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GREENHOUSE CHALLENGE PLUS



ENERGY AUDIT TOOL BOILERS + STEAM SYSTEMS

04



Australian Government
Department of the
Environment and Heritage
Australian Greenhouse Office



ENERGY AUDIT TOOL

BOILERS AND STEAM SYSTEMS

04



Contents

- __01 Overview
- __02 A: Background Information
- __03 B: Energy Audit Checklist
- __11 C: Energy Efficiency Action Plan
- __13 D: Resources

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Effective management of your organisation's energy usage is good business sense. It can produce both environmental and economic benefits – and importantly reduce your greenhouse gas emissions.

The Greenhouse Challenge Plus Energy Audit Tool has been developed to assist non-technical or semi-technical energy managers in small to medium organisations:

- identify actions to improve energy efficiency through the use of a simple but detailed audit checklist; and
- develop plans for implementing energy efficiency actions.

The checklist contains notes supplying the auditor with further explanation or hints on how to complete the tasks. It should be possible to complete the majority of tasks through simple observation.

The energy efficiency action plan – can also be utilised in the preparation of or alternatively form part of your organisation's annual progress report to the Greenhouse Challenge Plus programme—which details abatement actions.

The energy audit tool has been designed as a modular system. This means that you can utilise each of the volumes as stand-alone independent units or in combination with the other units.

This is *Volume 04 — Boilers and steam systems* of the Greenhouse Challenge Plus Energy Audit Tool, which includes the following 11 volumes:

- Volume 01** — Lighting (indoor and outdoor)
- Volume 02** — Lighting control
- Volume 03** — Chillers
- Volume 04** — Boilers and steam systems
- Volume 05** — Ventilation systems
- Volume 06** — Airconditioning systems
- Volume 07** — Office equipment
- Volume 08** — Domestic hot water
- Volume 09** — Building insulation
- Volume 10** — Infiltration (air leakage into buildings)
- Volume 11** — Compressed air

Your challenge to reduce energy consumption and greenhouse gas emissions starts now!

Need more information?

If you require additional information about the Greenhouse Challenge Plus Energy Audit Tool, contact your Industry Adviser on 02 6274-1229 or at email greenhouse@greenhouse.gov.au. Additional copies of the Greenhouse Challenge Plus Audit tool can also be downloaded from www.greenhouse.gov.au/challenge

A:

BACKGROUND INFORMATION

Steam is used in a variety of industries to transfer heat, because it is able to store heat in considerable quantities, and the heat can be given up at a constant temperature as the steam condenses. Steam is also used as a source of energy to power mechanical plants and equipment, to heat buildings and raw materials and to treat semi-finished products.

More energy is lost in industry through steam wastage than through any other medium. Research studies by industry experts in the early 1990s suggest that losses from steam systems make up approximately 35% of all identified potential energy savings on a site. Optimising steam production and distribution can therefore improve site efficiency and performance significantly. For process industries that require heating, boilers can account for 20 to 60% of total energy costs.

This volume will examine boilers and common steam distribution systems used for applications such as building heating. Steam is produced in two types of boilers:

- a) water tube boilers — used mostly for power generation and industrial applications where extremely high heat transfer rates are required.
- b) fire tube boilers — more typical industrial and commercial boilers where lower heat transfer rates are required. These boilers are commonly used for generating steam for heating buildings.

This volume will encourage consideration of the whole steam system: ‘upstream’ inefficiencies that will affect costs of producing steam, and ‘downstream’ inefficiencies like leaks, bad traps, or poor load control that result in a higher steam-demand than necessary.

Each question in the energy audit checklist, which follows, has a space where you can write your energy efficiency improvement ideas. You should refer to the explanatory notes when considering what can be done to improve energy efficiency. You may need to take additional notes and attach them to the checklist, or attach other relevant documentation (such as instruction sheets and site plans) in order to support your improvement ideas and completely document your audit.

Remember these are ideas, not decisions. When you have completed the energy audit checklist, select the energy efficiency improvements that are viable and enter them into the energy efficiency action plan in section C of this volume.

OPERATION AND USE

QUESTION 1: What types of boilers are used on the site?

- Water tube boilers
- Fire tube boilers
- Other:

Improvement ideas and notes:.....
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→ The main types of boilers are mentioned above. Water tube boilers are usually used in large industrial and power generation situations where extremely high heat transfer rates are required. The water is heated in tubes and the fire (combustion process) is contained in the space around the tubes. Fire tube boilers are used in the more typical industrial and commercial boilers, which generally require lower steam generation or have limited space. In this case the hot combustion gases are contained inside tubes within the boiler and the water is circulated around these tubes.

MAKE SURE YOU: Contact maintenance personnel or the manufacturer to determine boiler type.

QUESTION 2: Are steam generation units turned off when not in use?

- Yes No
- If so, when does this occur?
- Overnight
 - Holiday periods
 - Long weekends
 - Other:

Improvement ideas and notes:.....
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→ Turn off steam generation units when not in use. Consider shutdown timers that shut off a steam generation unit when running unloaded for a nominated time period. Operating procedures may also stipulate that units be shut down for periods of non-use.

MAKE SURE YOU: Consult maintenance or operational personnel.

B: ENERGY AUDIT CHECKLIST



QUESTION 3: Do operating procedures ensure steam is used only where necessary?

Yes No

If no, which activities do not need to use steam?Improvement ideas and notes:

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Improvement ideas and notes:.....

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→ Replace steam production with alternatives wherever possible (such as changing from steam heating to hot water heating, or using high pressure water cleaning instead of steam cleaning). Operational procedures (documented or verbal) should ensure that steam is only used for those purposes that require it.

MAKE SURE YOU: Examine the activities on the site using steam to determine whether alternatives may be used.

STRUCTURE

QUESTION 4: Are steam generating systems designed as modular units where parts of the system can be isolated?

Yes No

Improvement ideas and notes:.....

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→ As centralised steam systems often need extensive pipework reticulation which may give rise to large scale heat losses, such systems should be designed as modular units where possible, with isolation points allowing independent operation of different parts of the system. Installation of an additional primary heating circuit allows you to isolate secondary heating circuits for areas of the building that are not in use. A number of smaller steam generation plants located near the steam loads may also increase efficiency. Alternatively, if the site has a number of smaller steam generation units located close together, it may be more energy efficient to utilise a centralised unit.

→ Optimise energy efficiency by matching size and number of operating boilers to the given load.

MAKE SURE YOU: Consult maintenance or engineering personnel. Different sized boilers on the site connected to each other via pipework may indicate a modular design.

QUESTION 5: Has a timer been installed to control boiler sequencing?

Yes No

Improvement ideas and notes:.....
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→ Boiler sequencing timers should be installed to allow boilers to be sequenced according to variations in the heating load. Larger units will be operated during peak periods and smaller machines in periods of low-demand.

MAKE SURE YOU: Consult maintenance or engineering personnel, or the operating manual for the boiler.

QUESTION 6: Are there any excessive lengths of pipework associated with the steam generation systems?

Yes No

If no, which activities do not need to use steam?Improvement ideas and notes:.....
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Improvement ideas and notes:.....
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→ Reduce the length of pipework associated with steam generation systems wherever possible to minimise heat losses through evaporative cooling and other effects. For example, pipework servicing unused areas of the building like vacant offices reduces efficiency.

→ Distribute steam at the highest possible pressure, minimising the required size of pipework and subsequent heat losses from larger diameter pipework.

QUESTION 7: Are variable speed motor drives (VSD) used on any boilers?

Yes No

Improvement ideas and notes:.....
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→ Consider VSD for heating system circulation pump sets, as they reduce energy consumption.

MAKE SURE YOU: Consult maintenance or engineering personnel or the boiler's operating manual.

B: ENERGY AUDIT CHECKLIST



QUESTION 8: Do any boilers have automated load controls?

Yes No

Improvement ideas and notes:.....
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→ Automated boiler load controls regulate the amount of fuel fed into a boiler to suit the load. They can significantly improve the efficiency of a boiler. In addition, labour savings may be realised by reducing the requirement for the boiler to be attended.

MAKE SURE YOU: Consult maintenance or engineering personnel, or the operating manual for the boiler.

QUESTION 9: Are variable speed fans installed on boilers?

Yes No

Improvement ideas and notes:.....
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→ Boiler-fans control the air-intake for the combustion process. Install a variable speed draught fan to match the boiler fuel consumption to the load. This is an economic way to reduce energy consumption by the unit. Note that a boiler load control may be required to do this effectively. In addition, with some sophisticated boiler controls, it is possible to vary the forced draught fan speed according to the excess air, which is sensed in the boiler flue.

MAKE SURE YOU: Consult maintenance or engineering personnel, or the operating manual for the boiler.

QUESTION 10: Which elements of the steam generation system(s) are insulated? Please tick the appropriate boxes.

- Boilers
- Process vessels
- Pipework
- Valves, flanges and fittings
- Other:

Improvement ideas and notes:.....
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→ Due to their considerable surface areas, process vessels as well as pipework and valves should be insulated to reduce heat loss from walls, ends and fittings.

MAKE SURE YOU: Check that insulation is clearly visible on vessels and pipework if not encapsulated in an outer covering. Note that insulation types may include bonded asbestos and other hazardous materials and appropriate care must be taken when near these substances. Alternatively, consult maintenance or engineering personnel, or the operating manual for the boiler.

QUESTION 11: Is any heat recovery from steam generation systems undertaken on the site?

Yes No

Improvement ideas and notes:.....
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→ Heat recovery from flue gases using economisers or air pre-heaters is an efficient way to capture waste heat from boiler flues. Economisers transfer heat to the incoming feed water, and air pre-heaters transfer the heat to the incoming combustion air. Both technologies reduce the energy required to heat the boiler feed-water. Every 5°C increase in the feed-water temperature will save approximately 1% of the fuel used to raise steam.

MAKE SURE YOU: Consult maintenance, engineering or operating personnel.

QUESTION 12: Does the site have any capability for condensate recovery from steam generation systems?

Yes No

Improvement ideas and notes:.....
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→ Returning condensate back to the boiler for re-use saves energy since this preheats the water for steam production. Water is also being saved. Condensate systems will involve additional pumping, piping and valves. Refer also to notes on Question 17.

MAKE SURE YOU: Consult maintenance or engineering personnel.

B: ENERGY AUDIT CHECKLIST



QUESTION 13: Is boiler blow-down recovered?

Yes No

Improvement ideas and notes:.....
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- Waste-heat of the boiler blow-down may be recovered to be returned to the feed-water, using blowdown heat exchangers.
- There are two types of blow-downs: Mud blow removes the heavy sludge accumulating at the bottom of the boiler, whereas continuous or skimming blow removes light solids that accumulate in the water used for steam production.

MAKE SURE YOU: Consult your maintenance, engineering or operating personnel.

MAINTENANCE

QUESTION 14: Are regular inspections of the steam generating systems undertaken to detect leaks and pressure losses as well as breakdown of insulation?

Yes No

If so, how often?

- Every shift
- Daily
- Weekly
- Other:

Improvement ideas and notes:.....
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- Check for leaks and pressure losses throughout the steam generation system and associated pipework by implementing a regular (monthly) inspection or as part of an existing inspection. Inspections should include piping, joints, drain valves, flexible hoses. Ensure leaks are fixed as soon as possible to minimise excess energy usage.
- Ensure that the checking of insulation on pipework associated with steam generating units is also included in the inspection. Insulation around valves will break down, particularly where valve boxes are used, and replacing the damaged insulation with a more flexible type or valve blanket can reduce heat losses from valves.

→ Establish a defect tagging system for tagging leaks in the steam generation system to notify maintenance personnel.

MAKE SURE YOU: Consult maintenance or engineering personnel, or a maintenance management system, work orders or other sources.

QUESTION 15: Are the boilers and steam generation systems maintained and serviced according to the manufacturer's instructions?

Yes No

Improvement ideas and notes:.....
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→ Maintenance should include the removal of fouling residues of the steam generation systems as these reduce the efficiency of the boiler operation. Fouling can occur in two ways. Firstly, 'gas-side fouling' occurs when deposits from natural gas or fuel oil accumulate inside the unit. Secondly, 'water-side fouling' occurs when chemical deposits or scaling appears on the unit.

MAKE SURE YOU: Consult maintenance or engineering personnel, or look at service records for the units.

QUESTION 16: Are adjustments made to the boiler settings to maximise efficiency?

Yes No

Improvement ideas and notes:.....
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→ Have maintenance personnel make regular minor adjustments to the boiler settings and calibrations to maximise efficiency. This is best achieved using monitoring equipment, which measures the combustion efficiency of the boiler while the adjustments are being carried out. As fuel-burning appliances operate most efficiently at the optimum fuel-to-air ratio, maintenance of the oxygen trim (the amount of oxygen being input into the process) is one of the most important adjustments.

MAKE SURE YOU: Consult with maintenance or engineering personnel.

B:

ENERGY AUDIT CHECKLIST



QUESTION 17: Are steam traps maintained in optimum working condition?

Yes No

Improvement ideas and notes:.....
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→ Steam traps are used to remove the condensate from the gaseous side of the distribution system, and also to remove non-condensable gases like air from the entire steam system. They can discharge either to the atmosphere or to a closed loop system such as the condensate return system. Steam systems rely upon steam traps for effective steam distribution, dryness and condensate recovery. It is important that all steam traps are appropriately selected for their location and use, and are well maintained.

MAKE SURE YOU: Consult with maintenance or engineering personnel.

PURCHASING

QUESTION 18: Are energy efficiency options taken into account when purchasing or replacing boilers or steam generating systems?

Yes No

Improvement ideas and notes:.....
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→ Changing the fuel source (not suitable for all boilers) may reduce overall operating costs for steam generating systems. Recycled oil rather than new oil may be a cheaper alternative fuel source. Consult the operating manual and other relevant documentation before changing fuel types.

→ Check that the size of your boiler meets current demands only and runs above 60% load. Whether comparing new or existing boilers, their most efficient operating point is usually somewhere between 60% and 90% load.

MAKE SURE YOU: Consult purchasing procedures, guidelines or policies.

Note: As an alternative to using this action plan, you can also enter your energy efficiency actions as objectives and targets in an environmental management system, as a work order in your maintenance management system, or in another process that ensures nominated personnel complete the actions.

GOALS AND METHODS FOR ENERGY EFFICIENCY

Your energy efficiency goals

Example: "Reduce the energy use for lighting by 10% compared to last year's consumption." Be specific where possible taking into account technical, financial and operational inputs. Goals should be measurable where practicable.

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Your preferred energy efficiency options

Chosen from 'Improvement ideas and notes' in section B.

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Target completion date

Person responsible

C: ENERGY EFFICIENCY ACTION PLAN



Goal(s):.....

ACTION STEPS TO BE TAKEN *Specific steps needed to implement the preferred energy efficiency actions stated under 'goals and methods'.*

No.	Action	Person responsible	Due date	Date completed	Initials

COMPLETION *To be signed by person nominated under 'goals and methods'.*

Signature.....

Print Name.....

Title..... Completion Date.....

Please photocopy this form if additional action steps are required. Complete the page numbering and action numbering on all forms.

Page..... of.....

National Energy Efficiency

A comprehensive guide to the latest Commonwealth, State and Territory regulations, standards and guides on energy efficient appliances
www.energyrating.gov.au

A SELECTION OF OTHER USEFUL LINKS

1. Energy Smart Allies Directory.

Directory of suppliers of energy services and products including information regarding air compressors and their components.
www.energysmartallies.com/esa/middlesub.asp

2. Energy Smart Compressed Air Systems.

Sustainable Energy Authority of Victoria (SEAV).
'Boiler Optimisation' is part of Module 5 in a series of 'best practice design, technology and management fact sheets'.
http://www.seav.vic.gov.au/ftp/advice/business/info_sheets/BoilerOptimisationInfo_0_a.pdf

3. Energy Smart Compressed Air Systems.

Sustainable Energy Authority of Victoria (SEAV).
'Combustion Trim for Boilers' is part of Module 5 in a series of 'best practice design, technology and management fact sheets'.
http://www.seav.vic.gov.au/ftp/advice/business/info_sheets/CombustionTrimBoilers_0_a.pdf

4. Steam Systems Software Tools.

US Department of Energy.
A collection of free tools to help you identify and analyse energy system savings opportunities in your plant.
http://www.oit.doe.gov/bestpractices/software_tools.shtml

5. Upgrade Boilers with Energy-Efficient Burners.

US Department of Energy.
A best-practices program tip sheet about energy-efficient burners in boiler units.
<http://www.nrel.gov/docs/fy04osti/33470.pdf>

6. Improving Steam System Performance: A Sourcebook for Industry.

US Department of Energy.
Available as a free download.
<http://www.oit.doe.gov/bestpractices/steam/pdfs/steamsourcebook.pdf>

7. Steam Generation Information Pages.

US Department of Energy.
Provides information on energy efficiency for steam generation, steam distribution, steam end-use and steam recovery.
<http://www.oit.doe.gov/bestpractices/steam/>

8. Information Sheet: Energy Saving With Insulation.

Sustainable Energy Authority of Victoria (SEAV).
Recommends the types of insulation suitable for different process equipment in industry (industrial ovens, boilers, high temperature pipes, refrigeration piping, cool rooms and deep freezers).
http://www.seav.vic.gov.au/ftp/advice/business/info_sheets/EnergySavingInsulatio_0_a.pdf

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NOTES

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