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

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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

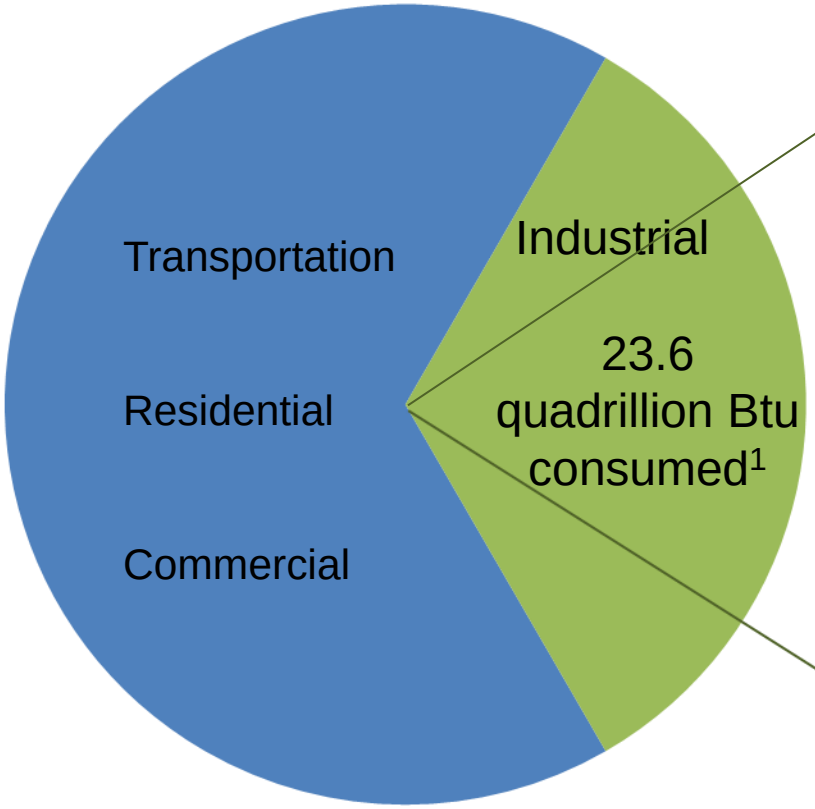
- **Congress**
- **Federal agencies including U.S. EPA and U.S. DOE**
- **NARUC**
- **Regional industry and environmental organizations**

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.

HEAT IS POWER
LET'S CAPTURE IT

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 heat[2]

- 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

WHP Waste Heat to Power

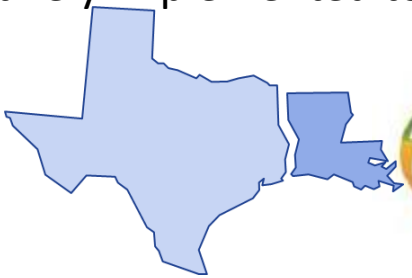
HEAT IS POWER LET'S CAPTURE IT

DOE WHP Market Assessment – Key Findings

Over 4,000 MW of projects with a payback of <u>three years or less</u>

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

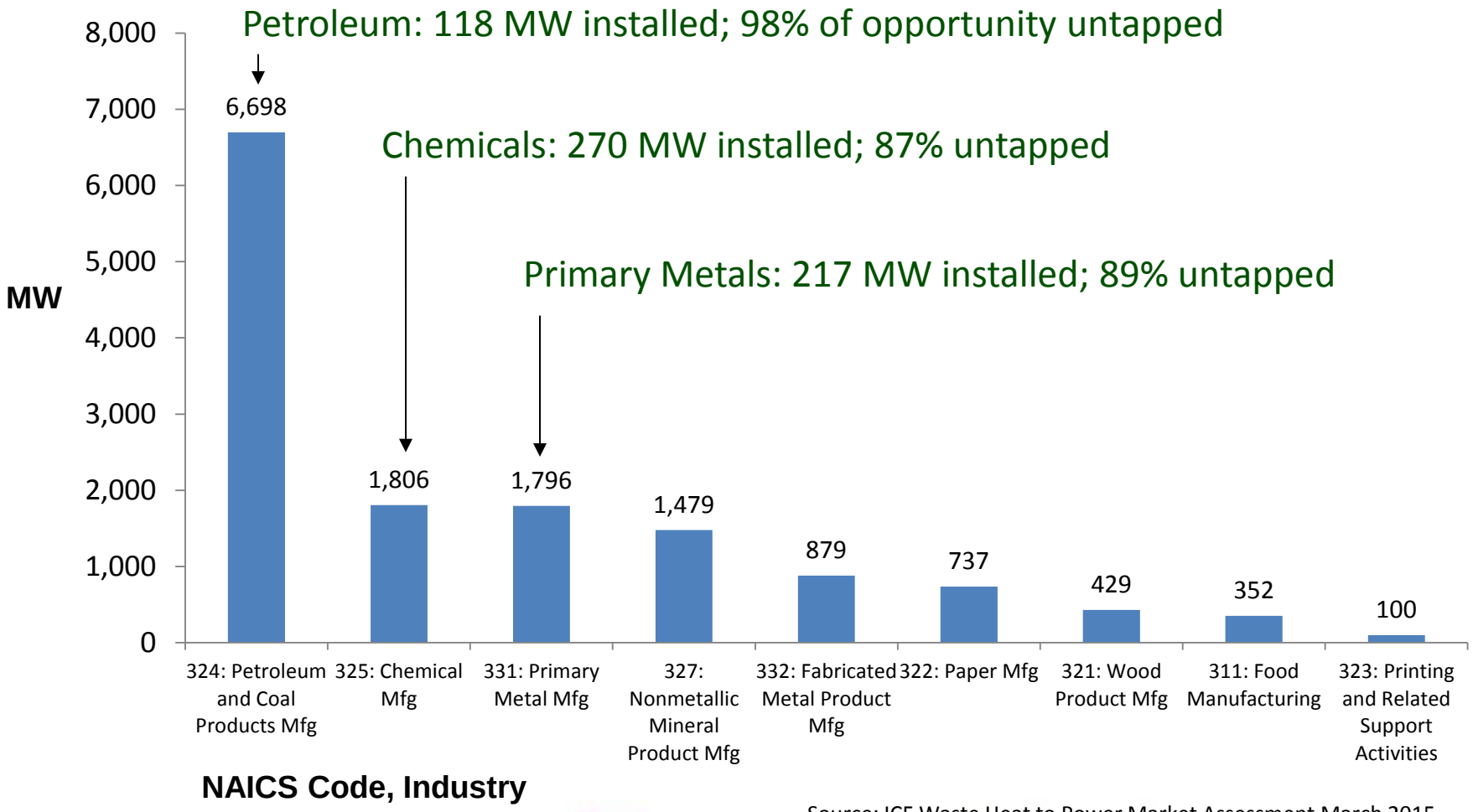
3,160 MW of potential opportunities in Texas, California and Louisiana alone, over 1,100 MW of which could be cost effectively implemented today



WHP
Waste Heat to Power

HEAT IS POWER
LET'S CAPTURE IT

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

GulfCoast GREEN ENERGY

Environmentally Responsible Distributed Generation

GREEN ENERGY™

WHP Providers

Alphabet Energy: Thermoelectrics

Cool Energy: Stirling Engines

Cornerstone Sustainable Energy: Thermal hydraulic

ElectraTherm: ORC

Ener-G-Rotors: ORC

Echogen: Supercritical CO_2

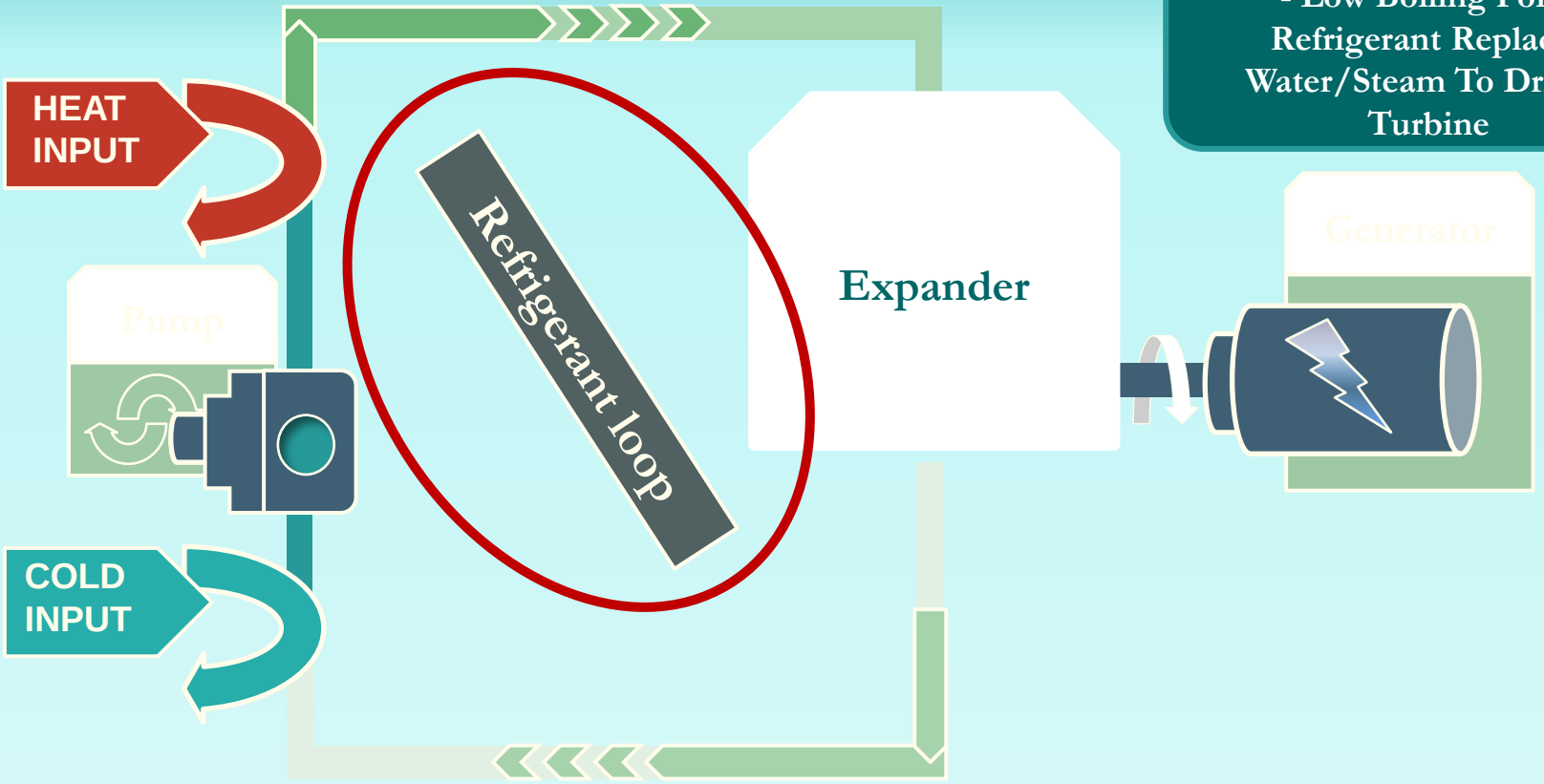
Gulf Coast Green Energy: ORC

Integral Power: Project Developer

Primary Energy: Project Developer

Waste Heat to Power Organic Rankine Cycle

Organic Rankine Cycle (ORC) - Low Boiling Point Refrigerant Replaces Water/Steam To Drive a Turbine



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

Courtesy: Dr. David Blackwell, Southern Methodist University

Power From Produced Water

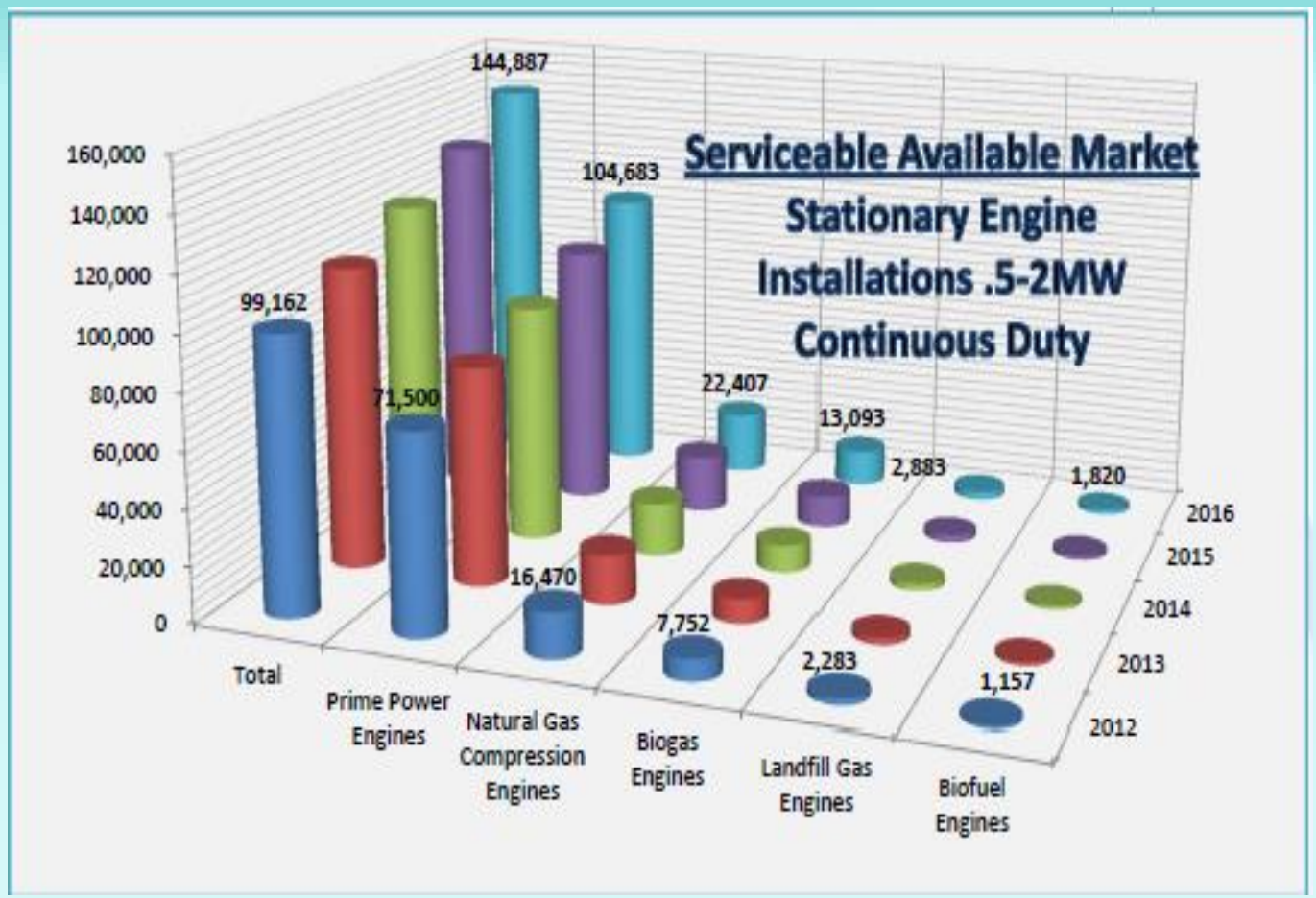
Geothermal, Romania

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

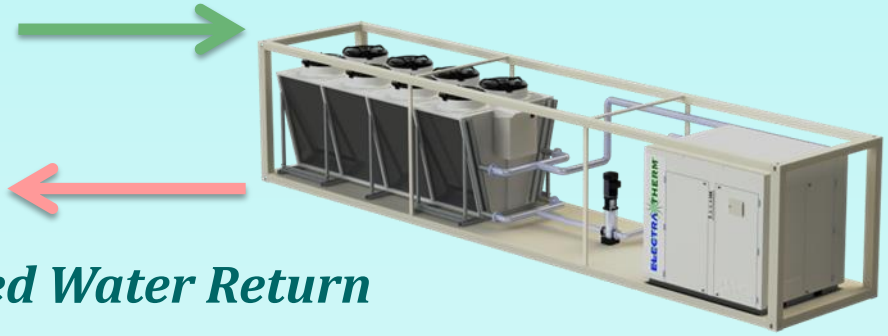
Stationary Engine SAM



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

Reciprocating Engines

Hot Water In



Cooled Water Return

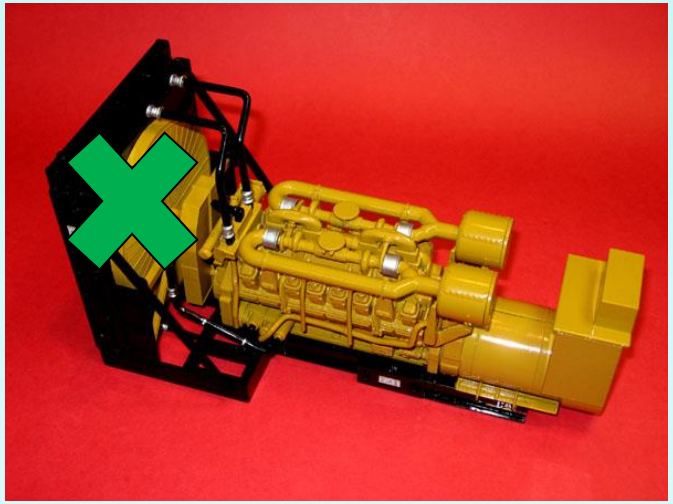
kWe Out

Produce More Power & Reduce Cooling Fan Load

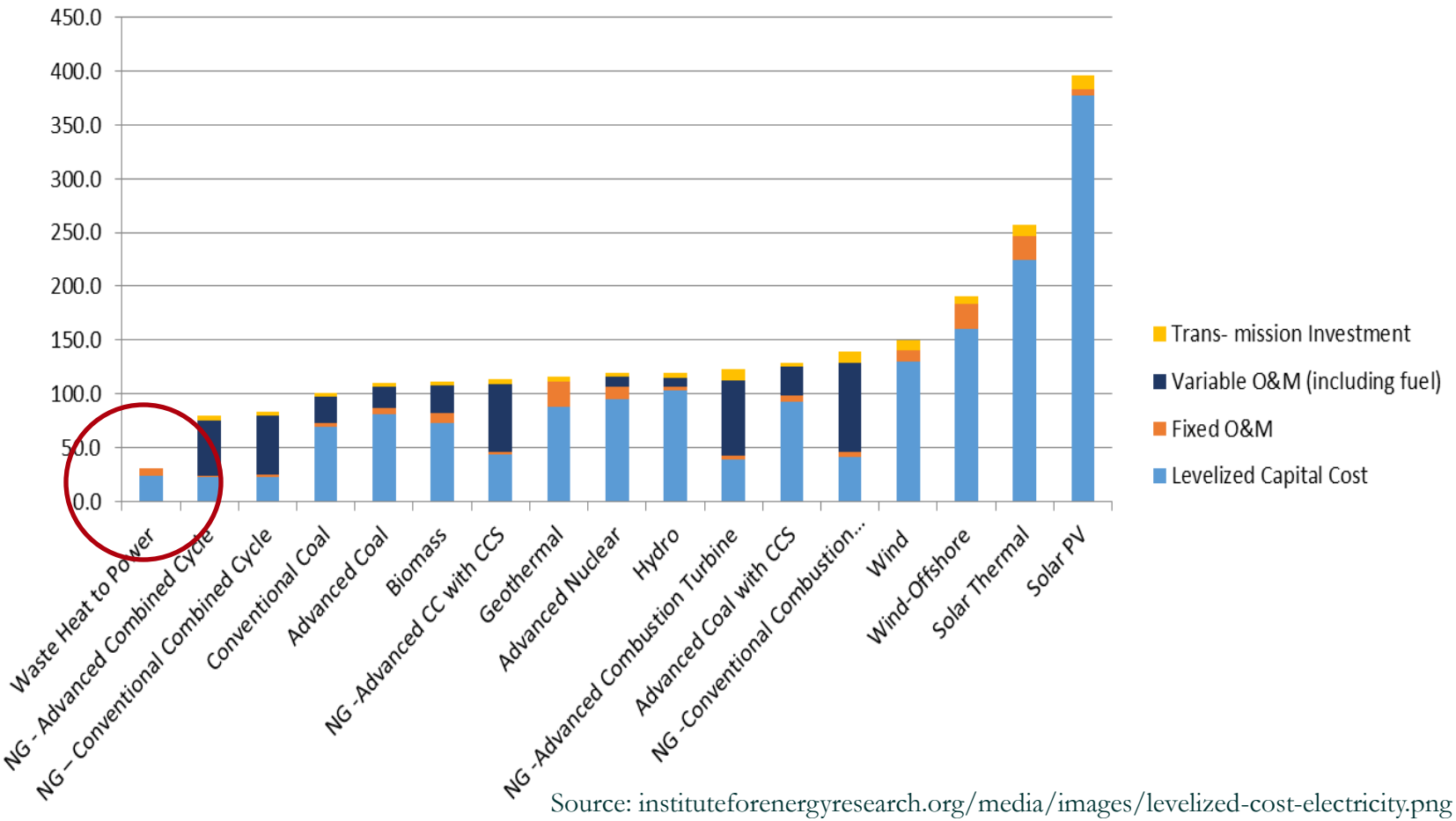
Waste heat from engine jacket water or combination exhaust & jacket water

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



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

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Industrial Energy Efficiency

Making America's power more efficient, resilient and our manufacturing more globally competitive

Pew clean energy initiative

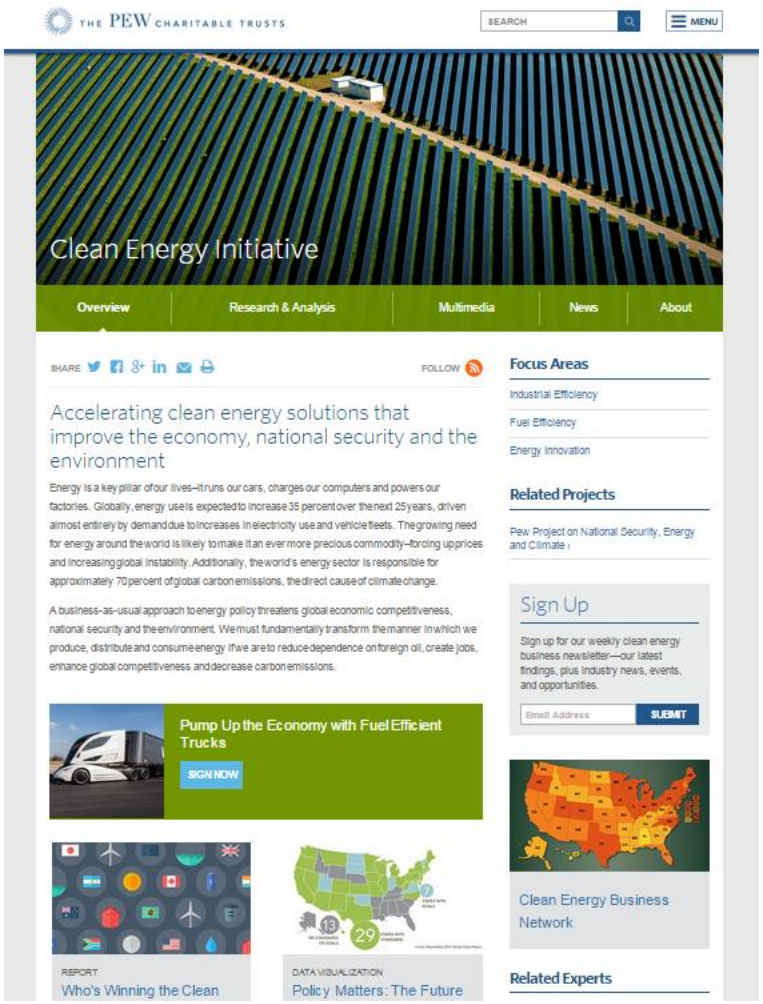
The goal is to accelerate the clean energy economy for its national security, economic and environmental benefits.

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

- Industry
- Utilities
- Transportation
- Research and Development

www.pewtrusts.org/cleanenergy

www.pewtrusts.org/businessnetwork



Industrial energy efficiency in the U.S.

The Problem

Finance is needed to help energy users cover capital costs

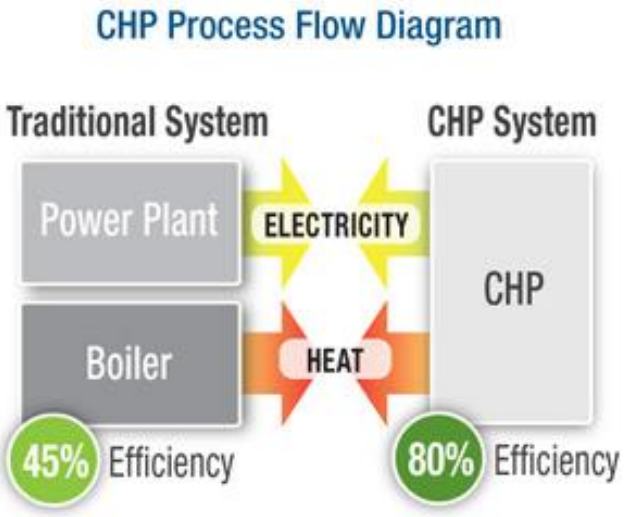
The currently available tax credit makes it difficult for projects to qualify and is limited in the scope of eligible technologies

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)

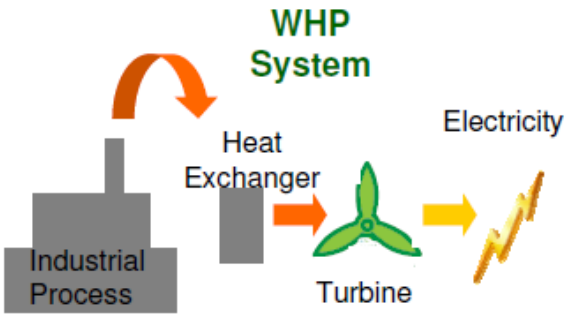
CHP generates electricity and thermal power from a single fuel source.



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 CrowleyD, -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

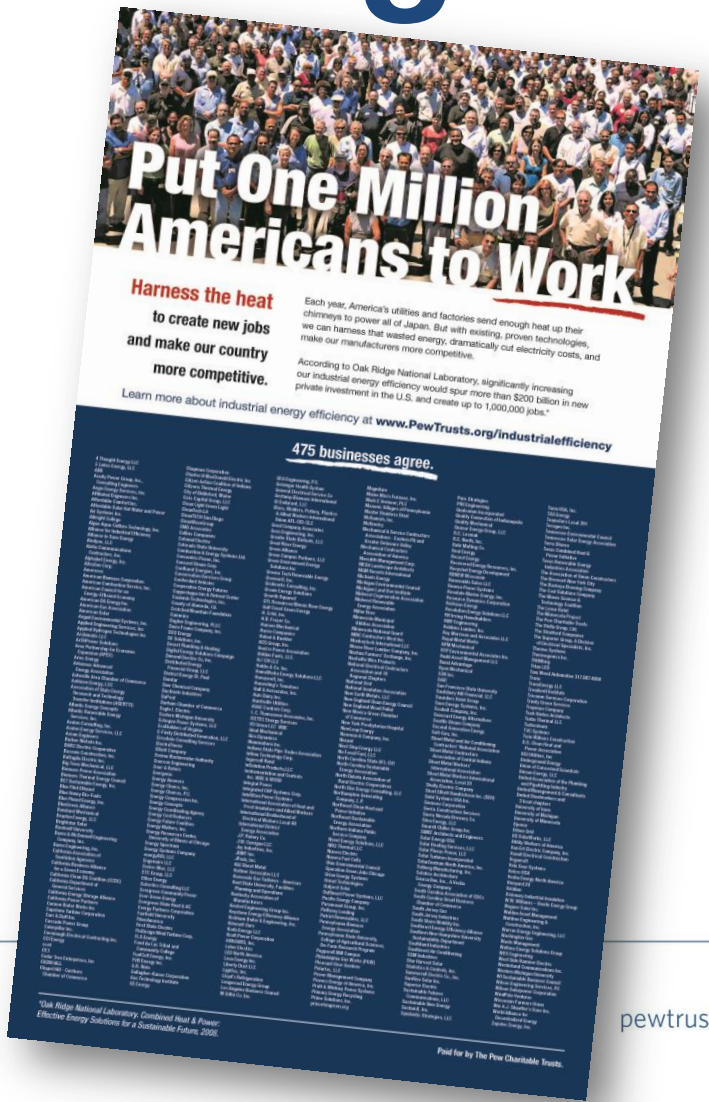
- **Parity** for clean energy technologies take advantage of benefits

Proposed Policy

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

Broad, bipartisan support, including:

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



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

WHP VIDEO

https://youtu.be/ZUSjhqqnxEg

Click graphic to play video

Source: Heat is Power

Questions? Contact:

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