



Energy *focus*

WE NEVER KNOW THE WORTH OF WATER TILL THE WELL IS DRY

THOMAS FULLER, Gnomologia, 1732

BACKGROUND

Due to increased gap in Demand & Supply of Gas and increasing Power Crisis, it is imperative to optimize the utilization of Gas, particularly in the Power Sector. A vast difference in the Energy Efficiencies of different power producers exists, hence, the **Ministry of Petroleum & Natural Resources**, Government of Pakistan, has taken an initiative to ensure optimal utilization of natural gas at Captive & Independent Power plants. A policy guideline has been given to the gas companies to conduct efficiency audit of all such plants and following Efficiency benchmark has been set by the Government.

Gas Engine/Gas Turbine

(based on co-generation technology)

Combined Cycle

(applicable to above 50 MW capacity power plant)



60%

50%



OBJECTIVE

Urge and Drive captive power consumers of Sui Northern Gas Pipelines Limited to be more energy efficient which would result in efficient utilization of Natural gas.



SUI NORTHERN GAS PIPELINES LIMITED

Our Vision

To be the leading integrated gas provider in the region seeking to improve the quality of life of our customers and achieve maximum benefit for our stakeholders by providing an uninterrupted and environment friendly energy resource.

Our Mission

A commitment to deliver natural gas to all doorsteps in our chosen areas through continuous expansion of our network, by optimally employing technological, human and organisational resources, best practices and high ethical standards.

Our Values

Commitment

We are committed

To our mission and vision and to creating and delivering stake holder value.

Courtesy

We are courteous

With our customers, stakeholders and towards each other and encourage open communication.

Responsibility

We are responsible

As individuals and as teams for our work and our actions. We welcome scrutiny and we hold ourselves accountable.

Competence

We are competent

And strive to continuously develop and improve our skills and business practices.

Integrity

We have integrity

As individuals and as teams our decisions are characterized by honesty and fairness.

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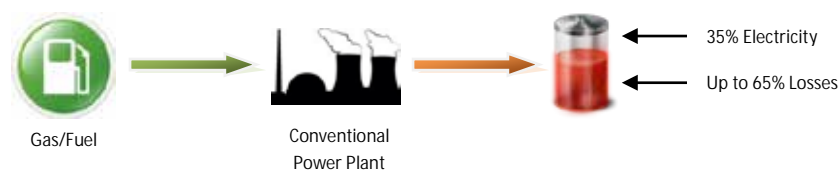
Energy Efficiency

Percentage of total energy input to a machine or equipment that is consumed in useful work, and not wasted as useless heat.



Conventional Generation

In conventional electricity generation, 35% of the energy potential contained in fuel is converted, on average, into electricity whilst the rest is lost as waste heat. Even the most advanced technologies do not convert more than 55% of fuel into useful energy.



Cogeneration

Cogeneration, also known as Combined Heat and Power, or CHP, is the production of electricity and heat in one single process for dual output streams. Cogeneration uses both electricity and heat, and therefore can achieve an efficiency of up to 90%, giving energy savings between 15-40% when compared with the separate production of electricity from conventional power stations and of heat from boilers. It is the most efficient way to use fuel. Cogeneration also helps save energy costs, improves energy security.

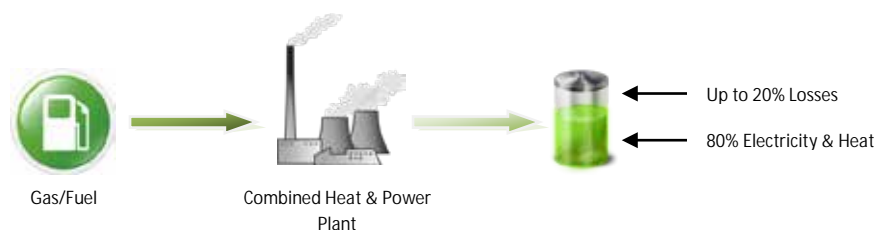


Figure 1 Cogeneration Plant with HRSG

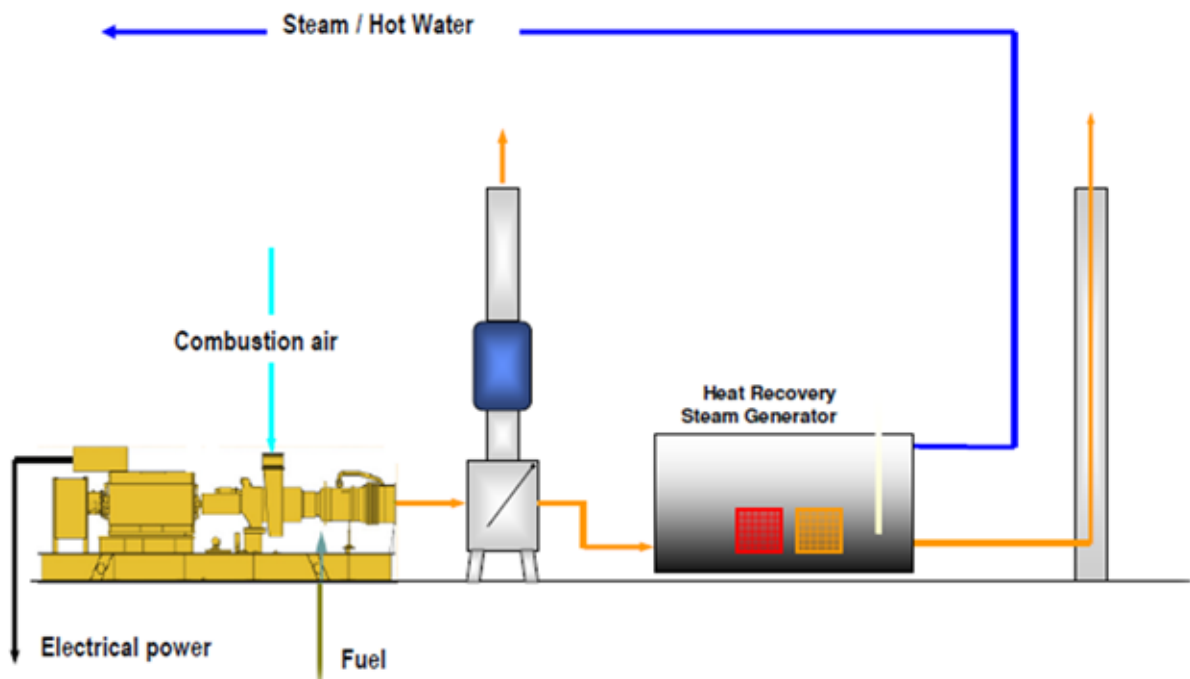
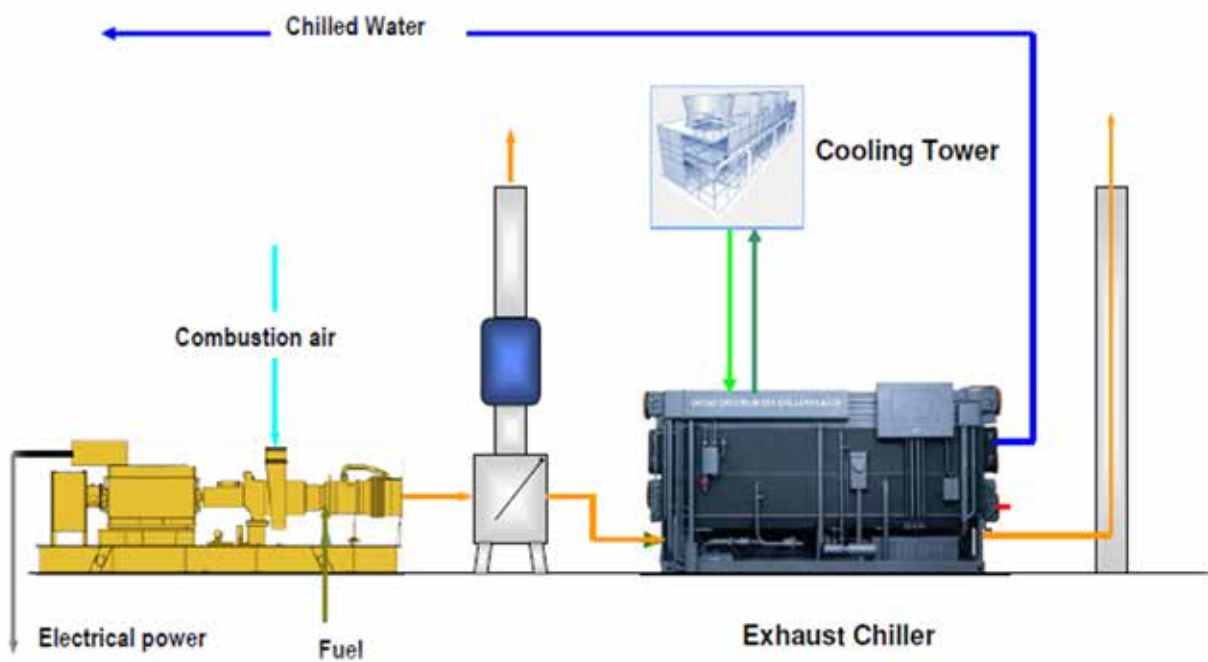


Figure 2 Cogeneration Plant with Chiller



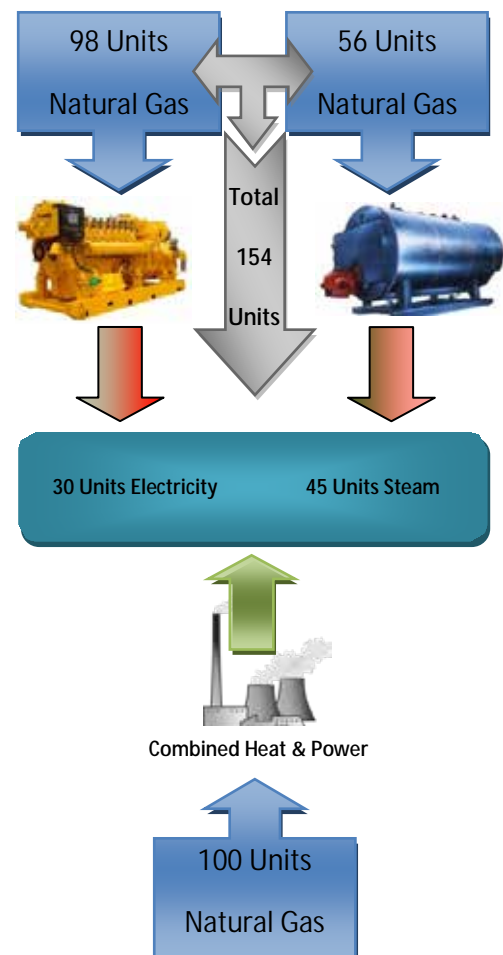
Advantages of Waste Heat Recovery

The waste heat recovery processes have no visible disadvantage on Ecology or Economy. On the contrary, these systems have many benefits which could be direct or indirect.

- Direct benefits:
 - The recovery process will add to the efficiency of the process,
 - Decrease the costs of fuel and energy consumption needed for that process.
 - Continuous operation, with low maintenance frequency
 - Potentially high return on investment
 - Easy installation and expansion
 - Short payback period
- Indirect benefits:
 - Reduction in Pollution:
Thermal and air pollution will dramatically decrease since less flue gases of high temperature are emitted from the plant since most of the energy is recycled.
 - Reduction in the equipment Sizes:
As Fuel consumption reduces so the Generating equipment size reduces.
 - Reduction in Auxiliary Energy Consumption:
Reduction in equipment sizes means another reduction in the energy fed to those systems like pumps, filters, fans etc.

Uses of Waste Heat

- Combustion air preheating
- Boiler feed preheating
- Load preheating
- Power generation
- Steam generation for:
 - Power generation
 - Mechanical power
 - Process steam
- Space heating
- Water preheating
- Air conditioning by absorption chiller
- Heating of liquid or gaseous process streams
- Air conditioning by absorption chiller

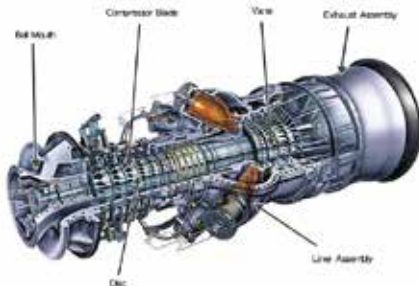


Co-generation Technology

At present, the two main cogeneration prime mover technologies are gas turbines and internal combustion engines. Fuel cells, micro turbines and Stirling engines show promise as prime movers for cogeneration in the near future.

Gas Turbine

The gas turbine has become the most widely used prime mover for large-scale cogeneration, typically generating between 1 and 100 MWe. Fuel is burnt in a pressurized combustion chamber using air supplied by a compressor. The hot pressurized gases (temperature about 1200°C) are used to turn a series of turbine blades, and the shaft on which they are mounted, to produce mechanical energy. This mechanical energy is normally used to produce electricity with a generator. The hot exhaust gases can be used (either directly or via a steam conversion step) to meet the local heat demand, to produce steam in a waste heat boiler for industrial processes or to produce electricity by allowing it to expand in a steam turbine.



Internal Combustion

Internal combustion engines operate on the same principles as automotive engines. They give a higher electrical efficiency than gas turbines. These are well suited to a variety of distributed generation applications, Industrial, commercial and institutional facility for power generation & CHP. Generally the cost of Internal combustion gensets is lower than gas turbine gensets up to 3-5MW size. Though the initial investment of such systems is low, their operating and maintenance cost is high due to high wear & tear.

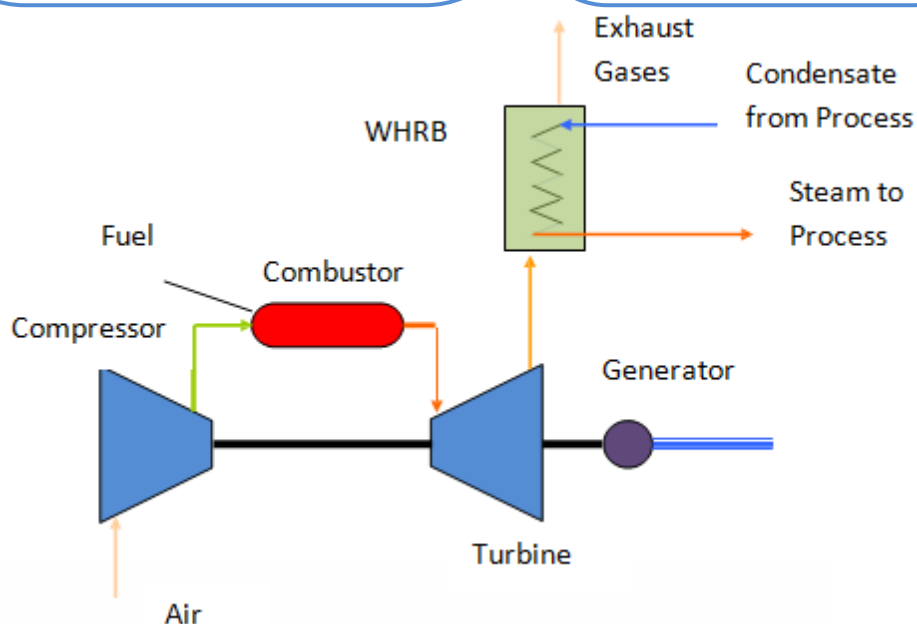


Figure 3 Gas Turbine Concept

Factors limiting the efficiency of an Internal Combustion Engine

- Friction loss
- Imperfect valve timing
- Losses in driving cam shafts
- Heat losses in exhaust gases.
- Heat losses during cooling of engine.
- Losses due to viscosity of lubricating oil.
- Energy consumed by auxiliaries like water pumps and oil pumps
- Transmission efficiency losses. Losses in clutches and fluid couplings, etc.
- Losses due to incomplete and imperfect combustion. Perfect combustion would result in the production of carbon dioxide and water.
- Compression ratio. The higher the compression ratio the higher the thermal efficiency. As in spark ignition or gasoline engines the compression ratio is limited by pre-ignition (not in compression ignition or diesel engines), the diesel engines are about 30% more efficient than gasoline engines.



Replace Spark Plugs & Filters Frequently to Ensure Fuel Efficiency through Complete Combustion

Combined Cycle Power Plant

Combined Cycle power plants are those which have both gas and steam turbines supplying power to the network. Combined cycle power plants employ more than one thermodynamic cycle – Rankine (steam) and Brayton (gas). In a combined cycle power plant, a gas turbine generator generates electricity and the waste heat is used to make steam to generate additional electricity through a steam turbine, which enhances the efficiency of electricity generation. Additionally, combined cycles are characterized by flexibility, quick part-load starting, suitability for both base-load and cyclic operation, and a high efficiency over a wide range of loads. Combined cycle power plants are being constructed all over the world these days due to the fact that they offer a high degree of thermal efficiency. Some plants in operation today consist of as much as fifty-two percent thermal efficiency, making this type of plant increasingly popular.

Another main reason that a combined cycle operation power plant is so popular today is the fact that this type of facility can be built rather quickly compared to a conventional steam plant. The most common fuel used by a combined cycle gas turbine power plant is natural gas.

Today's rising fuel prices and growing needs for electricity are putting much more demand to generate electricity at high thermal efficiency, low costs and as per international environmental standards. Combined cycle operation power plants meet these demands and actually surpass them by taking power plant performance to new levels. The combined cycle plants can produce high outputs of power at rates of around fifty-five percent, making them all the more attractive. This is leading to more and simpler cycle plants being converted into the much more efficient combined cycle

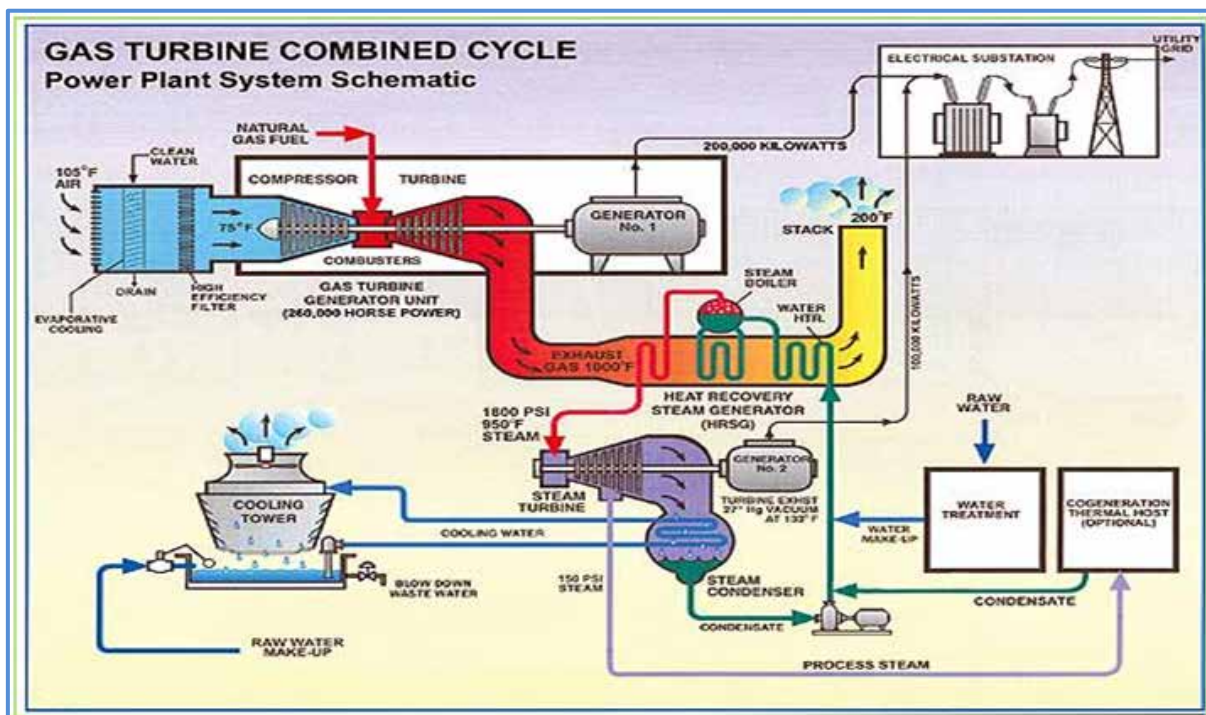


Figure 4 Gas Turbine Combined Cycle

Tri-Generation Power Plant

Tri-generation or CCHP (combined cooling, heat and power) refers to the simultaneous generation of electricity and useful heating and cooling from the combustion of a fuel or a solar heat collector. The supply of high-temperature heat first drives a gas or steam turbine powered generator and the resulting low-temperature waste heat is then used for water or space heating as described in cogeneration. Tri-generation differs from cogeneration in that the waste heat is used for both heating and cooling, typically in an absorption chiller. CCHP systems can attain higher overall efficiencies than cogeneration or traditional power plants.

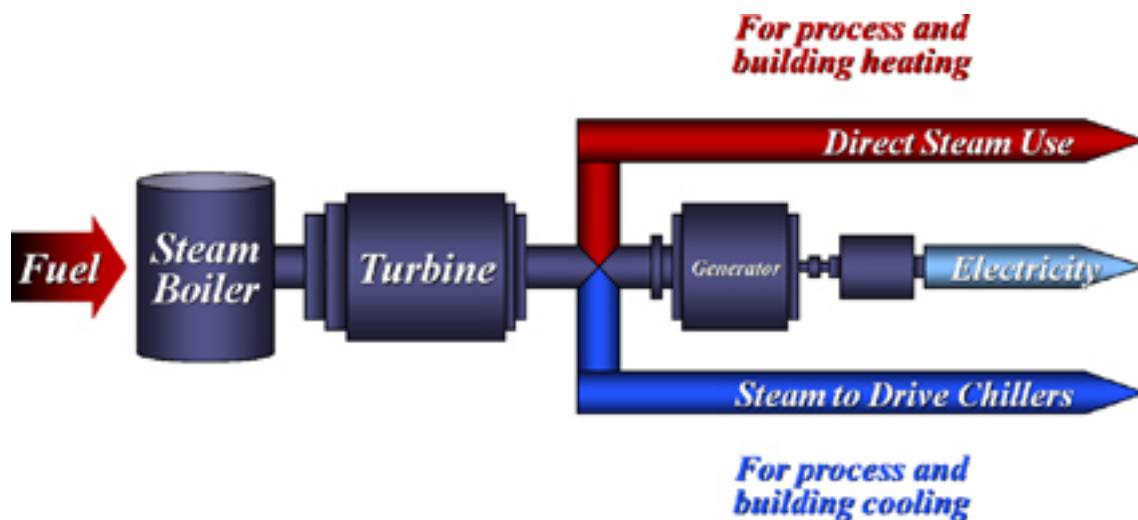


Figure 5 Tri-generation schematic

An example of tri-generation plant set-up at Ferrari's factory



Industrial Boilers & Steam Systems

We all have a responsibility to use our energies and our resources wisely and we all have a stake in preserving our environment. SNGPL is committed to helping customers use natural gas as efficiently as possible.

Efficiency is only useful if it is repeatable and sustainable over the life of the equipment. Choosing the most efficient boiler is more than just choosing the vendor who is willing to state that they will meet a given efficiency value. The burner technology must be proven to be capable of maintaining the air/fuel ratio year in and year out. Quality fan & damper designs, and simple linkage assemblies are easy to tune and accurately hold the air-to-fuel ratios.

Why choose the most efficient boiler? Because, the dividends that are paid back each year from high efficiency far outweigh any initial cost savings of a less efficient design. What is the most efficient boiler? It is a boiler that not only starts up efficiently but continues to operate efficiently year in and year out.

Two aspects are critical for assessing energy efficiency of the steam system in industry to make competitive products for the benefit of customers in international market place.

Combustion Efficiency

Combustion efficiency is an indication of the burner's ability to burn fuel and the ability of the boiler to absorb the heat generated. The amount of unburned fuel and excess air in the exhaust are used to assess a burner's combustion efficiency. Burners performing with extremely low levels of unburned fuel while operating at low excess air levels are considered efficient. By operating at only 9-15% excess air, less heat from the combustion process is being used to heat excess air which increases the available heat for the boiler load.

On well-designed natural gas-fired systems, an excess air level of 10% is attainable. An often-stated rule of thumb is that boiler efficiency can be increased by 1% for each 15% reduction in excess air or 40°F reduction in stack gas temperature. With an existing design of boiler and other equipment already built, there is little we can do to get rid of combustion losses.

Combustion Efficiency of Natural Gas

% Excess		Combustion Efficiency			
Air	Oxygen	Fuel Gas Temperature minus Temperature of Combustion Air ° F			
		200	300	400	500
9.5	2	85.4	83.1	80.8	78.4
15	3	85.2	82.8	80.4	77.9
28.1	5	84.7	82.1	79.5	76.7
44.9	7	84.1	81.2	78.2	75.2
81.6	10	82.8	79.3	75.6	71.9

Since we actually have four different kinds of losses and we have to control excess air flow to keep the below losses as low as possible.

- Unburned Gas Losses
- Unburned Carbon Losses
- Radiation Loss
- Flue Gas Loss

i. **Unburned Gas Losses**

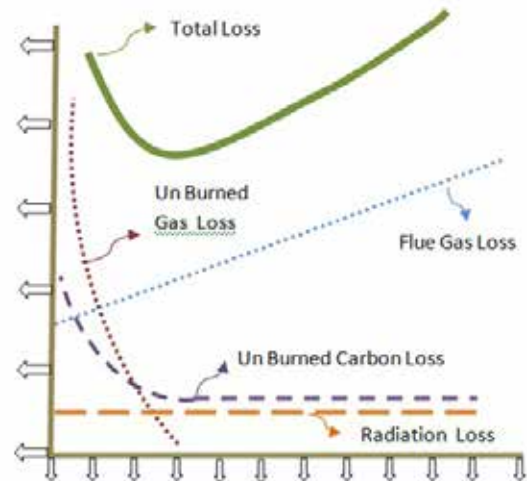
If there is not enough excess air and mixing, CO is formed instead of CO₂. This is a loss of heat. More excess air lowers the loss because more of the CO burns to CO₂.

ii. **Unburned Carbon Losses**

Some carbon is not burned. More excess air lowers this loss because there are more oxygen atoms around.

iii. **Flue Gas Loss**

Heat is lost because the flue gas goes out of the stack at relatively higher temperature. A lot of the heat is carried out by the steam in the flue gas. The more excess air, the greater the loss.



iv. **Flue Gas Loss**

Some heat radiates through the boiler walls. We can't do anything about in normal operation.

A more efficient and reliable steam system also means:

- Less downtime
- More boiler capacity for new processes, products, and production increases
- Lower input costs – natural gas, water, chemicals
- Higher net revenue
- Improved shareholder returns.

Environmental Benefits

An efficient steam system improves your facility's environmental performance by:

- Lowering greenhouse gas emissions
- Lowering CO₂ and NO_x
- Reducing water use

Steam System Operations

To remain efficient and competitive, industry need to reduce operating losses from steam systems. We know from experience that improving boiler efficiency, stopping steam leaks, improving insulation and incorporating heat recovery can save anywhere from 5% to 25% in annual natural gas consumption.

Losses from steam distribution systems can be produced by identifying leaking traps, over-sized or under-sized traps, blocked or flooded traps and assess the need for improvements in condensate return systems and auxiliary equipment.

A comprehensive process simulation of an industrial facility using energy and mass balance may help in optimizing energy use across an entire facility.

Suggested Actions

Boilers often operate at excess air levels higher than the optimum. Therefore periodic monitoring of flue gas composition and boilers tuning to maintain excess air at optimum level should be practiced.

DID YOU KNOW?

Steam System Improvement could cut down your natural gas usage by

5 – 25%

Example

A boiler operates for 8,000 hours per year and consumes 500,000 million Btu (MMBtu) of natural gas while producing 45,000 lb/hour of 150-psig steam. Stack gas measurements indicate an excess air level of 44.9% with a flue gas minus combustion air temperature of 400°F. From the table, the boiler combustion efficiency is 78.2% (E1). Tuning the boiler reduces the excess air to 15% with a flue gas minus combustion air temperature of 300°F. The boiler combustion efficiency increases to 82.8% (E2).



Annual Savings

$$\begin{aligned}
 &= \text{Fuel Consumption} \times (1 - E1/E2) \times \text{Fuel Cost} \\
 &= 29,482 \text{ MMBtu/yr} \times \text{Rs } 495/\text{MMBtu} \\
 &= \text{Rs } 13,612,500
 \end{aligned}$$

**IS
YOUR
STEAM
SYSTEM
DRAINING
YOUR
OPERATING
PROFITS?**

OPPORTUNITY

TYPICAL FUEL SAVING

Minimize vented steam	2.90%
Install feed water economizers	2.70%
Minimize boiler combustion loss by optimizing excess air	2.20%
Optimize condensate recovery	2.20%
Install combustion air pre-heaters	2.10%
Improve boiler operating practices	1.50%
Use high pressure condensate to make low pressure steam	1.50%
Repair or replace burner parts	1.50%
Improve system balance	1.40%
Clean boiler heat transfer surfaces	1.40%
Repair system leaks	1.40%
Reduce steam system generating pressure	1.30%
Improve quality of delivered steam	1.00%
Isolate steam from unused lines	0.90%
Install continuous blow down heat recovery	0.80%
Improve blow down practices	0.80%
Establish the correct vent rate for the dearator	0.60%
Add/restore boiler refractory	0.60%

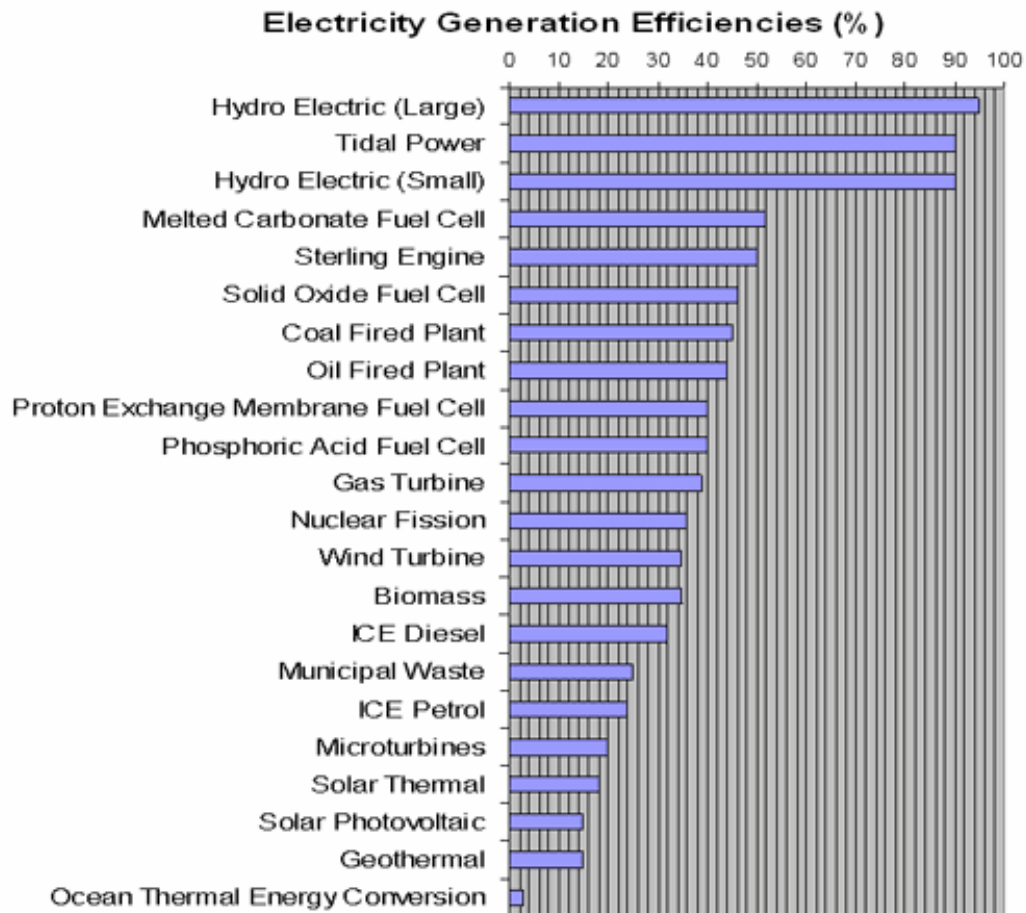


Figure 6 Theoretical efficiency of converting various energy sources by a variety of methods into useful electrical energy. It is clear that ICE Petrol/Gas is around 25 % Fuel Efficient.

Integrated Energy System

It is widely agreed that IES is a technology option that is underutilized in the building sector. While some of this is due to the insufficient economic returns related to seasonal heating and cooling loads, there are institutional reasons why IES is not more widely used in buildings. Many building owners make their decisions on the basis of first cost, and IES options tend to cost more than conventional alternatives. Furthermore, the building design community tends to be risk adverse, favoring the “tried and true” alternatives and not recommending options that they have not specified before. As a result, the vast majority of buildings do not include IES.



IES are defined as the co-production of power along with heat for heating, domestic water heating and thermal-driven cooling and humidity control. This includes using a variety of CHP technologies along with absorption chillers or desiccant dehumidification systems.

ENERGY CONSERVATION FOR RESIDENTIAL CONSUMERS

Right from your home, we have the power to reduce energy demand. When we reduce the demand, we cut the amount of resource usage like Sui gas that means now you are polluting the environment less, keeping the air cleaner for all of us and saving the money on our gas bill: plus reducing energy use increases our energy security.

If you have natural gas appliances in your house, take these steps to ensure that you will save energy & the money.

NATURAL GAS STOVES

- ü Cleaning your stove, burners and oven can extend the life of your appliance as well as increase the efficiency so you can save energy. A blue flame is more efficient than a yellow one.
- ü While cooking, adjust the flame to fit the bottom of the pot or pan. Turning up the flame beyond the bottom only wastes energy.
- ü Cover pots and pans with lids when cooking, it consume less energy while cooking.
- ü Water boils faster in covered pans.
- ü Cook vegetables in small amounts of water. Avoid over cooking, which wastes the energy and reduces nutritional value.

WATER HEATING

- ü Lower the water heater thermostat to the lowest level that meets your hot water. Each decrease by 5° C in water temperature can save gas usage up to 5%.
- ü Showers save hot water – a typical bath uses approximately 75 liters of hot water, while a 5-minute shower with an efficient shower head will use about half of that.
- ü Replace conventional water geysers with energy efficient instant water heaters.



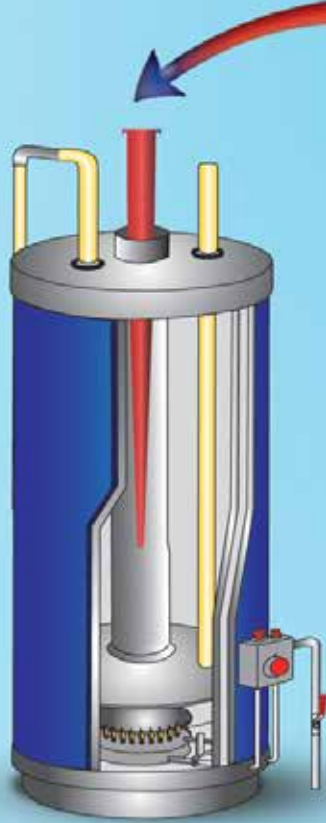
Install conical baffle on you water geysers and get guaranteed reduction in gas bill as illustrated below:

Prepare for the Winter! Use Conical Baffle in geyser to save

- ✓ **UPTO 25% GAS**
- ✓ **UPTO 45% CASH**

- Geysers without Conical Baffles consume more gas & increase gas bills.
- SNGPL recommends manufacturers and consumers to **install** Conical Baffles in their geysers and save on gas bills.

Conical Baffles may be purchased from SNGPL's Regional Offices. These are also available in the market with geyser manufacturers/sellers.



SUI NORTHERN GAS PIPELINES LIMITED

www.sngpl.com.pk

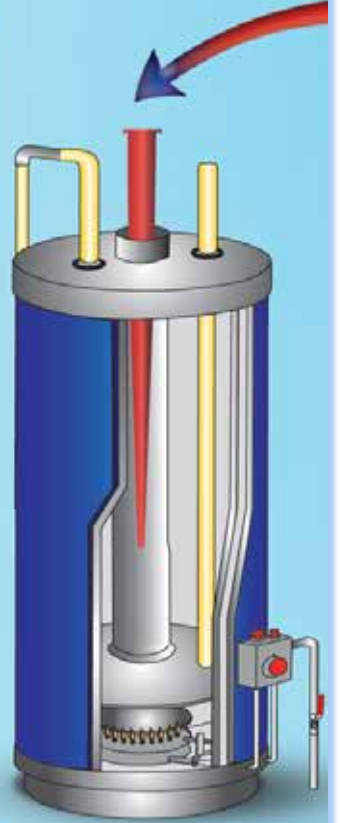
In case of gas leakage anywhere, report immediately on our Helpline: 1199

آنے والی سردیوں کیلئے تیار رہیں! گیزر میں کونیکل بیفل ڈالیں اور بچانیں

- ✓ **25% تک گیس**
- ✓ **45% تک کیش**

- کونیکل بیفل کے بغیر گیزرز زیادہ گیس استعمال کرتا ہے اور گیس بل میں اضافہ کرتا ہے۔
- سوئی ناردرن گیس پائپ لائنز لمیٹڈ (SNGPL) گیزر مینوفیکچررز اور صارفین کو تجویز کرتا ہے کہ گیس بل میں بچت کیلئے اپنے گیزرز میں کونیکل بیفل ڈالوائیں۔

کونیکل بیفل SNGPL کے مقامی ریجنل دفاتر سے خریدے جاسکتے ہیں۔ یہ مارکیٹ میں گیزر فروخت کرنے والی کمپنیوں اور مینوفیکچررز کے پاس بھی دستیاب ہیں۔



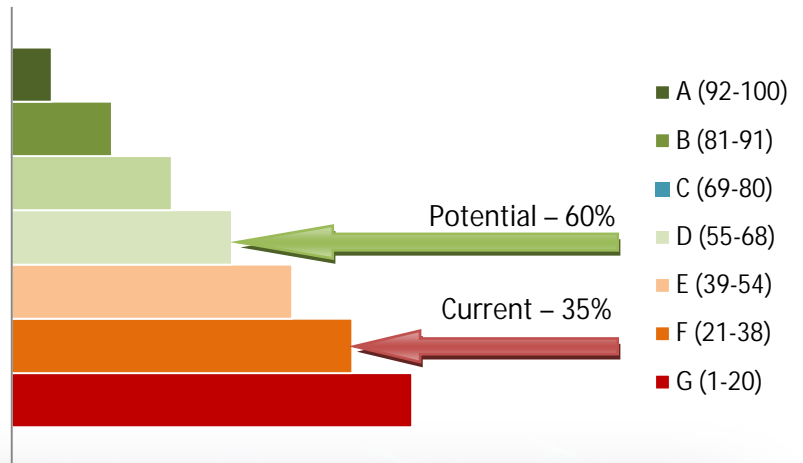
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**THINK
CONSERVE
ENERGY**

Energy Efficiency Rating



GO FOR
COGENERATION
FOR A BETTER
FUTURE



Sui Northern Gas Pipelines Limited

Gas House, 21 Kashmir Road,
P.O.Box No. 56,
Lahore 54000, Pakistan

Tel : +92 42 99082000, 99082006, 99080000
Fax : +92 42 99201369, 99201302
Email: customerservices@sngpl.com.pk

