No. 113/14/2015-GT
Government of India
Ministry of New and Renewable Energy
Block-14, CGO Complex, Lodhi Road, New Delhi-110 003, India
Website : www.mnre.gov.in Telefax : 011-24361298

PUBLIC NOTICE

The Ministry has plan to consider Waste Heat Power generation when hybridized with solar/Renewable energy predominantly as new source of energy thus making it eligible to avail the benefits as applicable to other renewable energy sources.

2. Ministry solicits views/suggestions/objections from the Public and Industry/Associations Stakeholders on the subject matter. Stakeholders may submit their comments/suggestions by post or through email at gkumar.mnre@nic.in or anubhay.mnre@nic.in by 31st December, 2016.

Director, MNRE
WASTE HEAT POWER (WHP)

Introduction

Substantial amount i.e. 20% to 50%\(^1\) of energy input being used by industry is wasted as heat into environment in form of exhaust gases, waste streams of air and liquids leaving industrial facilities. The industrial sector accounted for 44%\(^2\) i.e. 532 billion KWh of total electricity being consumed (1208 billion KWh)\(^3\) in India for year 2015. Even considering 30% of this energy input being wasted by industry accounts to 160 billion KWh annually or equivalent to 20000 MW of coal based power generation capacity. This huge amount of waste heat is caused due to equipment inefficiencies and thermodynamic limitations of the equipment/processes. Hence industrial facilities can reduce these losses by installing Waste Heat Power systems to improve overall equipment/process energy efficiency. Therefore waste heat power (WHP) generation will reduce the energy consumption per unit of production for Indian industries. Also WHP will result in savings of fossil fuels like Diesel/ high grade coal/ furnace oil, etc. mainly used for captive power generation and thereby reducing nation’s GHG emissions.

\(^1\) waste heat recovery - technologies and opportunities in U.S industry, prepared by BCS, incorporated march 2008.


\(^3\) list of countries by electricity production - Wikipediahttps://en.wikipedia.org/wiki/List_of_countries_by_electricity_production

Waste Heat Power Technologies

Waste heat is the energy that is rejected from a process at a temperature high enough to allow recovery of some fraction of energy for useful purpose economically. Technology for WHP is a decade old & proven technology for generating power economically through industrial process heat without additional fossil fuel requirement.

WHP technology coverts industrial process heat into electrical energy by directing hot exhaust gases to waste heat recovery boiler where they exchange heat with working fluid i.e. water/organic fluid, gets converted into high pressure vapour stream which then expands in turbine causing it to rotate and produce electricity. The expanded vapour is condensed into low pressure vapour liquid in water/air cooled condenser and then is recycled back into the boiler to continue the cycle. Unlike other renewable energy sources like wind, solar, wave power which are intermittent in nature and not able to produce power on 24 by 7 basis, WHP on other hand can produce power as long as industrial process is going on with plant load factor up to 80%, thus making it a reliable source of power.

Considering latest advancements in Waste Heat Recovery System Technologies (WHRS) in last decade, it has become possible to harness power from low/Medium temperature heat range i.e. through Organic Rankine Cycle (ORC), Kalina Cycle, etc. from industrial process heat. Waste heat can be classified according to its temperature at which it is discarded from the
process/equipment. Following table shows the classification of heat source along with Commercial waste heat power technologies available along with its limitations:-

<table>
<thead>
<tr>
<th>Temperature Classification</th>
<th>Waste Heat Source</th>
<th>Commercial waste Heat to power technologies</th>
<th>Characteristics of heat source</th>
</tr>
</thead>
</table>
| High (> 600°C)            | 1. Steel electric arc furnace  
2. Aluminium reverberatory Furnace  
3. Copper reverberatory Furnace  
4. Nickel refining furnace  
5. Copper refining furnace  
6. Glass melting furnace  
7. Iron copulas  
8. Coke ovens | • Waste heat boilers and Steam turbines | • High quality heat  
With high heat Transfer rate will Lead to high Power Generation Efficiencies.  
• Chemical and mechanical Contaminants in Heat source are limitations. |
| Medium (250°C to 600°C)   | 1. Gas turbine exhaust streams  
2. Reciprocating Engine exhaust streams  
3. Metal heat treating furnaces  
4. Drying ovens  
5. Baking ovens  
6. Curing ovens  
7. Cement kilns | • Waste heat boilers and Steam turbines (> 250°C)  
• Organic rankine Cycle (< 425°C)  
• Kalina cycle (< 550°C) | • Medium power Generation efficiencies.  
• Chemical and mechanical Contaminants in Heat source such as cement kilns Are Limitations. |
| Low (< 250°C)             | 1. Industrial boilers  
2. Ethylene furnaces  
3. Steam condensate  
4. Cooling water from IC engines  
5. Cooling water from furnace doors  
6. Cooling water from air compressors  
7. Cooling water from annealing furnaces  
8. Low temperature ovens  
9. Hot process liquids | • Organic rankine Cycle (>150°C)  
• Kalina cycle (>100°C) | • Low quality heat as energy is contained in numerous small sources that will lead to low power Generation efficiencies.  
• Acid Concentration in heat source are limitations for Heat recovery. |
World Scenario

The estimated USA waste heat power potential from industrial process heat available at a temperature high enough for power generation i.e. above 300°C with present technologies is 6,000 to 8,000 MW\(^4\) of electrical generation capacity. The estimated USA waste heat power potential from Non-industrial process heat available like exhaust from natural gas pipeline compressor drives and landfill gas engines, etc. is additional 1,000 to 2,000 MW of electric power capacity, hence total waste heat power potential is 7 to 10GW. Total installed capacity of waste heat power plants in USA is 557 MW as of 2012 where WHP is considered as renewable energy source in 17 US states renewable portfolio standards.

The estimated European Union (EU) waste heat power potential for the industrial sectors accounts for approximately 20 TWh\(^5\) of electric energy. This value represents 4.8% of total electricity consumption of EU industry in 2009 and implies avoided emissions of almost 7.5 million tonnes of CO\(_2\). The European Union funded the first Italian pilot power plant project based on waste heat power in highly energy-intensive industries like cement, glass, steel, etc. using the ORC technology with 0.5-10 MWh\(_e\) power generation size.

\(^4\) Combined heat and power partnership, prepared by U.S Environmental protection agency, May 2012

Indian Scenario

There is a significant potential for power generation through waste heat power in India as Indian industries are much less energy efficient as compared to other advanced countries. Maximum potential for WHP is in industrial sector which is highly energy intensive sector. Currently waste heat power based power plants are mainly installed in cement plants throughout India with installed capacity at 80.82 MW\(^6\) at 11 different locations as of 2014. Recently 13.22 MW waste heat power plant was commissioned at Awarapur cement works, Maharashtra by Ultra tech cement having 9500 TPD capacity. Other few waste heat power plants have been installed in glass industry, steel plants, etc. in last few years. Applications of Waste heat power systems in selected industrial sectors along with their approximately estimated WHP potential in India are as follows:

<table>
<thead>
<tr>
<th></th>
<th>Cement Manufacturing</th>
<th>1100</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Glass Manufacturing</td>
<td>50</td>
</tr>
<tr>
<td>3</td>
<td>Iron and steel manufacturing</td>
<td>800</td>
</tr>
<tr>
<td>4</td>
<td>Aluminium production/ Alumina industry</td>
<td>100</td>
</tr>
<tr>
<td>5</td>
<td>Metal casting/ foundries</td>
<td>150</td>
</tr>
<tr>
<td>6</td>
<td>Breweries/ Food industry</td>
<td>250</td>
</tr>
<tr>
<td></td>
<td>Activity</td>
<td>Potential (MW)</td>
</tr>
<tr>
<td>---</td>
<td>----------------------------------------------</td>
<td>----------------</td>
</tr>
<tr>
<td>7.</td>
<td>Petroleum refining (distillation/thermal cracking)</td>
<td>500</td>
</tr>
<tr>
<td>8.</td>
<td>Chemical industry</td>
<td>100</td>
</tr>
<tr>
<td>9.</td>
<td>Natural gas compressor stations</td>
<td>50</td>
</tr>
<tr>
<td>10.</td>
<td>Landfill gas energy systems</td>
<td>50</td>
</tr>
<tr>
<td>11.</td>
<td>Ceramic industry</td>
<td>150</td>
</tr>
<tr>
<td>12.</td>
<td>Pulp and paper industry</td>
<td>50</td>
</tr>
<tr>
<td>13.</td>
<td>Caustic Soda</td>
<td>400</td>
</tr>
<tr>
<td>14.</td>
<td>Industrial boilers/commercial sector</td>
<td>250</td>
</tr>
<tr>
<td>15.</td>
<td>Miscellaneous industrial sectors</td>
<td>1000</td>
</tr>
<tr>
<td>16.</td>
<td>Total potential for WHP</td>
<td>5000</td>
</tr>
</tbody>
</table>

Approximately estimated potential in selected industrial sectors for waste heat power generation is around 5000 MW.


**Benefits of WHP**

Installation of WHP in energy intensive industries can lead to major benefits as stated below:-

- WHP system can save energy costs per unit production by using industrial process heat for generating electricity and variety of other process applications such as preheating combustion air, generating hot water/steam in boiler, etc.
- Installation of waste heat power systems for captive power generation can cater up to 20-40% of power consumption for a given industry.
- Electricity generated from waste heat power can displace power from sources that generate emissions i.e. coal based thermal power plants.
- Industrial Process heat is an important source of power which provides the efficient utilization of resources/fossil fuels and also reduce carbon emissions. Waste heat power plant reduces its consumer’s reliance on fossil fuel based power generation.
- Generation of electricity from WHP does not add any carbon dioxide or heat in the atmosphere. Emission/temperature levels remains almost same even with increased generation capacity of electricity without using fossil fuels.