FEBRUARY 14 - 16, 2012
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LONG BEACH, CALIFORNIA
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Waste Heat to Power
An American Opportunity

Kelsey Southerland
Director of Government Relations, TAS Energy
Executive Director, Heat is Power
ksoutherland@tas.com
979.571.8094

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Co-Located Event: SOLAR POWER-GEN
Flagship Media Sponsor: RENEWABLE ENERGY WORLD MAGAZINE NORTH AMERICA
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HEAT IS POWER
LET'S CAPTURE IT

Hidden within American manufacturing and oil and gas processing is a largely unknown form of energy ***redefining renewable…***

Thousands of megawatts of untapped ***zero emission electricity*** *from heat currently wasting into thin air…*

technology exists to capture it today.

Power for 10 Million American Homes/Year

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Waste Heat to Power

Is the generation of zero emissions electricity from heat that is wasted as a byproduct of a process that is not the generation of electricity from a fossil fuel (a.k.a. industrial waste heat)

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Examples of Waste Heat

Industry	Potential MWs
Gas Compression	2,636
Refining	2,211
Chemical	1,650
Paper	924
Marcellus Shale	300
Boilers	371.5
Landfill Gas	365
Steel	330
Lime	271
Cement	240
Metal Casting	166
Glass	154
Aluminum	47.5
Total	**9,666**


Chemical Processing Plant


Refining


Gas Compression


Paper Mill

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Where is It?

Waste heat is most prevalent in the Southeast and Midwest regions of the United States

- Oil and Gas Processing
  - Gas Compressor Stations
  - Refineries
- Industrial Manufacturing
  - Steel, Chemicals, Paper, Cement, Glass, Food Processing

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How it Works

- Heat exchanging process
- Heat is captured by a ‘heat recovery’ unit which looks like a hood, or box attached to piping
- Captured heat directed to flow over a set of tubes containing a liquid fluid, either water or refrigerant
- The heat flowing over the tubes transfers its heat energy to the working fluid.

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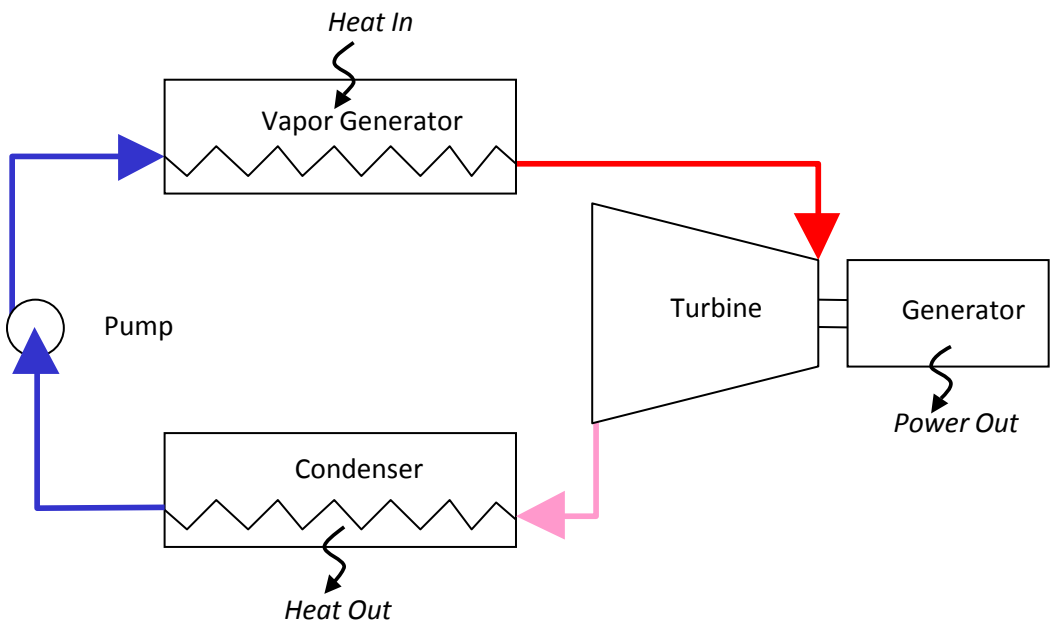

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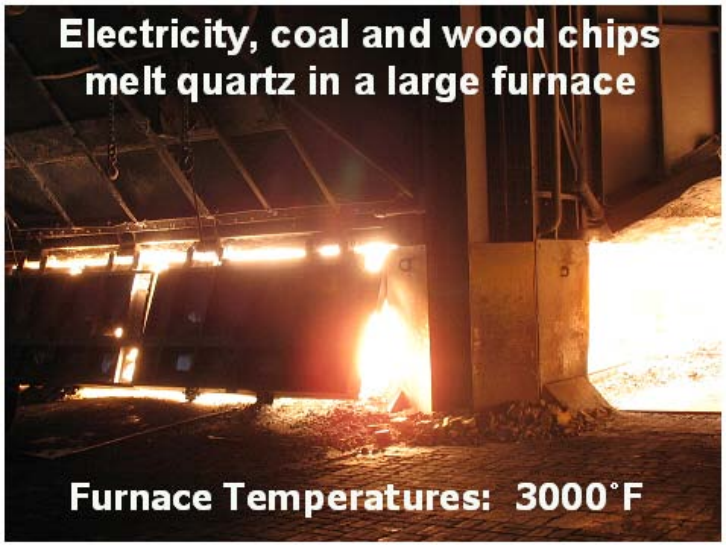
Traditional Technology

Steam: Large scale, high temperatures
MW range



- West Virginia Alloys uses electric arc furnaces operating at 7,000 degree F to melt quartz rock and produce nearly pure silicon.
- The ultra-hot exhaust is typically vented, but RED will install waste heat recovery boilers to recycle the heat into steam, which will drive a turbine generator.

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Innovative Technology

Organic Rankine Cycle: Low temperatures

kw-mw range

- TAS Energy and KGRA Energy will recover 490 F waste heat from Weyerhaeuser's biomass-based thermal drying system to generate 4.5 million kWh of CO2-free electricity per year.
- The project will displace the equivalent of more than 9 million pounds of carbon dioxide each year.

DOE study notes 90% of American waste heat is at temperatures below 800 F ~outside traditional steam turbine range

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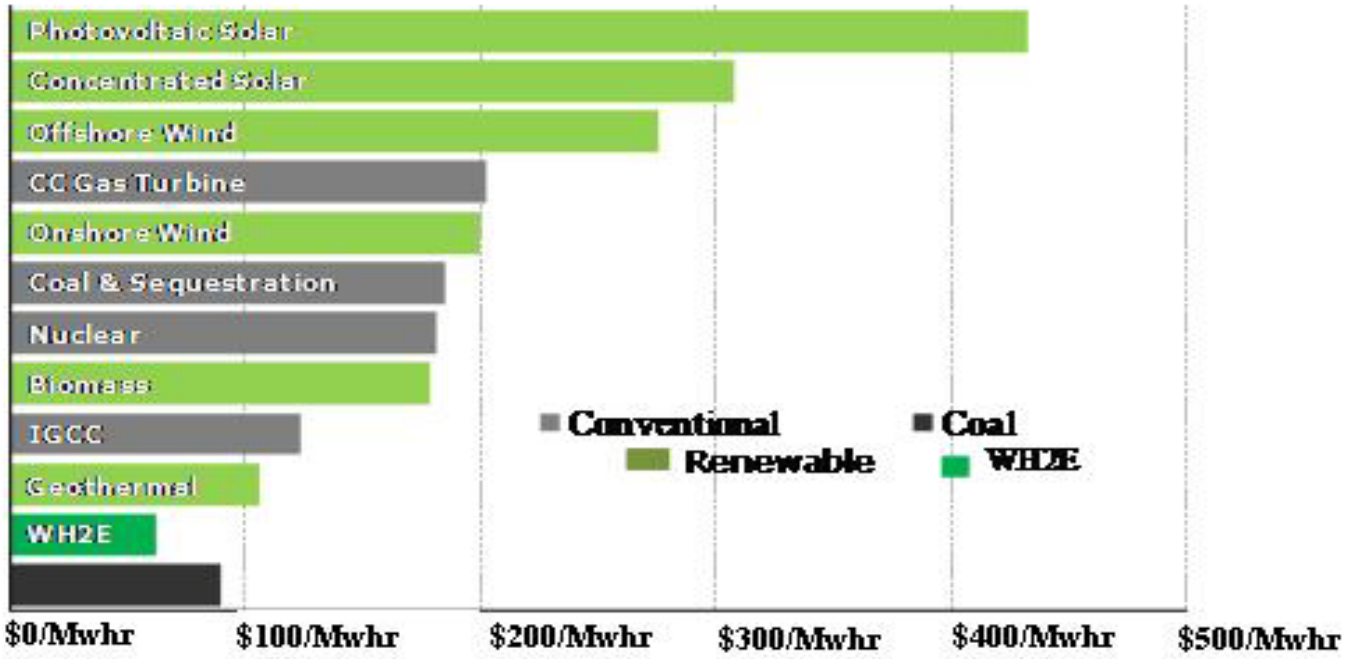
Cost Effective Electricity

- Once in operation, waste heat can generate electricity at a lower price/kwhr than any other new form of electricity generation, including coal



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American Jobs
Industrial Competitiveness

- Conservative estimates of 160,000 new American jobs will be created through developing the U.S. waste heat to power (WH2P) market (based on 4 jobs/$1M)
- Electricity from a free fuel source used onsite or sold to the grid will directly impact an industry's bottom line, keeping American industry (and jobs) in America
- In states with clean/renewable energy mandates, selling (qualified) WH2P to the grid can provide enormous profit opportunities

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U.S. Global Market for Export
Sustained American Manufacturing Jobs

- The supply chain for WH2P technology includes heavy machinery, iron, steel and aluminum, piping, etc- all American expertise products
- American innovators currently manufacture this technology with greater than 90% American content
- No other country has a hold on the global market for exports, leaving the door wide open for U.S. leadership…

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American Components

- TAS Energy's ORC systems are composed of greater than 90% American components
  - Generator from Ohio
  - Turbo expander from Colorado
  - Iron works from Texas

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Modular Technology

Exportable World Wide

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WH2P Recap

- Plentiful (and capture-able) source of emission free electricity
  - *in Southeast and Midwest America, traditionally renewable poor*
- Base-load and often onsite
- Free fuel
- Increased industrial competitiveness (read: American jobs)
- Win/win for industry and the environment
- Potential for U.S. to lead in global exports, with an all American supply chain (read: American jobs)

Power 10 Million American Homes/Year

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What Could Possibly Be The Problem?

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Barriers to Deployment

- Unequal treatment in state and federal legislation, including the tax code
  - Diversion to government recognized resources
- Inconsistent communication among industry

- Industrial favorability in power prices
- High initial capital costs without full commercial deployment
- Perceived technical risk- education needed
  - Lack of awareness of progress with new technology in geothermal
- Power generation is not an industrial's core business
- Incompatible with current utility structure

Impact of Policy

- State by State inconsistency leads to lack of investment in this budding market
- Federal policy recognizing waste heat to power as a renewable will provide clear opportunities nationwide
- In March, China's state owned WH company approached a Texas developer to develop American heat, if we don't, they will

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Inconsistent Industry Communication
Acronym Confusion

CHP: Combined Heat and Power

The sequential generation of useful heat and electricity from a single fuel source (does not include waste heat to power)

— AND/OR—

CHP: Clean Heat and Power

Efficient generation of electricity and heat captured for all useful purposes

(to include traditional combined heat and power and waste heat to power)

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Inconsistent Industry Communication

The Distinctions are Distinctive

Traditional combined heat and power (CHP), although generating electricity more efficiently, results in the emission of new carbon from its process, its fuel source is never heat.

WH2P is a zero carbon resource with heat as its fuel source, sharing characteristics with traditional renewables.

These are important distinctions.

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Heat is Power Association

MISSION

Heat is Power will serve as the voice of the waste heat to power industry to advance the market through education and advocacy

VISION

To see waste heat to power recognized as an emission free power resource and developed into a robust market

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Heat is Power Association

- Provide consistent communication and industry information on behalf of the waste heat to power industry to third parties
- Inform and educate the public, policy makers, media, industry, utilities, and regulators on benefits of waste heat to power development
- Legislation passed on the state and federal level to provide equal market access with other forms of emission free power (traditional renewables)
- Waste heat to power included in all future energy legislation as an emission free resource
- Coalition building within the clean energy community
- Networking and business development opportunities to get projects in the ground

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Heat is Power Association

Steering Members

Participant Members

Step 1: Consistent Terminology

Heat is Power is working with all industry players to be consistent in our use of terminology.

- **Waste Heat Recovery (WHR):** Emission free power generated, or thermal heat captured from the byproduct of industrial processing
  (umbrella term for WH2P and WH2T)
  - **Waste Heat to Power (WH2P):** Emission free power generated from industrial waste heat
  - **Waste Heat to Thermal (WH2T):** Thermal heat captured for useful purposes (such as drying the product) from industrial waste heat

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Successes

- Bipartisan Heat is Power Act Introduced in the House of Representatives
  - Offers 30% ITC and/or 2.1 c/kwhr PTC for waste heat (just like geothermal)
  - Introduced by Ron Paul (R-TX), Paul Tonko (D-NY), Shelly Berkley (D-NV), and Jay Inslee (D-WA)
  - Working to get more Republican cosponsors
  - Looking to see companion bill introduced in the Senate
- California's Self Generation Incentive Program (SGIP) includes "bottoming cycle" waste heat for incentives equal to solar ($1,250/kw)

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Successes

- President Obama visited the headquarters of ElectraTherm, a "Heat is Power" member
- Chair of the White House Council on Environmental Quality toured TAS Energy, a "Heat is Power" member
- EPA recognition of waste heat as 'best available control technology' for greenhouse gas emission regulation
- Increased media coverage "A Hidden Renewable Resource"
- Pew Environment Fund has joined the fight- published "Harness the Heat" ads in all "Hill Publications" before the State of the Union
- President Obama mentioned waste heat/industrial efficiency in State of the Union address

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Immediate Action Needed

- Senate Introduction of Heat is Power Act
- Republican Cosponsors in the House of Representatives
- New Members for Heat is Power Association
  - Reach of Industry, Case Studies, Financial Sustainability, Commission Reports & Educational Materials
- High profile education and awareness events
- Media coverage
- Project demonstrations of innovative technologies
- Support of Ohio Governor to include WH2P in state RES

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