

Trainer Instructions: Waste Heat Recovery

From: *Energizing Cleaner Production – a Guide for Trainers, UNEP/InWEnt, 2007*

Title	WASTE HEAT RECOVERY
Objective	To obtain an understanding of waste heat recovery, including the types of waste heat recovery equipment, how to assess their performance and the main areas for energy conservation.
Minimum duration and approach	<ul style="list-style-type: none"> ▪ 1 session (1.5 hours), including the quiz and workshop exercise ▪ Recommended approach: spend maximum 50 minutes on the PowerPoint presentation, and then go through the quiz as group in 10 minutes. Give participants 20 minutes to complete the workshop exercise and leave 10 minutes to go through the answers. ▪ Presentation: 32 slides ▪ Textbook chapter: 18 pages
Contents	<ul style="list-style-type: none"> ▪ Introduction ▪ Types of waste heat recovery equipment ▪ Assessment of waste heat recovery ▪ Energy efficiency opportunities
Assessment of participants	<ul style="list-style-type: none"> ▪ Pose questions during the presentation. ▪ Take the quiz with 10 multiple choice questions. ▪ Carry out the workshop exercise. Participants can be asked the following: <p><i>A reheating furnace has two burners that use furnace oil (FO). Combustion air is supplied directly at ambient temperature of 350C. The company plans to install a recuperator to recover waste heat from the flue gases to preheat the combustion air to 3000C.</i></p> <p><i>Calculate the annual furnace oil savings using the following data:</i></p> <ul style="list-style-type: none"> - % O₂ in flue gas: 6 % - Density of furnace oil (FO): 0.9 kg/liter - Annual FO consumption: 750 tons - Specific heat of air(@ 300 0C): 0.246 kCal/kg 0C - Stoichiometric air to Fuel ratio: 14 kg air /kg of furnace oil (theoretical air requirement) - Furnace efficiency: 20 % - GCV of furnace oil: 10200 kCal/kg - Cost of furnace oil US\$ 350/ton

	<p>If participants have difficulties completing this exercise, provide the steps and/or formulae they may need to carry out calculations.</p> <ul style="list-style-type: none"> - <i>Percentage excess air (EA) = $[\% O_2 / (21 - \%O_2)] \times 100$</i> - <i>Actual air requirement = $(1 + \text{excess air} / 100) \times \text{theoretical air requirement}$</i> - <i>Heat recovery = $(\text{Actual air} \times C_p \times \text{Temperature difference}) / \text{Furnace efficiency}$</i> - <i>Annual FO savings = $(\text{Heat recovery} \times \text{annual FO consumption}) / \text{GCV of fuel}$</i> - <i>Annual monetary savings</i>
<p>Other comments</p>	<ul style="list-style-type: none"> ▪ Case study options from www.energyefficiencyasia.org or other sources could be included in this session as illustrations of how other companies reduce energy consumption and costs. ▪ If there is limited time, it is possible to leave out the waste heat recovery session, because it is also covered in the other thermal equipment sessions as an energy efficiency opportunity. In that case, also remove the quiz and workshop.