



# Waste Heat Recovery Market Opportunities and Size

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# Opportunities

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- Traditional heat sources (high grade, 1000 F)
- Non-traditional heat sources (low grade, 100 – 400 F)
- Flares
- CO boilers



# Flares

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- 150-billion m<sup>3</sup>/year of gas flared each year, equivalent to total US residential natural gas consumption per year
  - Sources of waste gas include associated gas from wells, fugitive emissions, refinery offgas, petrochem offgas, coal-bed methane, biogas, landfill gas
- Economic value of flare gas is \$20-billion/yr at \$4/MMBtu for gas
- Equipment opportunities include:
  - Flares (not preferred due to wastage of valuable resource)
  - Alternative opportunities (preferred due to utilization of valuable resource)
    - Gas turbines
    - Natural gas reciprocating engines
    - Gas compressors
    - Reinjection for enhanced oil recovery (EOR)
    - GTL plant
- Total Flare market estimated at \$1-billion, but poor long-term growth potential due to EPA regs requiring capture after 2015
  - Texas had 1,950 applications for flare licenses in 2013, up five fold from earlier years
- Suppliers include John Zink, Zeeco, Callidus (Honeywell UOP), others



# CO Boilers

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- CO Boilers are extensively used in refineries in the fluid catalytic cracking (FCC) units to convert carbon monoxide (CO) to CO<sub>2</sub>, and to recover useful heat from the flue gas
- About 2/3rds of the worlds 650 refineries have FCC units
- Total CO Boiler market estimated at \$500-million
- Suppliers include John Zink, Zeeco, Callidus (Honeywell UOP), others



# HRSGs for High Quality Waste Heat

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- The HRSG market for traditional high-quality (high-temperature) waste heat markets is estimated at \$3.2-billion in 2013
- Major country users include the US and China, which combined account for more than 50% of the market
- Major applications include combined cycle gas turbine power generation plants and cement plants
- Market Drivers include the abundance of low-cost shale gas and the growing prominence of combined cycle gas turbine power plants for increased efficiency and reduced GHG generation in the US and the world, and waste heat recovery in cement plants in China



# HRSGs for Low Quality Waste Heat

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- The heat recovery market for non-traditional low-quality (low-temperature) waste heat markets is found in many industries, and uses heated water, heated air, or heated oil as the heat source.
- The heat recovery equipment may include organic rankine cycle HRSGs, or binary fluid (ammonia and water) Kalina Cycle heat recovery vapor generators (HRVGs).
- Total market is currently a fraction of the traditional HRSG market, at less than \$500-million per year, but shows promising growth in geothermal power and other low-quality industrial waste-heat recovery applications.