green Energy: ORC

Integral Power: Project Developer

Primary Energy: Project Developer

Waste Heat to Power Organic Rankine Cycle



Turbines, screws, and generators used as expanders

Oil and Gas Applications – Co-Produced Fluids

- Co-produced fluids
 - Currently there is cost to cool and separate
 - Source of additional power at well-head
 - Fuel saving at well-head
- Co-produced fluid: 1.2 MM wells
 - Inactive wells: 6MM
- Low temp (180F) capability



Table 1. Co-Produced Geothermal Fluids

Estimated equivalent geothermal power from processed water associated with existing hydrocarbon production, using 140°C (285°F) as a nominal fluid temperature.

State	Total Processed Water, 2004 (bbl)	Power, MW @ 140°C (285°F)
Alabama	203,223,404	47
Arkansas	258,095,372	59
California	5,080,065,058	1169
Florida	160,412,148	37
Louisiana	2,136,572,640	492
Mississippi	592,517,602	136
Oklahoma	12,423,264,300	2860
Texas	12,097,990,120	2785
Total	32,952,140,644 bbl	7,585 MW

Power From Produced Water



Geothermal, Romania



Gross Power Output Avg: **40kWe net**
Thermal Heat Input: **700kWt**
Hot Water Input Range: **105°C**
Hot Water Flow: **10.1 l/s**
Average Ambient Temp: **12°C**

Geothermal, Nevada



Gross Power Output: **up to 75kWe**

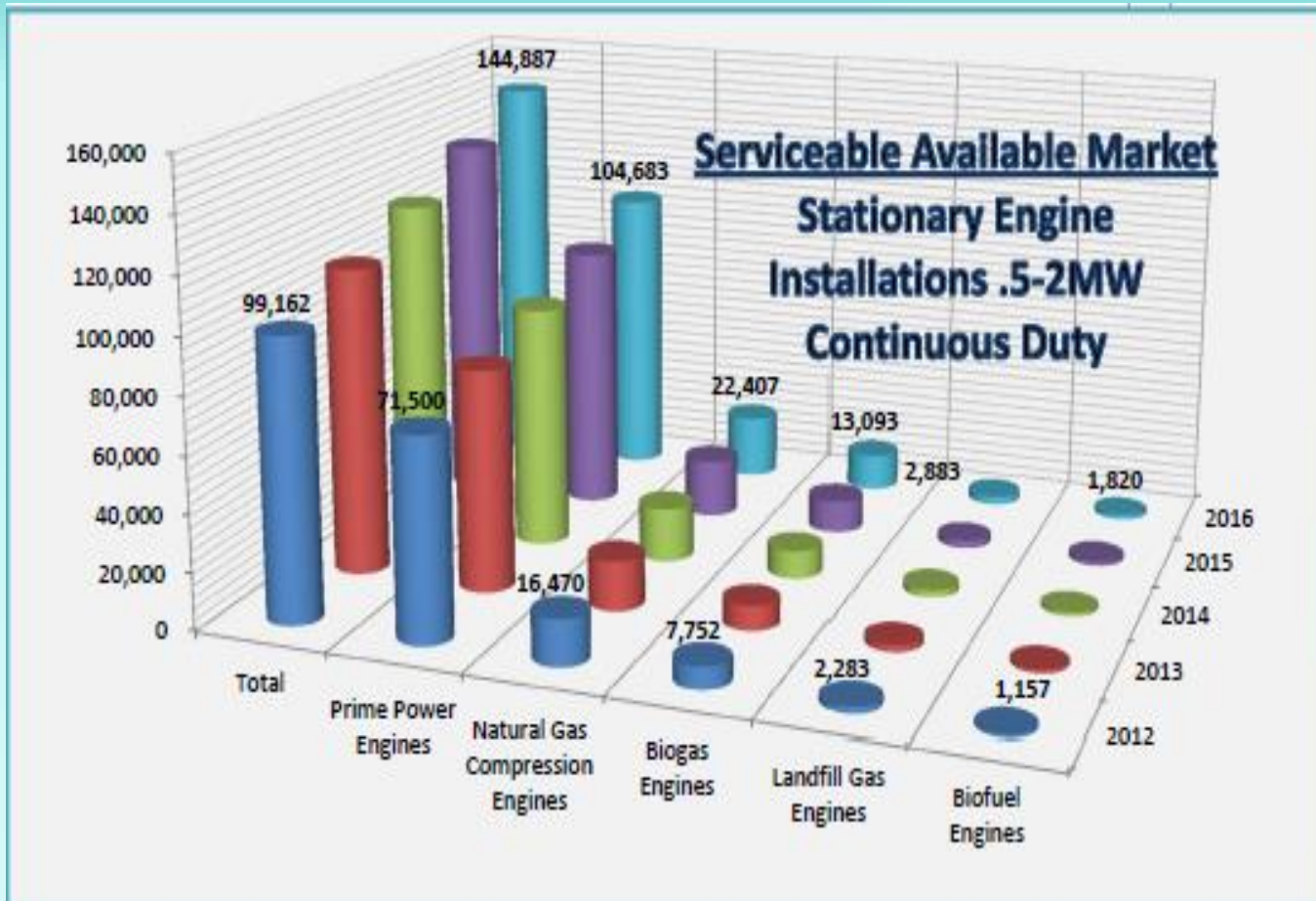
Thermal Heat Input: **660kWt**

Hot Water Input Range: **112°C**

Hot Water Flow: **150 GPM**

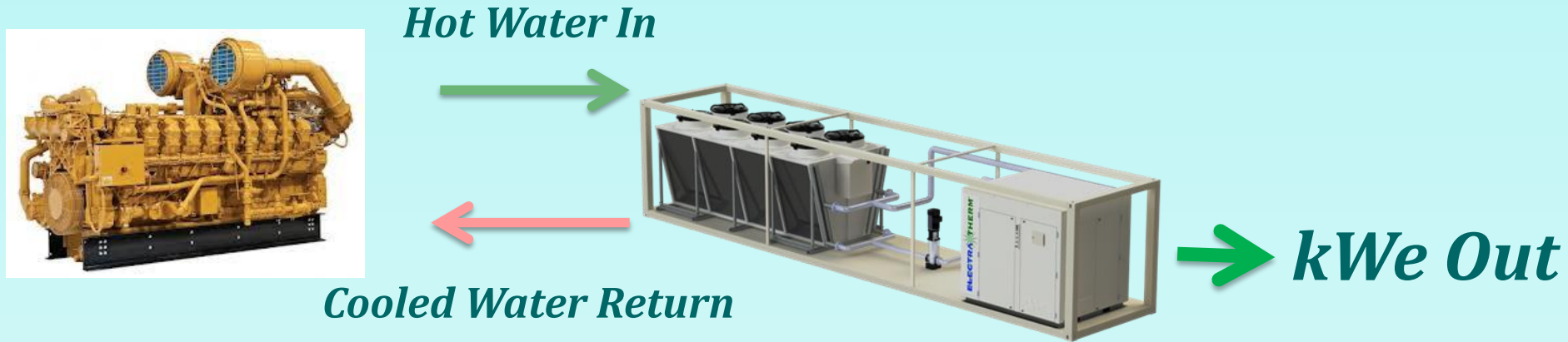
Air Cooled Condenser

Stationary Engine SAM



Sources: Diesel & Gas Turbine Worldwide, AEBIOM, US DOE
Prime Power figures are global; all others NA and Europe

Reciprocating Engines

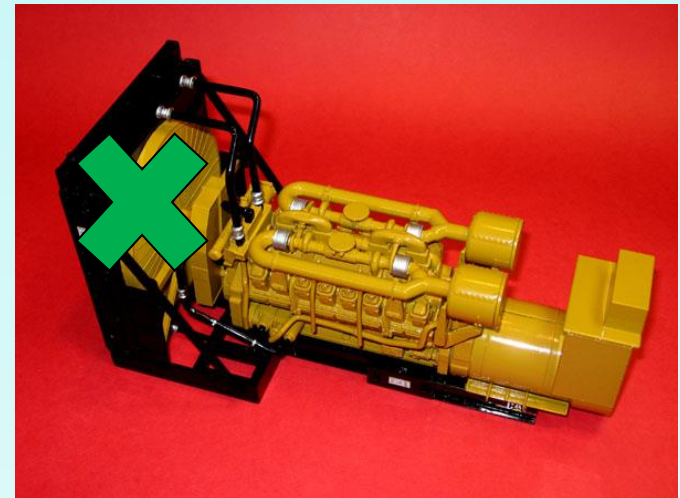


Produce More Power & Reduce Cooling Fan Load

Waste heat from engine jacket water or combination
exhaust & jacket water

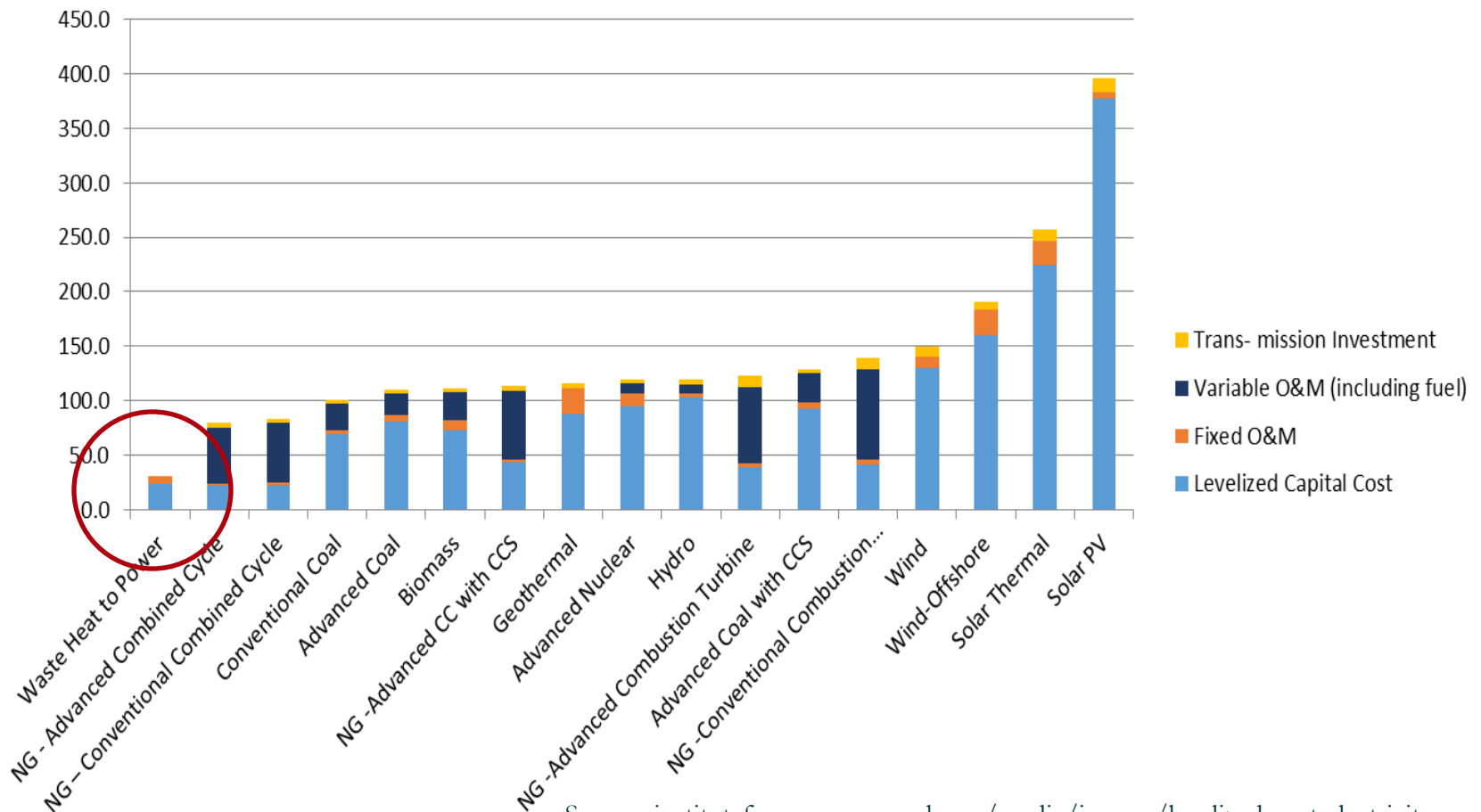
Radiator with a Payback

- **Avoid Radiator Expense** on a Greenfield Project
- **Offset ORC Capex** by 20-30%
- **Decouple Engine from Cooling**
Net Shaft H.P. to Engine = 5-6%
- **Value of kWe:**
Instead of using power from the engine to cool, make power.



Least Expensive Electricity Generation

Levelized Cost Of New Electricity Generating Technologies in 2016
2008\$/Megawatt Hrs



Source: instituteeforenergyresearch.org/media/images/levelized-cost-electricity.png



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The goal is to accelerate the clean energy economy for its national security, economic and environmental benefits.

The initiative promotes the adoption of key changes to U.S. energy policy in four sectors:

- Industry
- Utilities
- Transportation
- Research and Development

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Clean Energy Initiative

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Accelerating clean energy solutions that improve the economy, national security and the environment

Energy is a key pillar of our lives—it runs our cars, charges our computers and powers our factories. Globally, energy use is expected to increase 35 percent over the next 25 years, driven almost entirely by demand due to increases in electricity use and vehicle fleets. The growing need for energy around the world is likely to make it an ever more precious commodity—forcing up prices and increasing global instability. Additionally, the world's energy sector is responsible for approximately 70 percent of global carbon emissions, the direct cause of climate change.

A business-as-usual approach to energy policy threatens global economic competitiveness, national security and the environment. We must fundamentally transform the manner in which we produce, distribute and consume energy if we are to reduce dependence on foreign oil, create jobs, enhance global competitiveness and decrease carbon emissions.

Pump Up the Economy with Fuel Efficient Trucks
SIGN NOW

REPORT: Who's Winning the Clean

DATA VISUALIZATION: Policy Matters: The Future

Focus Areas
Industrial Efficiency
Fuel Efficiency
Energy Innovation

Related Projects
Pew Project on National Security, Energy and Climate

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Industrial energy efficiency in the U.S.

The Problem

Finance is needed to help energy users cover capital costs

The currently available tax credit makes it difficult for projects to qualify and is limited in the scope of eligible technologies

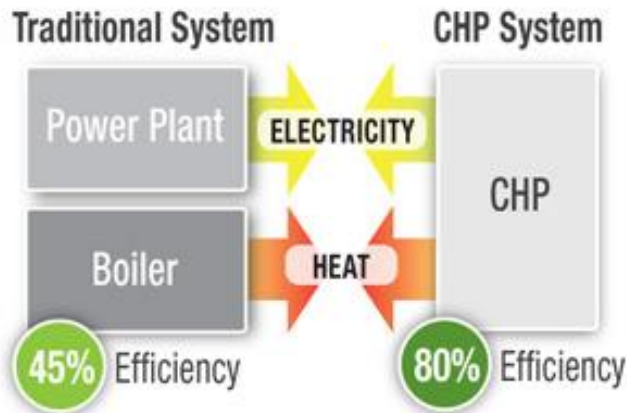
The Solution

The current Investment Tax Credit is in need of changes so as to ensure efficient power generating technologies like combined heat and power (CHP) and waste heat to power (WHP) have **parity** with other clean and efficient technologies in the available energy tax incentives.

Combined heat & power (CHP)

CHP generates electricity and thermal power from a single fuel source.

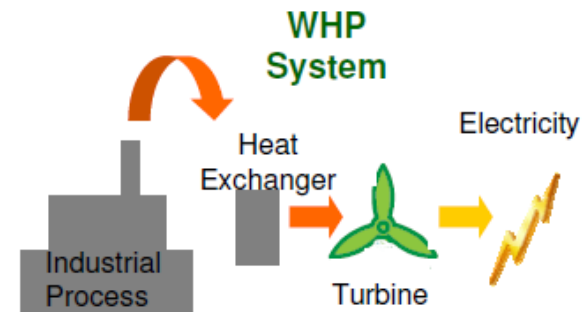
CHP Process Flow Diagram



Source: U.S. Department of Energy

Waste heat to power (WHP)

WHP captures the waste heat off an industrial process to make electricity.



No combustion, No emissions,
No fuel (therefore efficiency
can't be calculated)

Source: Heat is Power

Which waste heat streams qualify for the §48 investment tax credit?



Changes would make the tax credit more accessible

Current Policy	Proposed Policy
10% ITC for CHP	Expand ITC to 30% for CHP
Does not include WHP	Include WHP
Applies to the first 15MW of CHP projects which are smaller than 50MW	Apply to first 25MW, eliminate CHP project size cap
Ends Dec. 2016	Ends Dec. 2018

Senate Bills in the 114th Congress

Adding WHP to the existing tax credit

- Sponsored by Senators Dean Heller (R-NV) and Tom Carper (D-DE in Senate Finance Committee markup of tax bills in early 2015.
- Passed out of committee with one “nay” (Senator Pat Toomey (R-PA)) and is awaiting floor consideration.
- Would make WHP eligible for the existing ITC (10% credit for systems up to 50 MW in size).
- Changes to the credit would take effect on the date of enactment and would expire with the rest of the ITC at the end of 2016.

House Bills in the 113th Congress

H.R. 4916, the Power Efficiency and Resiliency (POWER) Act

Would address all of our recommended changes to the ITC, except extend the credit for 2 years (to 2018)

Rep. Allyson Y. Schwartz, D-PA

Rep. Mark E. Amodei, R-NV

Rep. Kathy Castor, D-FL

Rep. Chris Collins, R-NY

Rep. Joseph Crowley, D-NY

Rep. Christopher P. Gibson, R-NY

Rep. Richard L. Hanna, R-NY

Rep. Joseph J. Heck, R-NV

Rep. Steven A. Horsford, R-NV

Rep. David P. Joyce, R-OH

Rep. Peter T. King, R-NY

Rep. Richard E. Neal, D-MA

Rep. Gary C. Peters, D-MI

Rep. Charles B. Rangel, D-NY

Rep. Thomas J. Rooney, R-FL

Rep. Jon Runyan, R-NJ

Rep. Tim Ryan, D-OH

Rep. Steve Stivers, R-OH

Rep. Dina Titus, D-NV

Rep. Paul Tonko, D-NY

Rep. Peter Welch, D-VT

Rep. Gerald E. Connolly, D-VA

Rep. Chellie Pingree, D-ME

Rep. Carol Shea-Porter, D-NH

Rep. Ron Kind, D-WI

Comparison of Senate & House Bills

Current Law	Proposed Policy	
	The POWER Act	Senate WHP 2015 Action
10% ITC for CHP and geothermal	Expand ITC to 30%, on par with other technologies such as solar	
Does not include WHP	Include WHP as qualifying technology for 30% credit	Include WHP as qualifying technology for 10% credit
Applies to the first 15MW of projects which are smaller than 50 MW	Apply to first 25MW, eliminate project size cap	Applies to projects which are smaller than 50MW
Ends Dec. 2016	Expire Dec. 2018	Ends Dec. 2016

Master Limited Partnerships (MLPs)

Current Policy

- Existing financing tool utilized by oil, propane, pipelines, processors, coal, refineries, fertilizer, and timber industries.
- Business structures that are taxed at the shareholder level instead of the corporate level.
- Expanding MLP access to clean energy can lower soft costs.

Barriers

- Clean energy technologies are excluded for eligibility.

Solution

- **Parity** for clean energy technologies take advantage of benefits

Proposed Policy

- MLPs Parity Act – Senator Coons (D-CT)

Broad, bipartisan support, including:

- Manufacturers
- Large energy users
- Organized labor
- National security organizations
- Environmental organizations

Put One Million Americans to Work

Harness the heat to create new jobs and make our country more competitive.

Each year, America's utilities and factories send enough heat up their chimneys to power all of Japan. But with existing, proven technologies, we can harness that wasted energy, dramatically cut electricity costs, and make our manufacturers more competitive.

According to Oak Ridge National Laboratory, significantly increasing our industrial energy efficiency would spur more than \$200 billion in new private investment in the U.S. and create up to 1,000,000 jobs.*

Learn more about industrial energy efficiency at www.PewTrusts.org/industrialefficiency

475 businesses agree.

*Oak Ridge National Laboratory, Combined Heat & Power: Effective Energy Solutions for a Sustainable Future, 2006.

Paid for by The Pew Charitable Trusts.

Messaging for WHP

Competitiveness

- Cut costs and allow manufacturers to better compete in the global marketplace
- Create as many as 100,000 highly skilled new jobs
- Free resource produced whenever an operation is running
- Produce enough energy to power 11 million homes for a year
- No additional fuel needed, no additional combustion



Waste heat keeps industry powered up.

Industrial processes such as the production of steel, chemicals, paper, oil, and gas use a lot of energy, resulting in significant amounts of wasted heat. With the help of proven waste heat to power, or WHP, technologies, companies can capture that heat and turn it into electricity, producing the same amount that 10 million homes would use in a year.¹ Generating energy using WHP could create more than 100,000 American jobs.²

Tell the Senate to vote "YES" for the amendment to the EXPIRE Act, that would add WHP as a qualifying technology for the Investment Tax Credit.

Some of the many companies using WHP³

Albany County Sewer District (NY)	Highline Electric Association Trailblazer Pipeline (CO)	Northern Border Pipeline Co. (MN, MT, ND, SD)
ArceLorMittal (IN)	IMC Phosphates (LA)	Rain CII (LA)
Covanta (MI, NY)	J.R. Simplot Co. (ID)	Seadrift Coke (TX)
GE (AL)	Kennecott Utah Copper (UT)	SunCoke Energy (OH)
Graymont (PA)	Mosaic Co. (FL)	Valero Energy (TX)
Haverhill Coke (OH)		

¹Environmental Protection Agency, "Waste Heat to Power Systems," 2012.
²Heat is Power Association.
³Department of Energy, Combined Heat and Power Installation Database.

Harness the heat
to save energy, cut costs, and keep the power on.
Learn more about industrial energy efficiency at pewtrusts.org/industrialefficiency.



WHP VIDEO

<https://youtu.be/ZUSjhqqnxEg>



Click graphic to play video

Source: Heat is Power

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