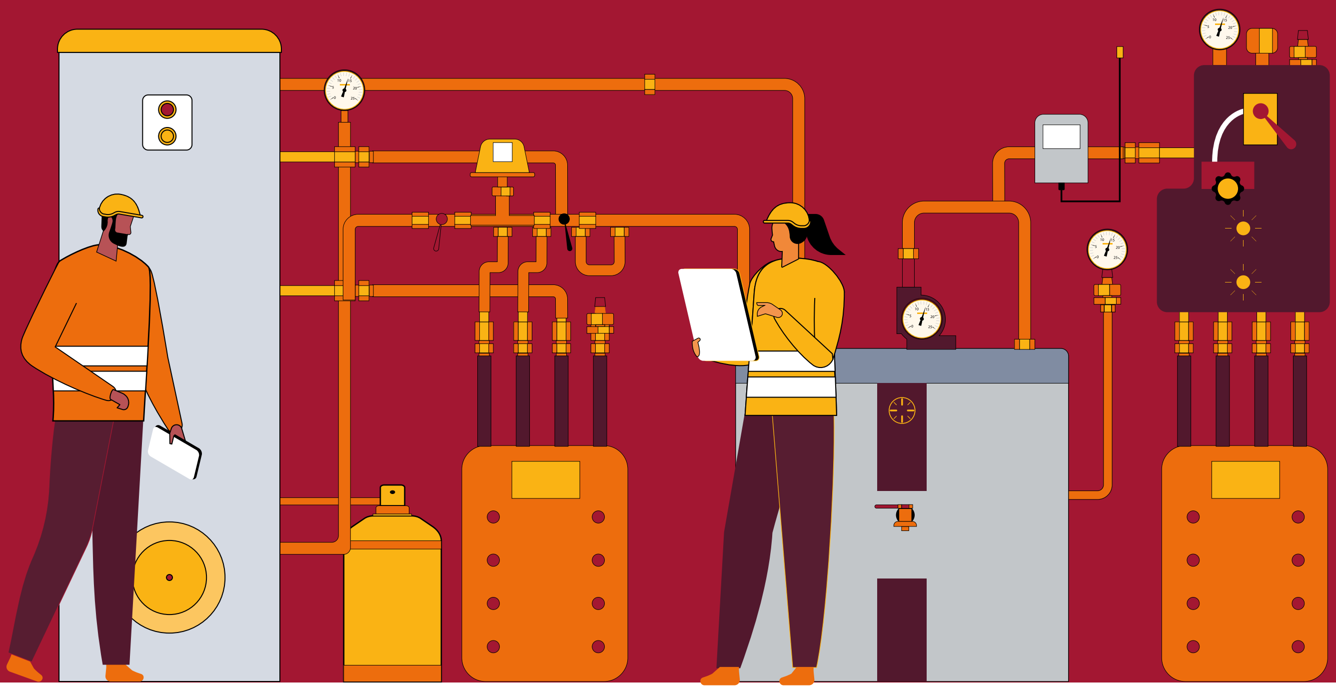
ACCELERATING INDUSTRIES' **CLIMATE RESPONSE** SRI LANKA

EFFICIENCY SOLUTIONS FOR INDUSTRIAL HEAT

BROCHURE

Efficiency Solutions for Industrial Heat

Energy Efficiency Solutions for Sri Lanka



European Union

Accelerating Industries' Climate Response in Sri Lanka is a project funded by the European Union and implemented by the United Nations Industrial Development Organization with the Ministry of Environment, Ministry of Industry and the Ministry of Power and Energy. The training programme is organized in collaboration with National Cleaner Production Centre, Sri Lanka.

Introduction

Industrial heating and steam systems require large amounts of energy. Yet despite making up almost one-fifth of global energy consumption, industrial heat processes are often overlooked in the effort to reduce costs and emissions. Considering that the vast majority of industrial heat originates from fossil-fuel combustion, it is critical for organizations to take advantage of the many opportunities that improve energy efficiency in industrial heat processes and free up investment for potential renewable energy applications.

There is no shortage of resources available for industrial managers looking to make their company more energy efficient. In fact, there is so much information it can often be difficult to know where to start or what is worth researching further. This industrial heat efficiency knowledge brochure provides an overview for leadership teams on what heat and steam process optimization is, the opportunities for renewable energy integration, and how paying attention to heat system efficiency can bring added value to your organization. In this brochure you will find insights from UNIDO's global experts as well as external links to recommended references, manuals and technical guides. You can also find out more about the Accelerating Industries' Climate Response in Sri Lanka project, a 5-year initiative led by the Ministry of Environment, Ministry of Industry and Ministry of Power and Energy and the United Nations Industrial Development Organization (UNIDO) that is helping Sri Lankan industries get the training and technologies they need to become more energy efficient and harness the potential of renewable energy.

How is heat used in industry?

Since the late 17th century, steam and thermal energy has been used for a variety of industrial processes. In fact, the majority of goods and commodities consumed in modern society from cars, steel and cement to paper, cosmetics and canned food all require a degree of heat and/or steam in their processing and production.

The **three most common process heating systems** used in industry today are **fuel-based**, **electricity-based** and **steam-based** systems. Increasingly renewable heat systems are also emerging.

Did you know?

Industrial processes account for half of global heat consumption while the other half is used mostly in buildings for space and water heating as well as cooking, and for agriculture.[1]

[1] IEA, Renewables 2019: Market analysis and forecast from 2019 to 2024.

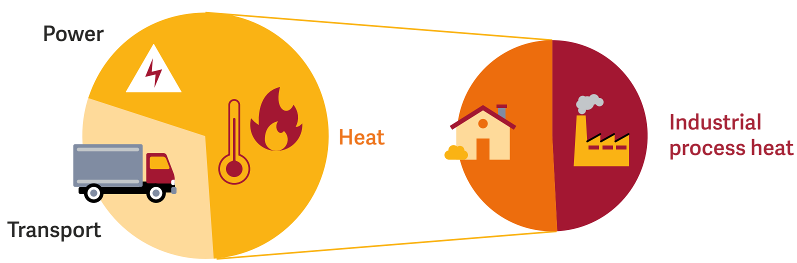


Figure 1. Industrial process heat consumption

In **fuel-based** process heating, heat is generated by the combustion of solid, liquid or gaseous fuels and transferred either directly or indirectly to the materials. Examples of fuel-based process heating equipment include furnaces, ovens, heaters, kilns and melters.

Electric-based systems use electric currents or electromagnetic fields to heat materials. Examples of electric-based heating systems include induction heating and melting, electric arc furnaces, infrared ovens and vacuum furnaces.

Steam-based systems use steam, typically generated through the combustion of fuels, to supply heat to the materials directly or indirectly. Examples of steam-heated systems include distillation columns, water or air heating, paper drying and humidification.

As technology has progressed in recent decades, **industrial heat processes powered by renewable sources** — predominantly solar, geothermal and biomass — are being used in a variety of industrial applications similar to traditional process heating.

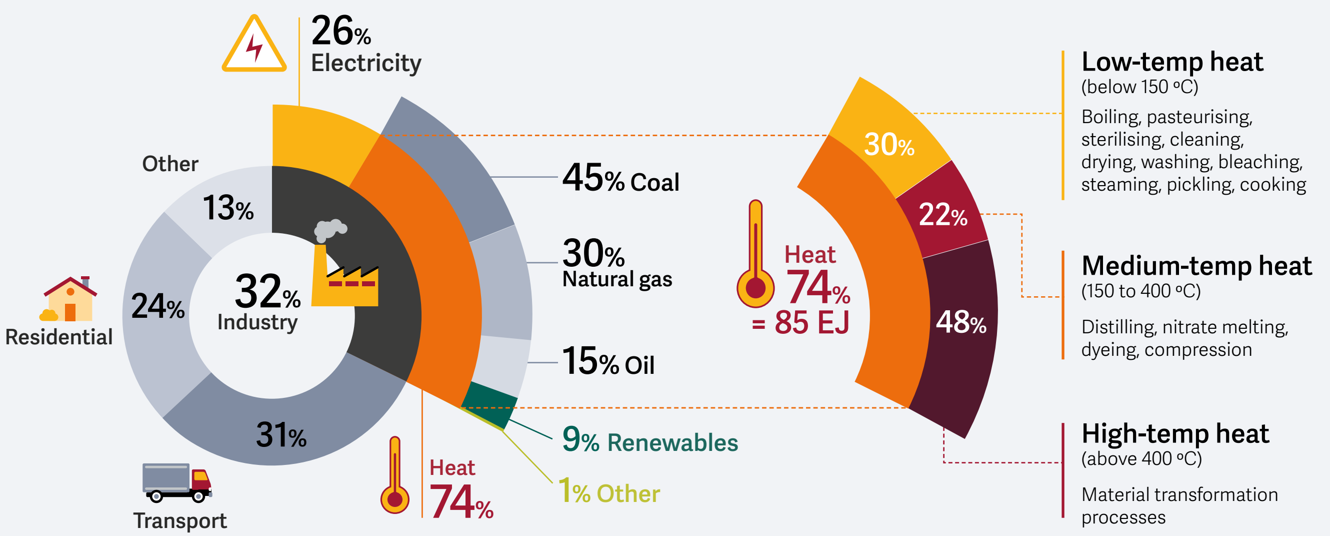
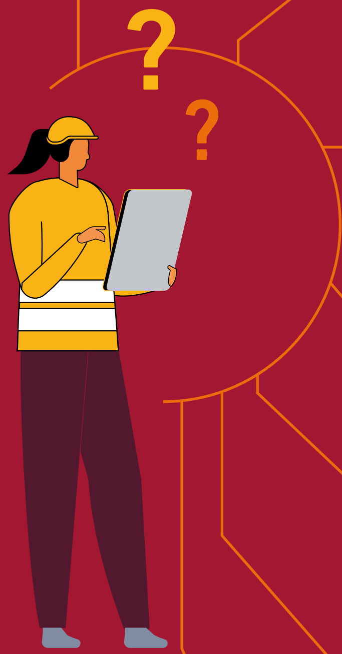


Figure 2. Share and breakdown of heat demand in industry

Note: EJ = exajoule

Source: Solar Payback (2017), based on IEA statistics and calculations by IRENA

Questions to ask when assessing the efficiency of an industrial heat process



1. What are the current system conditions and operating parameters?
2. What are the thermal energy requirements for both the supply and demand sides of the heat process system?
3. Where is energy being lost or wasted?
4. Is there a way to reuse, recycle, or recover excess heat from process flows, air streams, or condensate flows?
5. Is the fuel the most appropriate available for the heat application at hand?
6. Is there an opportunity to generate and integrate renewable energy into the heat process?
7. Are there opportunities for cogeneration?

EFFICIENCY SOLUTIONS FOR INDUSTRIAL HEAT APPLICATIONS

There are a number of ways process heating, steam and thermal energy systems can be made more efficient.

UNIDO's training and industrial heat capacity building programmes are divided into three broad areas:

STEAM SYSTEMS OPTIMIZATION

PROCESS HEAT OPTIMIZATION

RENEWABLE ENERGY FOR INDUSTRIAL HEAT

Steam systems optimization

Steam is widely used in the industrial sector for a multitude of processes which require heating, stripping, drying and cleaning among many other applications.

While steam is among the most efficient and cost-effective heating sources available, data from industry shows that average steam energy usage in industry could be as much as 35-40 per cent of the entire onsite energy consumption. Therefore, it is very important to optimize steam systems and minimize their operating costs.

This diagram details a typical steam system which includes a boiler for steam generation, distribution in the form of piping and valves, end-use equipment such as evaporators, cookers and dryers, and also condensation recovery which includes steam traps and collection tanks.

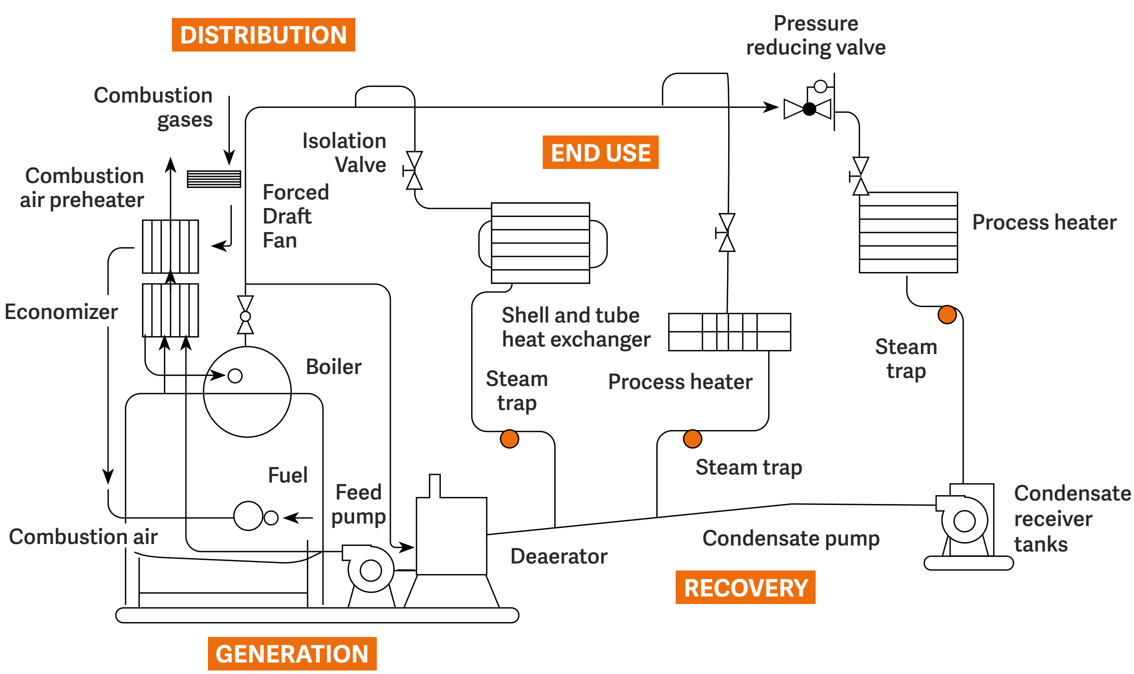
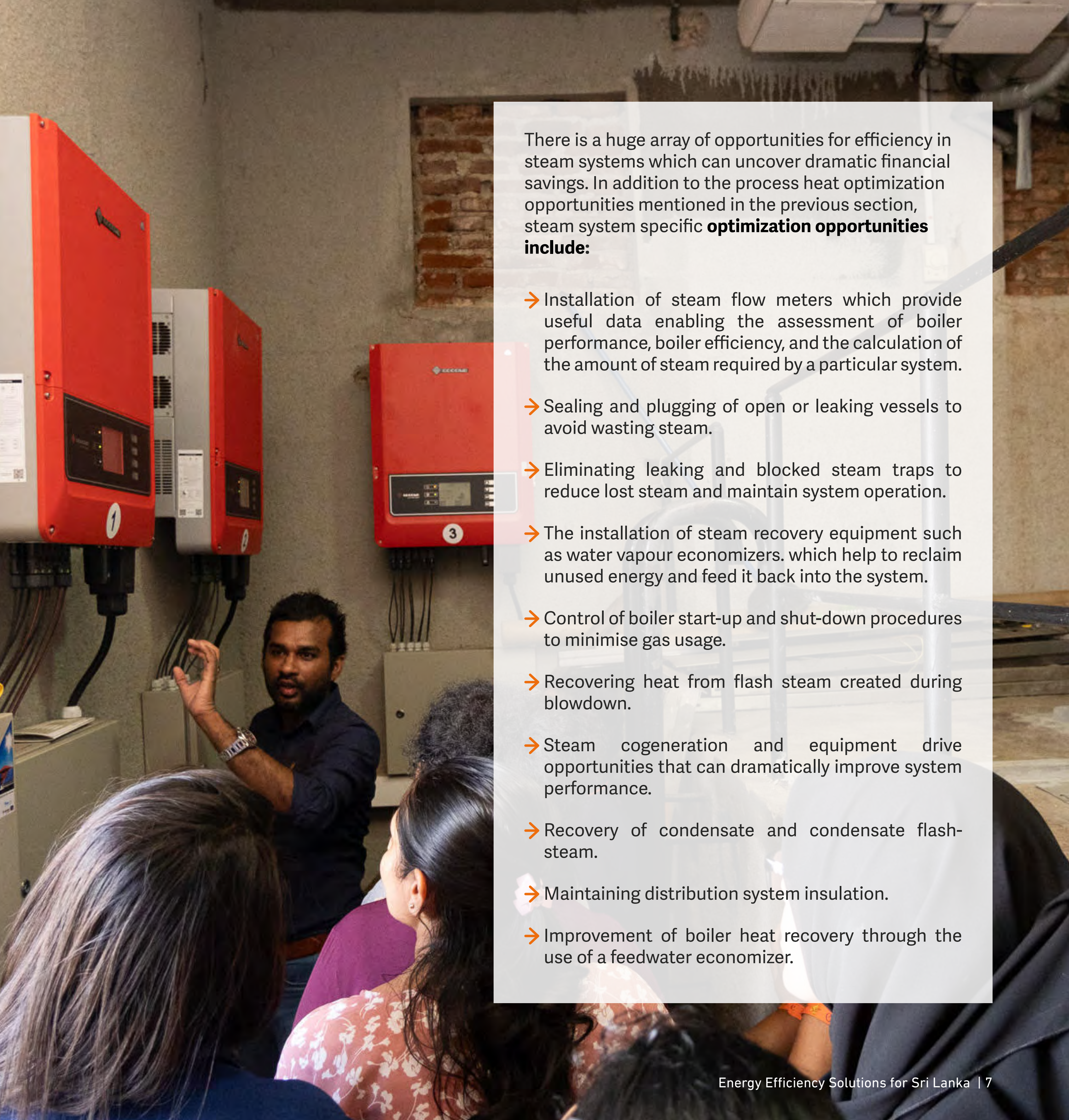


Figure 3. Generic Steam System

Source: US DOE Steam Best Practices Program - Steam System Sourcebook



There is a huge array of opportunities for efficiency in steam systems which can uncover dramatic financial savings. In addition to the process heat optimization opportunities mentioned in the previous section, steam system specific **optimization opportunities include:**

- Installation of steam flow meters which provide useful data enabling the assessment of boiler performance, boiler efficiency, and the calculation of the amount of steam required by a particular system.
- Sealing and plugging of open or leaking vessels to avoid wasting steam.
- Eliminating leaking and blocked steam traps to reduce lost steam and maintain system operation.
- The installation of steam recovery equipment such as water vapour economizers. which help to reclaim unused energy and feed it back into the system.
- Control of boiler start-up and shut-down procedures to minimise gas usage.
- Recovering heat from flash steam created during blowdown.
- Steam cogeneration and equipment drive opportunities that can dramatically improve system performance.
- Recovery of condensate and condensate flash-steam.
- Maintaining distribution system insulation.
- Improvement of boiler heat recovery through the use of a feedwater economizer.

What is boiler blowdown and heat recovery?

Boiler blowdown is the removal of water from a boiler to dispose of chemical impurities. Its purpose is to control boiler water parameters within prescribed limits to minimize scale, corrosion, carryover, and other specific problems. Blowdown is also used to remove suspended solids present in the system. Heat can be recovered from boiler blowdown by using a flash recovery vessel and a heat exchanger to preheat boiler makeup water.

Blowdown heat recovery applications can capture up to 90 per cent of the heat energy that would otherwise be lost to the environment. The heat is often reused for processes such as pre-heating the boiler as well as heating water inside the deaerator.

Other steam systemization opportunities such as adopting a regular maintenance programme for equipment like steam traps do not require significant investment and, based on UNIDO's experience, can easily yield 5 per cent of energy savings on average.

Blowdown is often a really good area to focus some attention on because you can recover almost all of the blowdown energy and put it back into the steam system.

Greg Harrell, leading international expert on steam system optimization

We all run to the boiler house. The great gleaming set of boilers seems to be the obvious place to look for efficiency opportunities. But we really don't consider deeply enough just how we are using steam or heat within the context of the entire system. Thinking in this way is how organizations unlock some of their biggest energy savings.

Alfred Hartzenburg, South Africa based energy management and heat process expert

ADDITIONAL RESOURCES

UNIDO case study

Even SMEs can benefit greatly from SSO: A case study from South Africa

READ

- UNIDO Manual for Industrial Steam System Optimization and Assessment
- Improving Steam System Performance
- Boiler Tune-Up Guide for Natural Gas and LIght Fuel Oil Operation, Written for the United States Department of Energy, Greg Harrell, PH.D., P.E.
- NCPC South Africa's Steam and Process Heating: Best Practice Guide

Process heat optimization

While thermal energy may be created and concentrated in a boiler, or a furnace, it's critical to remember that industrial heat processes are part of a broader system.

In some cases an industrial plant may involve various industrial heat systems, some require steam and others may be powered by gas for example. To achieve the best results in terms of energy efficiency, industry managers must consider the whole heat process system rather than just the individual components.

Understanding the current operations and energy needs as well as the management of the industrial heat system is the first step toward systemically optimizing an entire heat process. This means measuring and assessing how much energy is currently used in each stage of a particular process and in the system as a whole.

Waste heat recovery?

For many industrial and commercial sectors, heat and power recovery technologies offer the most significant single opportunity to reduce total fossil fuel consumption and improve energy efficiency. Harnessing and repurposing surplus heat with recovery technologies is one of the best strategies to achieve significant reductions in energy costs and greenhouse gas emissions. Efficiency opportunities in this area can be as simple as redirecting excess heat to the central heating system of a particular plant or related office building.

Opportunities for process heat optimization include:

- Improving the efficiency of combustion (burners) and other heat generating equipment by controlling the air-fuel ratio and eliminating air leakages into direct-fire furnaces.
- Regular maintenance of furnaces and heating systems to increase heat transfer from heat source to process load.
- Reducing heat losses through effective insulation of piping and related transfer equipment which helps to trap and conserve heat, as well as the implementation of systemized procedures for regular maintenance.
- Recover and reuse waste heat through various technologies and equipment.
- Where possible automate process measurements and controls.
- Identify and set appropriate operating temperatures to avoid overheating and waste heat.
- Avoid non-productive loads and idle periods where heat is being used.

ADDITIONAL RESOURCES

READ

- U.S. Department of Energy, **'Waste Heat Recovery: Technology and Opportunities in U.S. Industry.'**

Renewable energy for industrial heat

Worldwide, industrial heat generation mainly relies on the burning of fossil fuels: predominantly natural gas and the combustion of coal. However numerous emerging technologies and approaches are helping industries from all sectors to generate heat from renewable sources.

Over the past 10 years UNIDO has focused specifically on the application of solar thermal energy in industry. In countries like Egypt, through its **Solar Heating for Industrial Processes (SHIP)** project, UNIDO has successfully demonstrated and thus initiated a market environment for the diffusion and local manufacturing of solar energy systems for industrial process heat. In Malaysia, a country that boasts an abundance of year-round sunshine, the focus is on creating an enabling environment for local manufacturing organizations to invest in the application of solar thermal systems. This includes dedicated user training and technical support as well as the development of regulatory frameworks and financial incentive schemes to encourage solar thermal energy uptake and thermal energy efficiency.

Many industrial processes in the chemical, food and beverage, machinery, mining, textile, and wood industries use temperatures that can be easily generated with solar thermal technologies, either as hot water or steam. Since fixed costs dominate the overall financing structure of solar thermal energy, processes that have a summer peak load as well as those that can be applied all year long are of special interest for the use of solar thermal applications. Economics improve the higher the costs for competing energy sources are.

While the application of solar thermal in industrial processes is in a relatively nascent stage, technologies particularly for lower temperature ranges and processes in industries such as food, beverage, textiles, paper, and pulp industries are already commercially available for implementation on a large-scale.

Solar thermal applications include:

- Water pre-heaters for industrial cooking, steam requirements and energy generation
- Photo-voltaic solar applications for electric boilers
- Solar air collectors, found primarily in the food processing industry, replace gas and oil-based drying
- Solar concentrators including parabolic dish collectors, linear parabolic trough collectors and linear Fresnel collectors which reflect concentrated sunlight onto thermal receivers

Different collector technologies exist for providing diverse temperature levels, which can be used for many industrial processes. The complexity of installation and the integration increases with temperature demand.

ADDITIONAL RESOURCES

UNIDO case study

- **IIOI Pan Century Oleochemicals, Malaysia**
- **Lotus Garments, Egypt**

READ

- IEA-ETSAP & IRENA, 2015 '**Solar Heat for Industrial Processes: A Technology Brief.**'
- Technology Platform on Renewable Heating and Cooling, 2014 '**Solar Heating and Cooling Technology Roadmap.**'
- IAEE INTEC, 2020 '**Solar Heat Integrations in Industrial Processes: Technology Position Paper.**'

Creating a 'circular economy' with bioenergy

Bioenergy is a form of renewable energy that uses organic renewable materials (known as biomass) to produce heat, electricity, biogas and liquid fuels. Unlike other renewable sources, such as wind and solar, bioenergy can be used for high-temperature heat demand in heavy industry. According to IRENA, biomass could substitute two-thirds of the industrial fossil fuel demand as fuel and feedstock (40-80 EJ). The global renewable energy agency predicts that 80 per cent of the total realisable economic potential of renewables in industry worldwide will come from biomass (23-28 EJ). However, there is still work to be done to scale-up the supply of bioenergy, and make it economically viable for industry.

To drive the uptake and application of bioenergy in industries worldwide, UNIDO recently launched a series of training programmes in biogas technology and the application of it in industrial organizations. In addition to this, in countries like Turkey, Brazil, Cambodia and South Africa, where bioenergy potential remains largely untapped, UNIDO and partners are working to establish the infrastructure and generate the capital required to scale a thriving bioenergy sector. A specific focus of UNIDO's work in this field is producing bioenergy from agricultural waste, so the industry becomes 'circular' in nature, meaning tha gy can be reused and circulated throughout the supply chain indefinitely.

The benefits

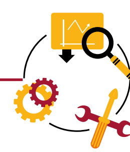
One of the major goals of a heat and steam process energy assessment is to help industry identify, quantify and act on relevant energy saving opportunities.

Often this leads to the classic question of: What is the return on investment (payback) for implementing efficiency interventions, new technologies and/or processes? In many cases investments into heat system efficiency improvements can be recouped in less than two years thanks to energy savings which range from 2 to 30 per cent. This has enabled many organizations to remain profitable and competitive in globalised markets.

Environmental benefits

Considering Industrial heat is predominately powered by non-renewable fossil fuels,[2] efficient use of thermal energy and efforts to transition to renewable fuels for heat are among the most important ways industry can contribute to mitigating climate change and comply with emerging national environmental regulation.

2 **Bellevrat, E & West, K 2018, 'Clean and efficient heat for industry,' IEA.**



ADDITIONAL RESOURCES

READ

- → NCPC, 2020, '**Biogas & power quality training courses, South Africa**'
- → The Industrial Energy Accelerator, 2021, '**From waste to energy: Turkey looks to biomass to achieve 'green growth**''
- → IRENA, '**Renewable energy options for the industry sector: Global and regional potential until 2030**.'

WATCH

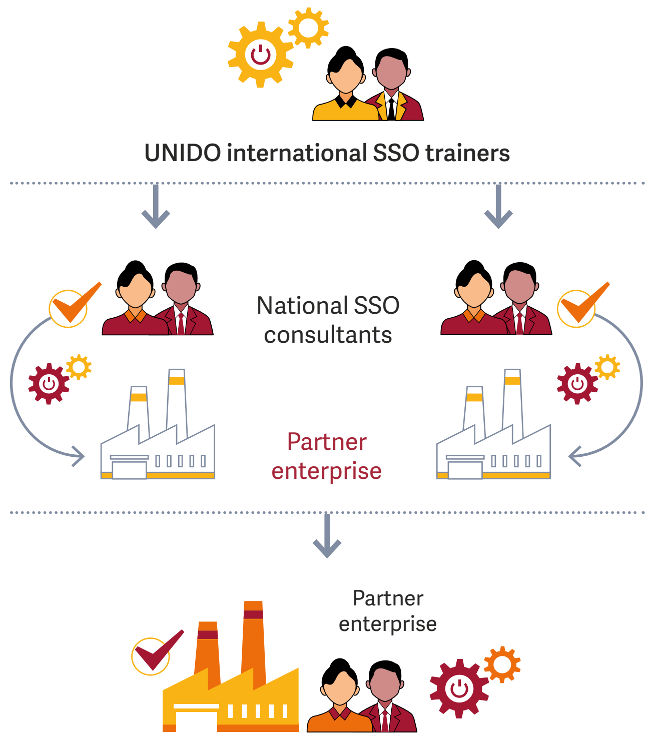
- → UNIDO, 2021, '**Developing Cambodia's biogas technology for rural electrification and greenhouse gas mitigation**'

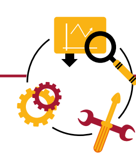
UNIDO's flagship Steam System Optimization programme

A hands-on experience

UNIDO's Steam System Optimization (SSO) programme was born out of a deep understanding of efficiency opportunities generated through countless steam system analyses conducted in plants around the world. What has emerged over the past 10 years is a flagship steam system optimization training programme that has capacitated, enabled and produced great national champions for industrial energy efficiency and steam system optimization.

Broken into three categories depending on the depth of training required, UNIDO's SSO programme is designed to simultaneously foster demand and supply in national markets for energy efficiency services. The training takes participants beyond the classroom and into partner enterprises. Ultimately, the training aims to provide industry practitioners with a fundamental understanding of steam systems and their components, as well as the thermodynamic principles that govern their operation. Participants are equipped with the adequate tools and knowledge to assess an organization's steam system and recommend opportunities that enhance energy efficiency and optimize the heat process.





ADDITIONAL RESOURCES

WATCH

→ Alf Hartzenburg on **UNIDO's 'Unparalleled' Steam System Optimization Training Programme**

Greening Sri Lanka's Industries through Steam System Optimization

The Government of Sri Lanka is spearheading carbon reduction in key industries through its partnership with the EU-funded Accelerating Industries' Climate Response in Sri Lanka project, implemented by UNIDO. The goal is to reduce industry greenhouse gas (GHG) emissions by 7 per cent by 2030, and become entirely carbon-neutral by 2050. Steam systems have great capacity to enhance energy efficiency and help propel Sri Lanka towards those goals, as well as saving money.

Sri Lanka's first training on Steam System Optimization (SSO) was delivered to 29 industry professionals in 2023. The SSO training equipped participants to spot and implement opportunities to improve energy use and reduce emissions. Employees in pivotal sectors like tourism, fisheries, tea plantations and agriculture took the training. As a key producer and exporter of tea, natural rubber and finished rubber products, as well as apparel and textiles to the global market, many of Sri Lanka's industries fall into the heavy steam user category. Therefore, steam usage is a vital stepping stone in Sri Lanka's aspirations for a cleaner and greener future.

The trainees completed classroom sessions, on-site hands-on training, personalized coaching, and training via a web-based simulation developed by the US Department of Energy. They were also given tools and guidelines developed by UNIDO, and sent in groups to practice what they'd learned at manufacturing plants. Individuals and teams completed assessment reports, which were reviewed and approved by the international SSO experts.

"

The SSO trainers introduced techniques and tools for measuring and assessing energy wastage in our steam lines, providing more accurate quantitative values. Following the implementation of improvements at our plant, I estimate potential annual savings of up to US$5,000."

Pulasthi Nammuniarachchi, of Associated Motorways (Pvt) Ltd.

"

After the SSO training equipped me with the skills to pinpoint energy wastage in our systems, I successfully garnered management support to initiate an insulation project. This project will include a steam distribution system with automated steam valves for greater overall efficiency."

Vidya Wijethunga of Michelin Lanka Private Limited.

"

I gathered information that was valuable to the ongoing project aimed at phasing out coal usage at Teejay. I was able to determine an optimal boiler configuration and explore alternative energy-saving opportunities."

Darshana Guruge, of Teejay Lanka PLC

The UNIDO Steam Systems Optimization (SSO) training programme

A systemic approach for efficiency

PREPARATION

- 2-3 MONTHS — Engage cohort
- 1 DAY — Introductory workshop to companies' management

USER TRAINING

- 2 DAYS — Theory & practical exercises

EXPERT TRAINING

- 3 DAYS — Demonstration of steam systems assessment
- 3-6 MONTHS — Put new knowledge into practice
- 3-4 WEEKS — Make recommendations

PROGRAMME COMPLETION

- 1 DAY — Revision & lessons learned
- 2-3 WEEKS — Final examination
- 1 DAY — Graduation ceremony

COMMUNICATION & DISSEMINATION

OUR TARGETS

Our goal is to help cut greenhouse gas emissions in Sri Lanka's industrial sector by 7 per cent by 2030. We will do this by supporting Sri Lankan companies to improve the efficiency of industrial processes and move to renewable energy.

400
LOW COST/NO COST ENERGY EFFICIENCY SOLUTIONS IMPLEMENTED BY INDUSTRIES

200
ENERGY EFFICIENCY PROFESSIONALS TRAINED TO IMPLEMENT ENERGY EFFICIENCY MEASURES

100 INDUSTRIES IMPLEMENT ISO 50001 EnMS AND ESO MEASURES
50001 ISO STANDARD

100
SUPPLIERS TRAINED TO DESIGN AND INSTALL RENEWABLE ENERGY SYSTEMS

80
BANKABLE INVESTMENTS PROPOSALS GENERATED FOR FINANCING

50
GOVERNMENT OFFICIALS TRAINED IN GHG EMISSIONS ACCOUNTING, VERIFICATION AND REPORTING

10
CO_2
HIGH IMPACT LOW-CARBON TECHNOLOGY DEMONSTRATION PROJECTS IMPLEMENTED

CASE STUDIES PUBLISHED ON IMPLEMENTATION OF INDUSTRY DECARBONIZATION SOLUTIONS
70 CASE STUDIES

5
NATIONAL INSTITUTIONS INTEGRATE EnMS AND ESO IN THEIR TRAINING PROGRAMMES

Your industrial heat optimization questions answered

UNIDO has steadily grown its cohort of international and national industrial heat process experts over the past decade. With collective experience in all of the world's major industrial countries and regions our network of specialised consultants have a long track record of leading organizational teams to achieve impressive results through system optimization. In this kit you will find a video where two of our experts answer common questions about industrial heat processes.

Dr. Greg Harrell

Dr. Greg Harrell currently serves as the Director of Milligan University's Engineering Programme in Northeast Tennessee. Greg has conducted energy assessments and training for industrial clients on six continents in 30 countries and 42 US states. As a leading international expert on steam system optimization, Greg regularly contributes his knowledge to UNIDO's specialized industrial heat training programmes and curriculum including the Steam System Optimization Manual which was published in 2018.

Alfred Hartzenburg

Alf is the National Project Manager of the South African Industrial Energy Efficiency Project. Following a 35 year career in industry Alf joined the National Cleaner Production Centre South Africa (NCPC-SA) in 2011 and has since become a qualified UNIDO trainer in energy management systems, energy performance management and indicators as well as steam, fan, compressed air and electric motor systems optimization.

ACCELERATING INDUSTRIES' **CLIMATE RESPONSE** SRI LANKA

www.industriesclimateresponse.com

Accelerating Industries' Climate Response in Sri Lanka is a project funded by the European Union and implemented by the United Nations Industrial Development Organization with the Ministry of Environment, Ministry of Industry and the Ministry of Power and Energy. The training programme is organized in collaboration with National Cleaner Production Centre, Sri Lanka.

Accelerating Industries' Climate Response in Sri Lanka Project
Ground Floor, New CSL Building | No. 133, Kinsey Road, Colombo 08, Sri Lanka.
Tel/Fax: +94 112689155, E-mail: aicr-srilanka@unido.org

European Union