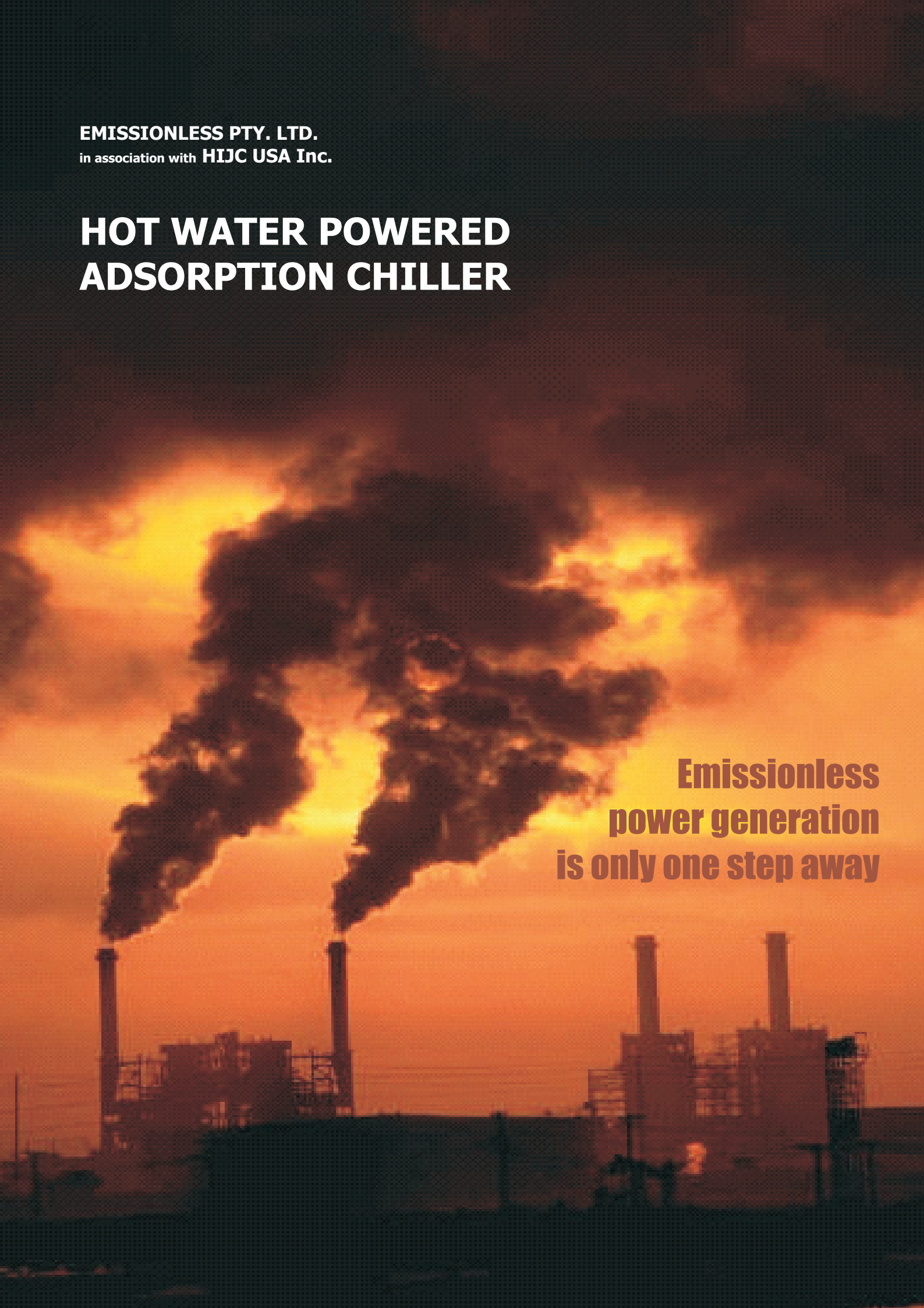
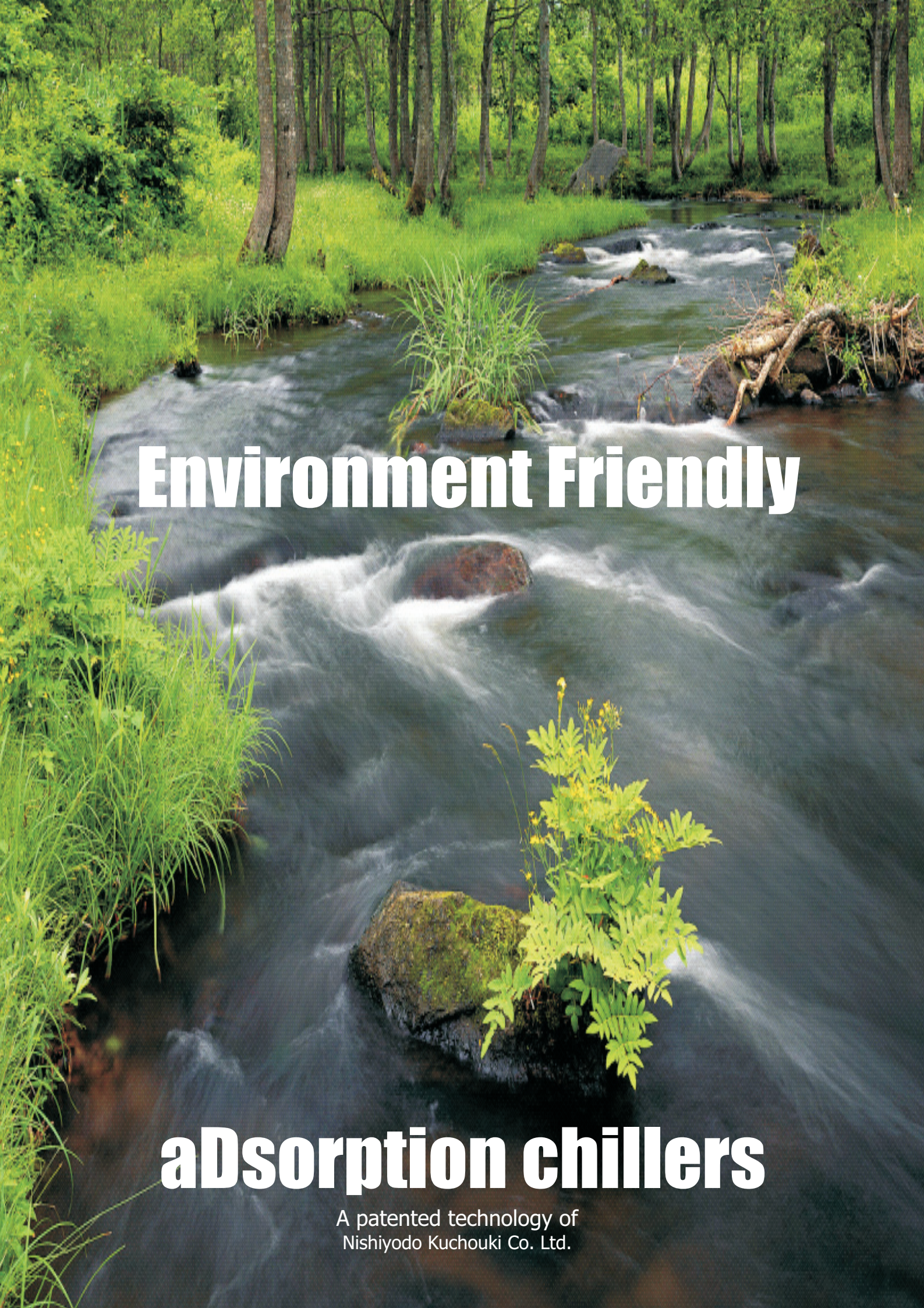
EMISSIONLESS PTY. LTD.
in association with **HIJC USA Inc.**

HOT WATER POWERED ADSORPTION CHILLER




Environment Friendly
aDsorption chillers
A patented technology of
Nishiyodo Kuchouki Co. Ltd.

Emissionless is proud to present another environment friendly energy recovery technology to Australian industry.

Adsorption Chillers

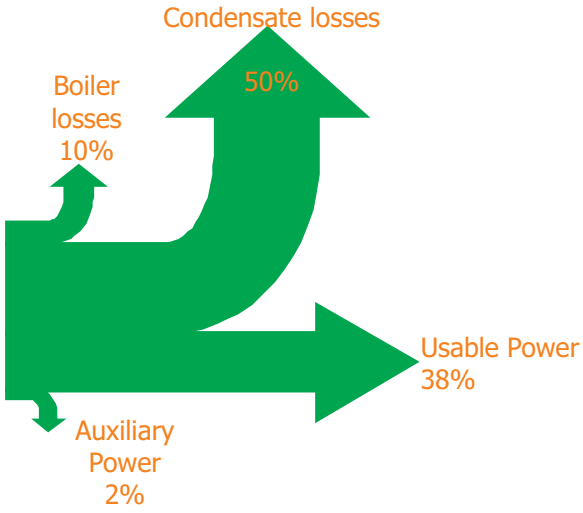
Distinctively different to

Absorption Chillers

Chillers are widely utilized throughout industry for process cooling applications and also in the commercial arena to comfort air conditioning.

In these times of increasing energy costs and environment awareness, it's becoming necessary to dramatically minimize energy wastage and where ever possible recovery valuable resources.

Power generation is a notorious waster of energy.



In your typical coal fired power station about half of the input energy is not utilized. Instead it's released into the atmosphere, most commonly in the form of steam plumes.

Typically, for small private power producers, it's either not viable or economically prudent to not include some means of waste heat recovery.

Absorption chillers have been used for many years to utilize low grade and waste heat from power generators. Their use has been particularly beneficial where process cooling could also be locally employed.

Whilst the basic absorption chiller concept is admirable from an environment protection perspective, unfortunately, absorption chillers have high maintenance costs, due to the fact that they use lithium bromide (LiBr) as their refrigerant. They are therefore economically disadvantaged and as such are not embraced by the large power users that produce the most GHG.

Now that's all changing since the advent of the aDsorption chiller.

Now, efficient energy conservation can be achieved by utilizing waste heat to drive an A**d**sorption Chiller, which can cost effectively replace any a**b**sorption chiller.

Waste heat from systems such as diesel engines, gas engines, gas turbines, fuelcells, coal, biomass, & MSW fired boilers can all be used in conjunction with a**d**sorption chillers to achieves co & tri-generation.

Using the waste heat from various processes including: food (poultry, dairy products, juice, and breweries), chemical, plastic, rubber, paper and cement can enhance the heat balance of the process.

Another source of waste heat are steam boilers, that are used year round in such applications as hospitals and hotels, which can use their waste heat in the summer to cool their facilities.

Additionally, the a**d**sorption chiller can also tap in to natures own waste heat such as geothermal and even, the ever varying, solar heat.

The a**d**sorption chiller is highly reliable and safe with low operating cost due its simplicity of operation.

The a**d**sorption chiller does not contain any Li-Br or other chemical refrigerant which means no crystallization, no corrosion no chemical testing or hazardous leaks.
The a**d**sorption chiller also does not have high voltage motors or large compressors.
The control system is self contained and trouble-free. No external temperature control valves are required to protect the chiller for capacity control.

The a**d**sorption chiller contains only water as the refrigerant and a proprietary, permanent silica gel which lasts 30 years as an adsorbent.

The evaporator section cools the chilled water by the refrigerant (water) being evaporated by adsorption into the silica gel in one of two adsorbent chambers.

It can produce chilled water temperatures of less than 4°C with hot water temperatures ranging from 90°C to as low as 50°C.

The hot water regenerates the silica gel in the second of the two adsorbent chambers.
The water vapor released from the silica gel by the hot water is condensed in the condenser section which is cooled by a cooling water, such as, from a cooling tower.

Key Benefits

- ☑ Water used as refrigerant,
  - No freons (CFC's)
  - No Li-Br
  - No ammonia
  - No corrosion
  - No hazardous leaks
  - No chemical testing
  - No replacement
- ☑ No compressor, which means;
  - No alignment
  - No high voltage
  - No high pressure
  - No overhaul
  - No oil change
  - No surging
  - No vibration or noise.
- ☑ Stable chilled water ou-put
  3°C to 9°C
- ☑ Driven by a wide hot water temperature range
  90°C to 50°C
- ☑ Stable operation, even with the fluctuating hot water temperatures and flow rates that are normal in waste heat recovery applications. No back-up burner required.
- ☑ Simple and short start-up & shutdown time
- ☑ Constant operation - 24 hours, 7 days a week.

Energy Efficient

C.O.P. up to 0.75 using only hot water

<1 kWe to produce 3 MW of cooling

Optimized to use;
- **Engine jacket water**
- **Turbine condensate**
- **Flue exhaust heat**
- **Excess steam**

Two operating modes
- **Standard & Economy**

Preserves process steam

Steady cooling output even with highly varying heat inputs

1-3 year pay-back period

Sub-zero systems also available

Key Features

HISTORY
The A**d**sorption Chiller was developed and first produced by Nishiyodo Kuchou Manufacturing Company in 1986. Since then the a**d**sorption chiller has been used and closely evaluated in a wide range of applications in Japan, Europe and USA with sensational results.

EFFICIENT ENERGY USE OF WASTE HEAT
The C.O.P. has been improved by 13% with the introduction of higher efficiency heat exchangers. Total efficiency ratings of power generation systems can be improved by including the a**d**sorption chiller in co-generation or tri-generation applications.

FOOTPRINT HAS BEEN REDUCED BY 40%
A 40% reduction of the overall footprint was achieved by simplifying the internal construction

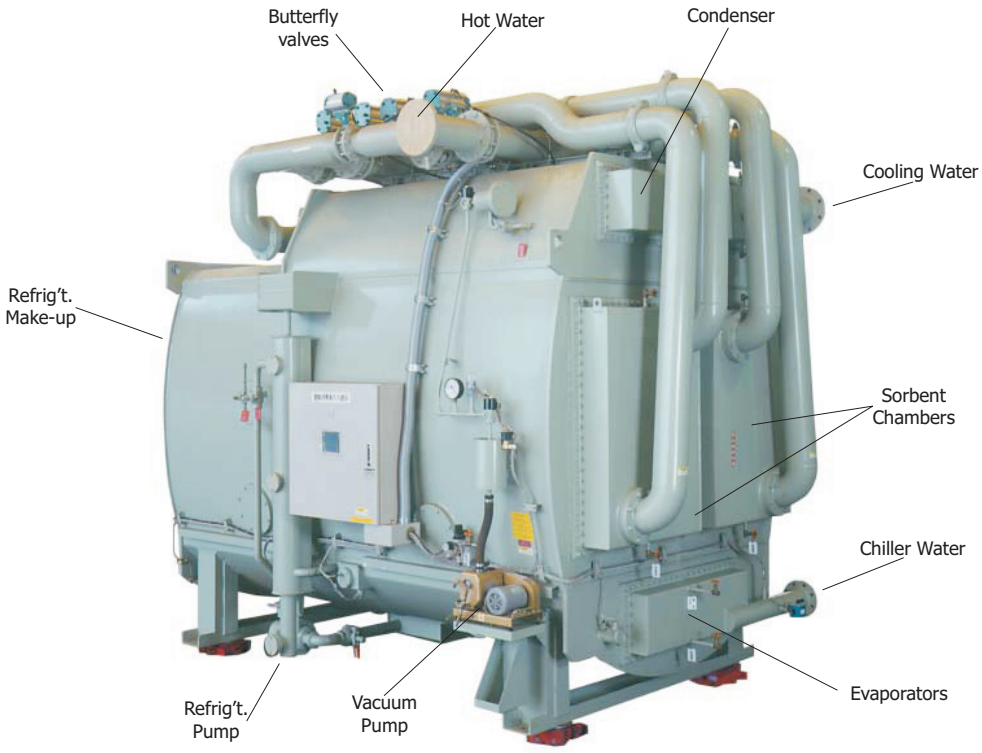
PRODUCES 3°C to 9°C CHILLED WATER
A highly sensitive temperature sensor in the high efficiency evaporator allows the production of chilled water temperatures of as low as 3°C.

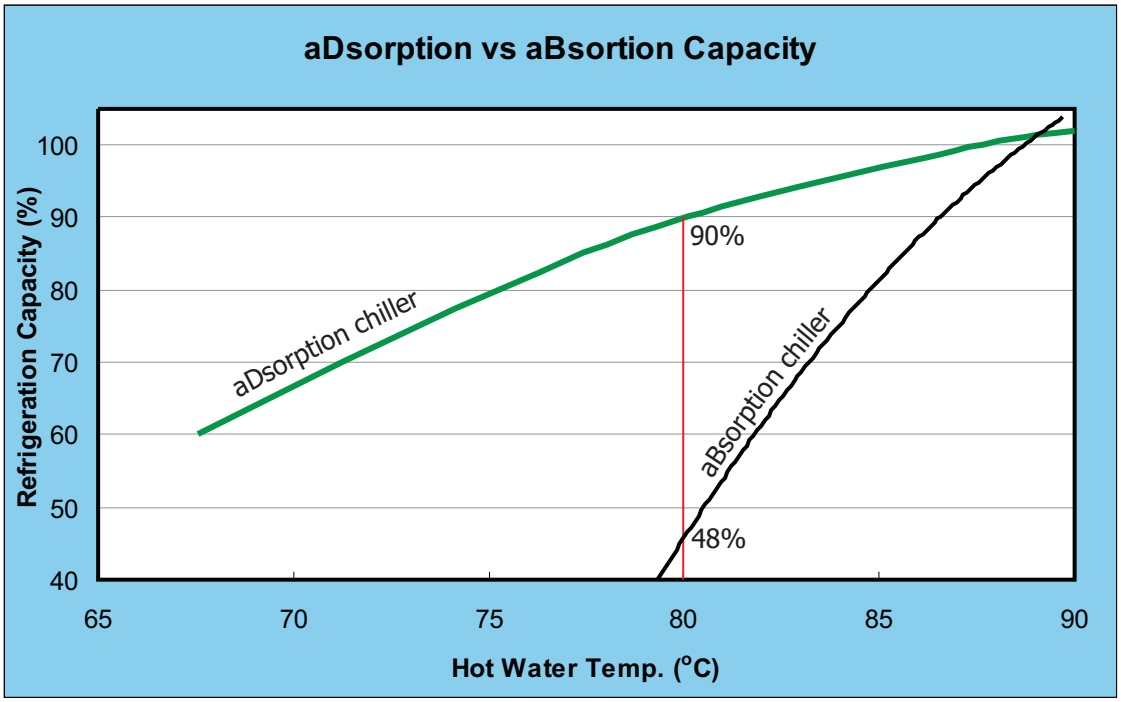
THE ADSORPTION CHILLER WAS DESIGNED FOR CONTINUOUS
Heavy industrial process cooling operation 24 hours a day, 7 days a week, the year around.

SIMPLE IN MAINTENANCE AND OPERATION
The a**d**sorption chiller is simple in its design. The silica gel and the water are contained in their respective vacuum chambers. The operation of the chiller is very simple, operating from a programmed sequencing controller. It does not require a skilled operator. Additionally, operation is safe because there is no refrigerants, oils or other chemicals used in the system.
Maintenance is very simple and inexpensive. No daily maintenance is required.

THERE IS NO RESTRICTION ON COOLING WATER TEMPERATURE LIKE AN ABSORPTION CHILLER. THE LOWER THE COOLING WATER TEMPERATURE THE HIGHER THE CAPACITY.
The recommended range for the hot water is from 90 to 50°C. We do not recommend hot water temperatures above 90°C, because of the possibility of water flashing and surging at the suction of the pump. With hot water temperatures as low as low as 50°C, the C.O.P. will be reduced, but the chiller can still operate.

System Components





BETTER PERFORMANCE

From the graph above it's evident that a**b**sorption chillers are capable of a higher level of cooling capacity than absorption chillers, when the waste heat input diminishes.

A BUILT-IN UNLOADING CONTROLLER MAINTAINS THE CHILLERS HIGH EFFICIENCY EVEN AS IT UNLOADS.

The controller senses in and out chilled water temperatures and evaporator temperature. The controller provides seven steps of unloading in order to maintain required capacity at reducing heat consumption.

FAST START-UP

The a**d**sorption chiller can produce chilled water in as little as seven minutes after pushing the start-up button on the touch screen.

VERY FEW MOVING PARTS, MEANS NO VIBRATION OR NOISE.

Chilled water temperatures of less than 4°C can be produced with hot water temperatures as low as 50°C. The a**d**sorption chiller's electrical load for the 150 ton model of just 0.4KW, for the controls and two small pumps. The controls include a control panel and solenoid valves. One of the pumps is a vacuum pump for non-condensable gases, which operates only at start-up and for one hour every forty hours. The second pump is a refrigerant (water) pump that runs only while unloading.

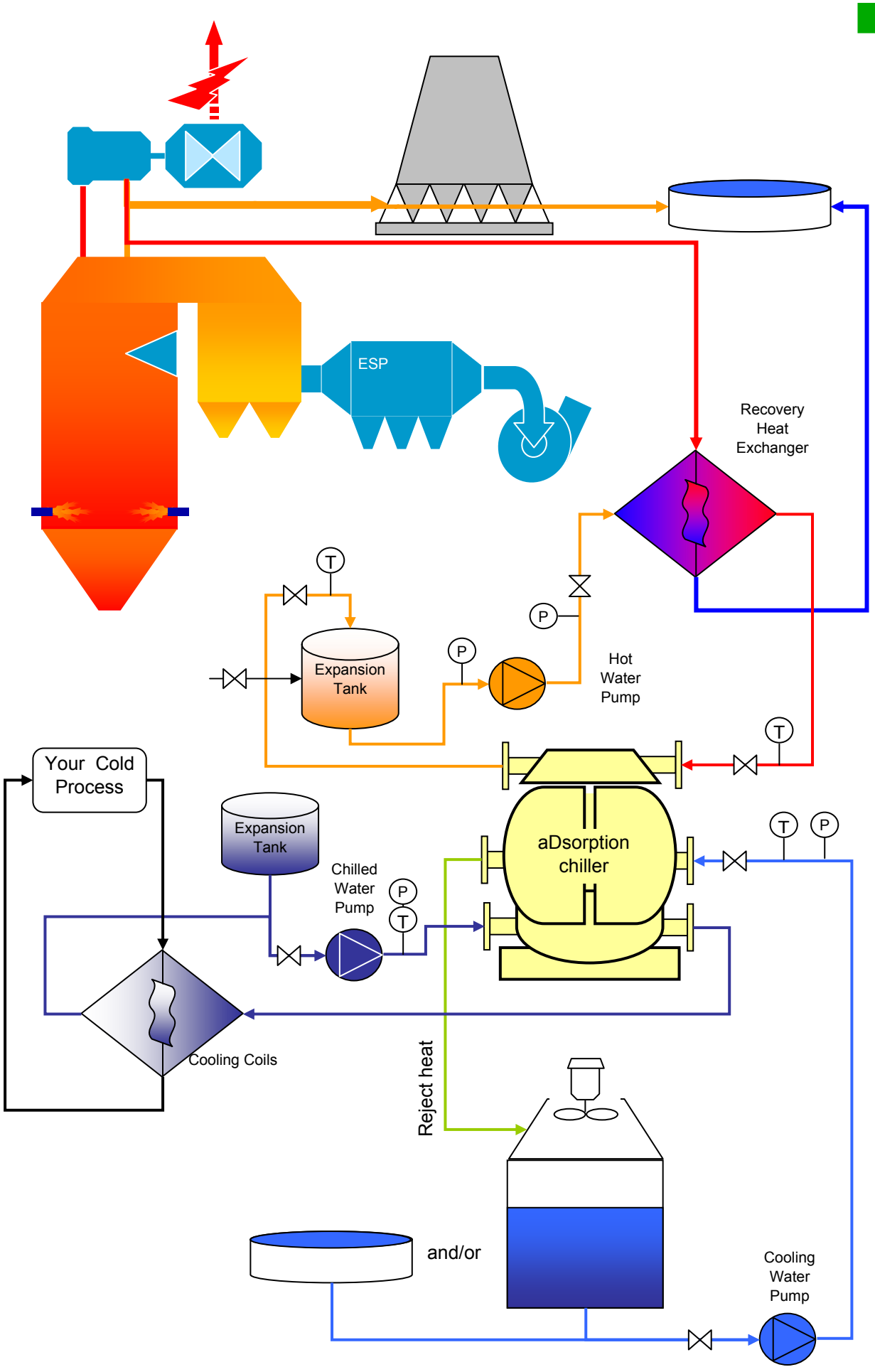
Other operational costs, such as maintenance are also very low.
Maintenance consists of periodically checking the oil level in the vacuum pump and replacing the seats on the butterfly valves once every three years.

MODULAR DESIGN

The a**d**sorption chillers are manufactured in a range of standard, skid mounted packaged sizes ranging in cooling capacity from 18.6 RT (59 kW) to 453 RT (1,593 kW). These standard units are fully shop assembled, pre-wired and ready to operate. (Unpack, plug-in and run). These units are sized for easy transport on non over-dimentional semi-trailers or can be packed inside shipping containers. Typically chiller systems are made up by combining multiple standard units. For mega tonnage cooling capacities, customized, on-site assembled systems are provided.

ADSORPTION vs ABSORPTION

Parameter	Hot Water Adsorption Chiller	Hot Water Absorption Chiller
Energy Input medium	Especially developed to use hot water, with it's supply pressure not being an issue.	Can use hot water, but most brands require steam at moderate pressures.
Energy Input Source	Any waste or excess heat source. Any hot flowable gas, liquid or solid. i.e. - exhaust gas, boiler condensate, oil cooler, sand cooler, kiln exhaust gas cooling, etc…	Most commonly boiler waste steam.
Hot Water Temperature	50 - 90°C 75% Capacity @ 70°C	79 - 100oC 50% Capacity @ 70°C Min. 58°C
24 Hrs continuous operation	Yes	**No!** Li-Br solution concentration increases in the refrigerant during operation. So dilution operation to separate Li-Br from the refrigerant is required each day. In the case of automatic dilution cycle, the chiller does not generate Chilled water during the dilution cycle.
> 8000 hrs/ year operation	Yes	**No!** The absorption chiller can not run 8000 Hrs/year due to requirement of Li-Br and inhibitor PPM level concentration maintenance (each 2 to 3000 Hrs). Li-Br solution will be diluted as the chiller runs, so Li-Br should be added to maintain the proper concentration. Additionally, when the solution is diluted, the corrosion inhibitor, which is either Cr or a Mo oxidizer that protects the metal by controlled oxidization, will be become unbalanced and become a strong oxidizer to corrode the system. The inhibitor must also be added and the concentration checked again to maintain proper balance (each 2 to 3000 Hrs). If the absorption chiller is not maintained in this manner, it will wear out in 4 years.
Maintenance Cost	Low	**High!** $ 8,000.00 / Year.2000 Hrs. 100TR $ 20,000.00 / Year. 8000 Hrs. 100TR. Concentration analysis costs you $ 1,500.00 for one chemical component. In absorption chillers there are normally 4 chemical components for a cost of $6,000.00 every 2000 to 3000 hours of operation.
Cooling Water Temperature	Any - Lower temp = more capacity	22°C min. 3 way control valve required
Minimum load	Standard	Sophisticated control required. To follow this load change from 100% to 25%, the absorption system needs buffers like hot tanks at hot water line and chilled water line. Additionally PID control system for hot water, cooling water and chilled water. If the temperature can not be maintained, the machine will shut down.
Refrigerant	Tap water	Distilled Water
Sorbent	Silica gel	Litium Bromide (LiBr)
Vacuum Pump	Yes - Only runs 1 Hr every 40Hrs	Yes
Refrigerant Pump	Runs only when chiller unloads	Continuous
	Canned	Hermetic/Magnetic
Sorbent Pump	N/A	Continuous
Control Valves	Butterfly Valves	3 Way Control Valves
Cooling Tower Size	Heat of rejection equals Cooling	Capacity plus amount of heat input
Corrosion	No	Yes! Even with the best maintenance from the manufacturer, heat exchanger bundles need replacement due to corrosion after 2.5 to 3 years when operating at 8000 hours per year.
Crystallization	N/A	Yes Low temp. Cooling water Air leakage into the machine Power loss/ failure of dilution Malfunction of system control Failure of a pressure-reducing valve Loss of Heat source
Warm up (Start)	0 - 7 min. after long stop	30 min.
Inhibitor	N/A	Inhibitor - May contain heavy metal Check inhibitors' warning label
Chiller Life Expectancy	>20 years	7 to 9 years
Sorbent replacement frequency	N/A	4 to 5 years - $ 1,200 / 30 gal. + old Li-Br disposal fee. Li-Br is hard to dispose of because the heavy metals in the corrosion inhibitor.
Heat Exchanger replacement	N/A	Should be considered due to due to corrosion problems.
Back -up Boiler/Heater	Not necessary	Needed for <85oC hot water Add to installation cost (Users might notice the machine is being driven by the boiler/heater rather than the waste heat source)
Required Hot Water Temp	Operates down to 50°C	Shut down at 82°C
Required Cooling Water Temp	Fluctuations is not a problem	Should be stable, Needs 3 way-control valve 24 - 29°C
Chilling Capacity Control	Built-in 7 step unloading	Need 3 way-control valve to by-pass return water extra cost.
Chilled Water Temperature	3°C Standard mode	5 - 9°C
Maintenance	Vacuum pump oil level & Butterfly valves seat every 3 years	Liquid analysis, Pumps, Controls, Back Up Boiler, Li-Br replacement, Heat Exchanger replacement, Air Leaks (Almost all Absorption Chillers in hospitals and hotels are replaced with centrifugal chillers due to bothersome and expensive maintenance.)
Competency	Mechanical	Mechanical, Chemical, Metalurgical
Purchase Price	Similar	
Operating cost	Low - Simple, basic, infrequent maintenance. No consumables. Low electricity consumption.	**Very high** - Constant repairs & maintenance. Corrosive nature of LiBr takes its toll on the equipment. LiBr becomes depleted and must be regularly replaced. LiBr replacement & spent substance disposal cost is high. Electricity consumption is higher.
Pay back period	1 to 3 years	Doubtful



TYPICAL COOLING APPLICATION SCHEMATIC

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With special thanks:

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