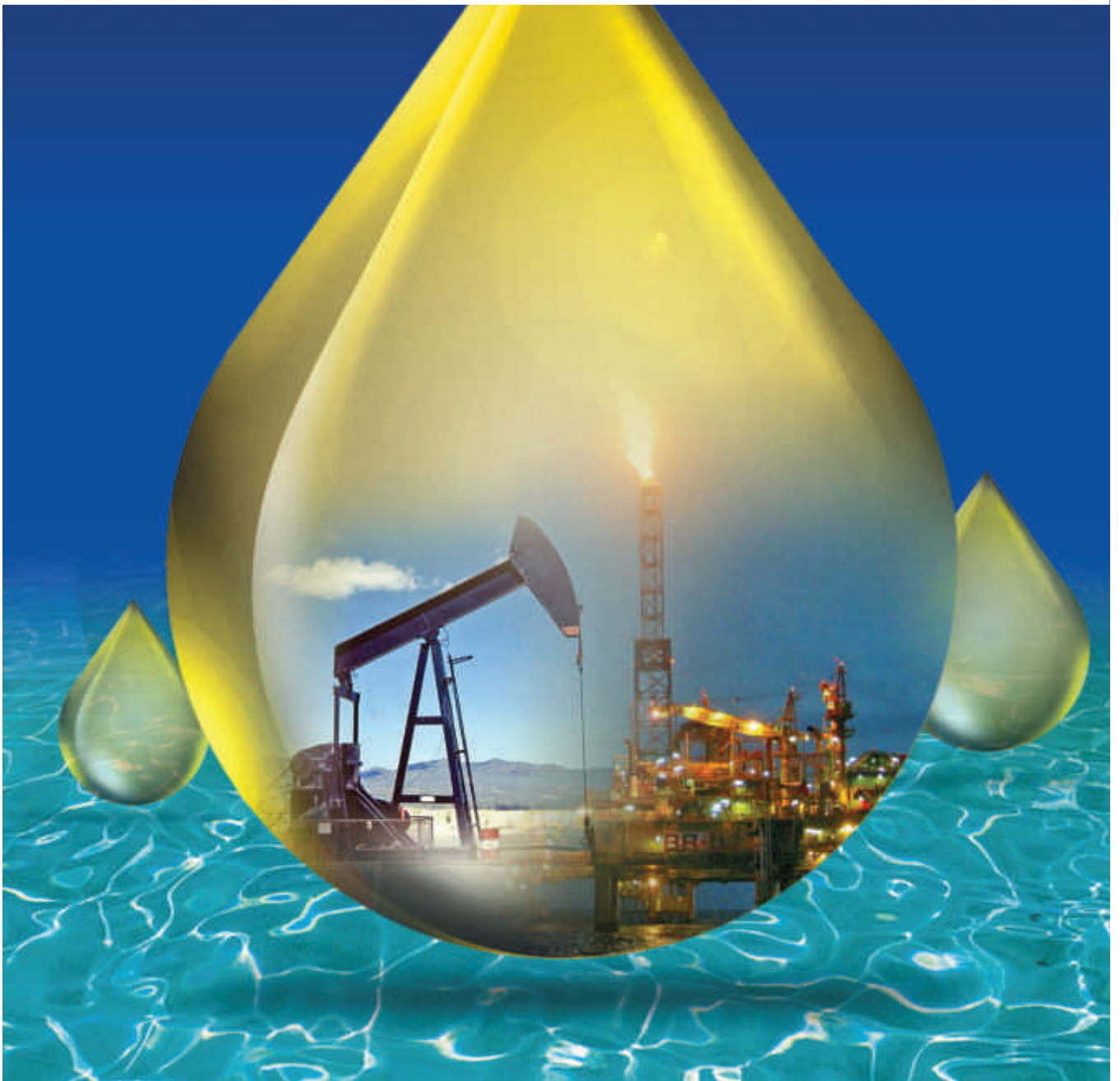


Upstream Oil & Gas Products



Energy Solutions

Improving your business is our business

Thermax is an engineering company that helps business enterprises perform competitively and sustainably in global markets. In over 75 countries, clients make use of Thermax's products and solutions for energy efficient and eco-friendly operations: heating equipment and power plants that use a wide variety of fuels including solar energy; absorption chillers that use heat in place of electricity; waste heat recovery units; water & waste water management, air pollution control systems; performance improving chemicals.

The company provides its customers value added services – audits of energy and water, system modifications for optimal use of resources, annual maintenance contracts, energy rentals and O&M of power and water installations.

Thermax operations are supported by innovative R&D and partnerships with global technology majors. It has an international sales & service network spread over 24 countries and state-of-the art facilities (in India, Denmark and China) that manufacture to international standards.

Thermax Babcock & Wilcox Energy Solutions(TBWES)

TBWES, a wholly owned subsidiary of Thermax Limited provides equipment and complete solutions for generating steam for process and power needs through combustion of various solid, liquid and gaseous fuels, as well as through heat recovery from turbine/engine exhaust and (waste) heat recovery from industrial processes. TBWES also offers heaters for various applications in the Chemical, Petrochemical and Refinery segments. Its services arm offers renovation and modernization solutions for old boilers and heaters.

The major industry segments served in India and across the world are Steel, Refinery, Petrochemical, Power, Cement, Sugar, Distillery, Fertilizer, Paper, Chemical, Non Ferrous Metal and Textile.



Thermax is focused on customer satisfaction through constant up gradation of technologies and a deep sense of understanding of the market needs. Thermax has acquired a reputation of accomplishing innovative and challenging projects.

Thermax Today

Core businesses in energy and environment: ♦

Boilers and Heaters for Industry

- ♦ Boilers for Power Utilities
- ♦ Absorption Coolers
- ♦ Water and Waste Treatment Solutions
- ♦ Chemicals
- ♦ Air Pollution Control
- ♦ Power (Turnkey Projects)
- ♦ Power Plant Auxiliaries
- ♦ CDM Solutions

▪ ISO 9001 : 2015 accredited

▪ ISO 14001: 2015 certified plant

▪ OHSAS 18001 : 2015 certified plants

▪ Manufacturing facility spread over 27 acres at Chinchwad near Pune in Western India

▪ Manufacturing facility spread over 100 acres at Savli near Vadodara Western India

▪ Assembly facility near Mundra Port region on Western Coast of India

▪ Manufactures to international standards–ASME, EN,



Product Offering



4 X 100 Mn Btu/Hr Once Through Steam generators at Shell project in Canada.

TBWES offers solutions in the Oil & Gas segment. These offerings cover the entire spectrum of Upstream as well as the Downstream segment. These systems involve using any of the mediums acceptable for the process like :

- Water
- Water-Glycol
- Thermal oil

Manufactured as per Technology developed by Thermax

Upstream Offerings

- Waste Heat recovery units on Gas turbines.
- Fired heaters for Off shore platform & On Shore for Water glycol/Thermal oil/water heating/Crude heating
- Once Through Steam Generators - For Enhanced Oil Recovery



THERMAX



5 units of 36.19 mw waste heat recovery unit supplied to one of the renowned oil major in Abu Dhabi



Waste Heat Recovery Units



FPSO, being positioned in Offshore waters.

Waste Heat Recovery Units (WHRU)

WHRUs are engineered to recover waste heat from the exhaust of Gas Turbines or Reciprocating engines, heating media could be Water glycol mixture or Thermal Oil or water depending on the application. These units are installed on

- Offshore platforms.
- Floating Production Storage and Offloading Vessels (FPSO's).
- LNG Tankers.
- Onshore terminals and Gas Processing Plants.

There are over 100 installations for the Upstream Oil & Gas segment. These units are working in very diverse locations such as Sakhalin island, Asian Offshore Waters, North Sea, Africa Off shore & the Americas.

WHRU Systems are designed to offer maximum flexibility to the operator. Thermax offer Heat recovery units fitted with combustion systems to provide additional heat release. The units supplied by us can cater to the heating of

- Water
- Water Glycol Mixtures
- Thermal Oil

Manufactured as per Technology developed by Thermax



3 nos Water Glycol heaters of 16 MW duty for BP Clair platform phase 1 in the North Sea on a Solar Gas Turbine



WHRU with a typical 2 stack design behind a gas turbine.





Waste Heat Recovery Units

TBWES a wholly owned subsidiary of Thermax Limited has built a number of Heat recovery units down stream of the Gas turbines , Gas engines / Oil fired engines. The heat recovery units have been configured on engine size ranges from sub MW up to 160 MW machines. These units have been configured as heat recovery units or as supplementary fired units as well. The units have been built on machines supplied by :

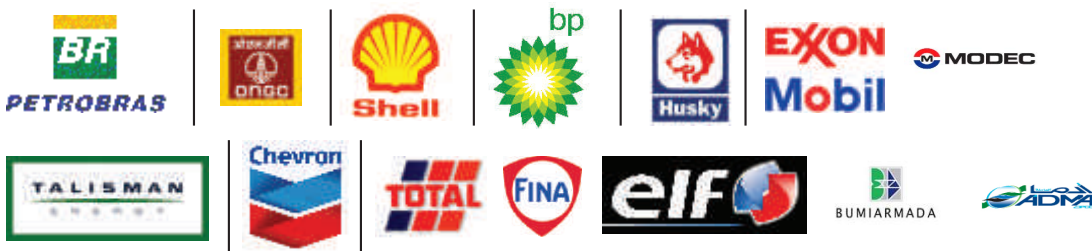
- Solar
- General Electric
- Sulzer
- Rolls Royce
- Wartsila
- Hitachi
- Siemens
- Dresser Rand

TBWES offers the unique option of specially designed integral by pass systems.

This system offers special features such as :

- Compact space saving design
- Integral by pass facility.
- On line isolation of WHRU.
- Single stack option.
- Removable tube bundle.
- Optimum gas side pressure loss.
- Supplementary fired units
 - with FAF
 - without FAF

Some of the OIL Companies using the WHRUs



WHRU assembly with Integral Bypass & Multi Louver type damper for the Shell Bonga project. The project uses 4 nos of Water heater each of 10.7 MW on Solar Mars Gas turbines.



Fully Shop assembled stainless steel tube bundle for a project in South America for Petrobras Brazil on Rolls Royce RB 211 gas turbines .



Once Through Steam Generators



Facility using once through stem generation at EOR site in Venezuela

Once Through Steam Generators (OTSG)

These are steam generators that are designed to generate steam by combination of liquid or gaseous fuel. This units are modular in construction and capacities ranging from 25MM Btu/Hr upto 300 MM Btu/Hr

TBWES is a leader in the field of Once Through Steam Generation (OTSG). The first ever licensed OTSG technology was provided by TBWES to Canadian Boilers Ltd. in Canada. The designs catered to the requirements of such application in the early 80's. These units were very compact and used the helical closed coil design. Many such units have been successfully installed and operating in Canada.

The designs have since been up graded to cater to the requirement of handling produced water, a wide range of heavy fuels like Bitumen etc. The new adaptations use the helical spaced tube that provides a number of advantages over the serpentine coil designs.

Manufactured as per Technology developed by Thermax



4 coil type boilers at Shell site in Canada, generating 33 TPH steam at 162 Bar pressure.



45 Te/h Coil Boiler being transported



Once Through Steam Generators

Applications of Once Through Steam Generators (OTSG)

These are steam generators that are designed to handle water with very high Total Dissolved Solids (TDS). The steam generated is used for

- Steam Assisted Gravity Draining of oil (SAGD).
- Enhanced Oil Recovery (EOR).

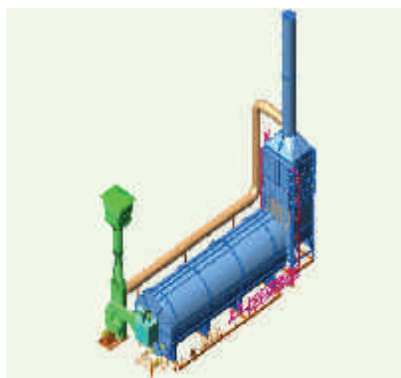
TBWES designed OTSGs are built with following advantages :

- Ability to fire Oil & or Gas - Individually and in combination
- Ability to burn 100% Bitumen (Heavy Oil - API 9)
- Quality of steam ranging from 70% to dry saturated.
- Easy maintenance in convection tube bank
- Flexible configuration - Horizontal or Vertical layout
- Ability to handle produced water.
- Helical tube radiant configuration - for long life and reduced pressure drop.
- Special extended surface design & Cleaning device in convection bank - minimize fouling & improved availability
- Nox reduction with optional flue gas recirculating system.
- Special radiant tube support design, resistant to high temperature corrosion
- Packaged design for mobile unit

Some of the OIL Companies using the OTSG



Vertical up fired OTSG for Bitumen firing at JACOS site in Canada



Horizontal OTSG with recirculation



Trailer mounted mobile steam generator.



Waste Heat Recovery Units - Recent References



S.No	Client	City	Installn Country	EPC	EPC Country	# of units	Capacity in mw	Fuel or heat source	Commg. Year
1	Petrobras America Inc.	Caroica Offshore	Brazil	MODEC	Singapore	4	27.98	GE LM2500+G4	2013
2	ONGC	Navi Mumbai	India	L&T	India	3	13.5	Kawasaki Compressor	2011
3	ONGC	Navi Mumbai	India	L&T	India	1	7	Solar Mars	2011
4	Sonatrach Algeria	Menzel Ledjmet Est Onshore	Algeria	GE Oil & Gas	-	3	18	PGT 25 DLE	2011
5	ONGC	Navi Mumbai	India	Afcons Gunanusa JV	India	1	14.5	Siemens SGT 400	2011
6	ONGC	Navi Mumbai	India	Afcons Gunanusa JV	India	1	13.5	Kawasaki Compressor	2011
7	PTT Thailand	Offshore	Thailand	GE Oil & Gas	Thailand	2	16.47	LM 2500+	2011
8	ONGC	Navi Mumbai	India	Essar Offshore	India	4	6.7	Solar Mars	2010
9	Abu Dhabi Marine Operating Company (ADMA-OPCO)	Abu Dhabi	UAE	NPCC Technip Consortium (NTC)	UAE	3	9.2	GE PGT 25+	Under Execution
10	Abu Dhabi Marine Operating Company (ADMA-OPCO)	Abu Dhabi	UAE	Hyundai	Korea	5	36.19	Rolls Royce trent 60	Under Execution
11	Bumi Armada, Malaysia A/c ENI, Italy	Offshore Angola	Italy	Dresser Rand	Norway	3	20.67	GE LM2500+G4	2016
12	ONGC	Mumbai	India	SapuraKencana HL Sdn Bhd	India	2	14.5 & 13.5		2017

BUSINESS OVERVIEW

Project Management

In-house capabilities include project management and supply of entire product basket. Project Management skills include QA, planning, procurement, expediting, document control, inspection, reporting etc., and are well developed and practised. Every major project has a dedicated Project Manager appointed as a 'single point' responsibility for project execution. They also ensure in house as well as Subcontract Liason required for project execution.

Engineering

A core engineering team well experienced in thermal and mechanical design, detail drafting and specification for UOG products, related systems and services.

Fully computerised design processes for products and systems, using both in-house and proprietary software packages, are applied to:

- Thermal design
- Mechanical pressure part design
- Fluid dynamics
- Stress analysis
- Structural design
- CFD analysis
- Vibration analysis

Products and systems can be designed in accordance with a wide range of internationally accepted standards, including but not limited to :

ASME	GOST (Russia)
CSA	Stoomwezen
EN	AD Merkblätter (German)
ISO	NR - 13 (Brazil)
DOSH (Malaysia)	NORSOK (Norway)



Manufacturing

Based on project requirements, UOG has freedom to manufacture at strategic locations worldwide, including the use of the Company facilities at Pune or Vadodara in India or port based assembly yard. Units can also be manufactured at offshore locations.

All 'associate' manufacturing plants are accredited to established international quality standards (ISO 9001-2008, ASME, TUV, Lloyds etc.) and are selected on a project by project basis as most appropriate.



Stainless Steel Tube bundle for Petrobras project



Trial assembly of inlet/outlet boxes of a WHRU



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TBWES

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Thermax Business Portfolio

- Heating
- Cooling
- Power Generation
- Air Pollution Control
- Chemicals
- Water and Wastewater Solutions
- Solar
- Specialised Services