

## Topic 6 Hot Water Heaters and their control.

### Purpose:

In this section you will learn the types of hot water heaters and the control and protection devices used in water heaters.

**Objectives:** at the completion of this section the learner should be able to:

- Describe types of water heaters (instantaneous and storage) and their methods of control.
- List intrinsic safety devices (pressure relief and thermal cut-out).
- Perform testing of over temperature cut-out point of a thermostat.
- Explain switchboard requirements to supply a controlled load water heater.
- Draw the internal circuit of a twin element water heater, and supply connections.
- List tariffs employed by local supply authorities
- Describe a solar heating system and its integration into an installation.

Types of water heaters (instantaneous and storage) and their methods of control.

## Rheem Storage Hot Water Systems

### Single Element

For tanks of 250, 315 and 400L, 4.6kW, 230 V elements are commonly used.

$$I = \frac{P}{V} = \frac{4600}{230} = 20A$$

$$\text{Hot Resistance} = \frac{230^2}{4600} = 11.5\Omega$$

Also available are 3.45 and 2.3 kW elements for smaller tank capacities like 160, 80, and 50 Litres.

Mains pressure

Mains pressure

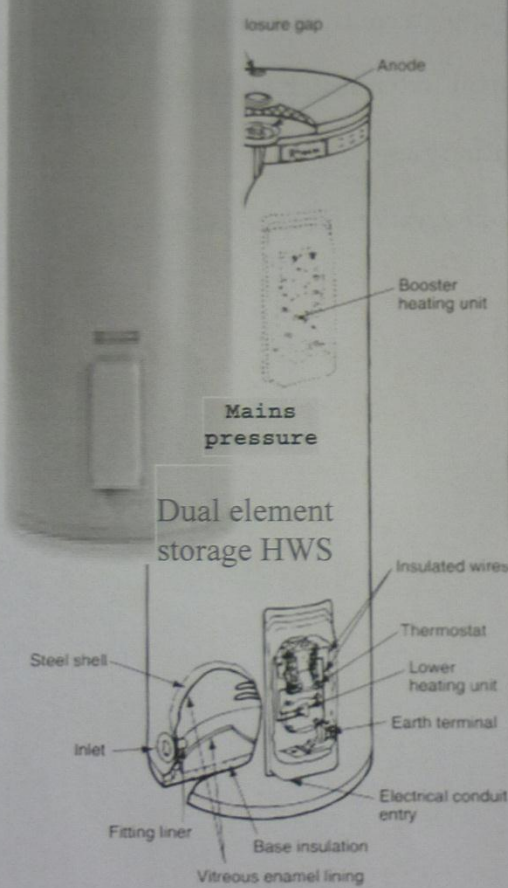
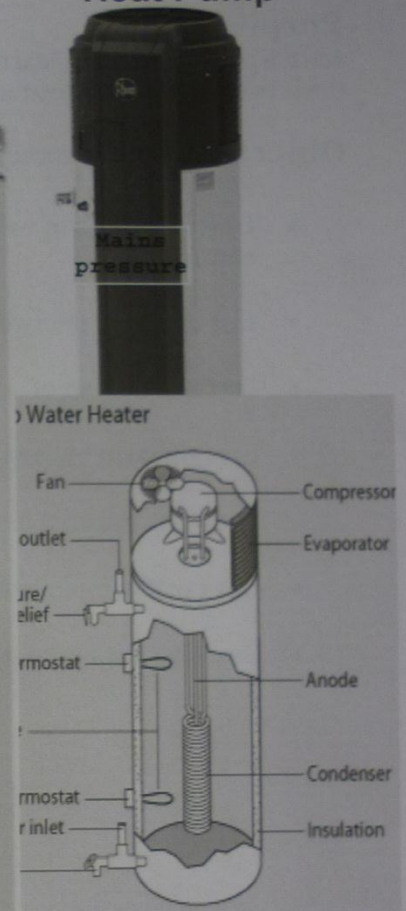


Fig. 21.9(a) Cutaway section of heater

Southcorp Water Heaters

## Heat Pump



A heat pump water heater absorbs heat from its surroundings and pumps it into a storage tank.

A fan passes outdoor air over the evaporator. Heat from the air is absorbed by the refrigerant in the pipes. Heat changes the liquid refrigerant from a low temperature liquid to a low temperature low pressure vapour.

The vapour then passes through a compressor which increases its pressure and temperature.

The hot vapour is pumped into the coil of the heat exchanger (the condenser) in the water tank.

The high temperature, high pressure vapour condenses back to a low temperature liquid and is pumped back to the evaporator.

The whole reason for using a storage hot water system is to heat the water when the electricity can be purchased at a low cost, i.e. At the off-peak rate. This is usually between 11 pm and 7 am.

A control relay connects the HWS to an electromechanical kilowatt-hour meter whose energy is billed at a much lower rate than the ordinary rate.

Alternatively one controlled output terminal of an electronic meter is energized during Off-Peak hours to supply storage heating systems. The output from this terminal is billed at the off-peak rate.

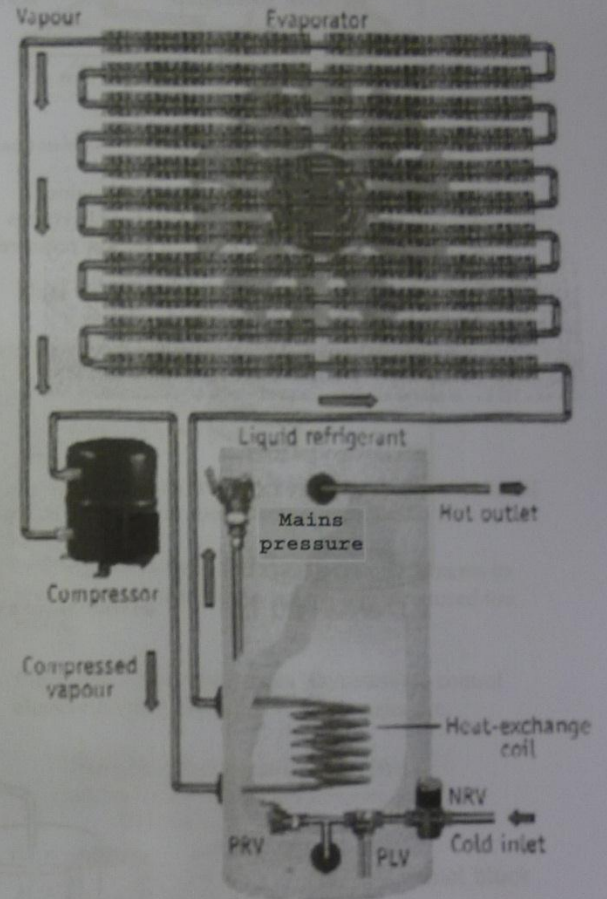
Local councils require energy efficiency of new buildings. This may rule out the use of electric storage hot water systems, and lead to the choice of more energy efficient heat pump or solar hot water heating. Gas hot water heating may also be chosen as it is considered to be better for the environment.

Smaller storage hot water systems (under 250 Litres) are no longer connected by supply authorities to the off peak rate.

The smaller systems are connected to a continuous supply. They are described as being continuous and not controlled.

### Heat pump HWS

A heat pump water heater is much more efficient than an electric element powered HWS. It uses much less electrical energy to heat a quantity of water.



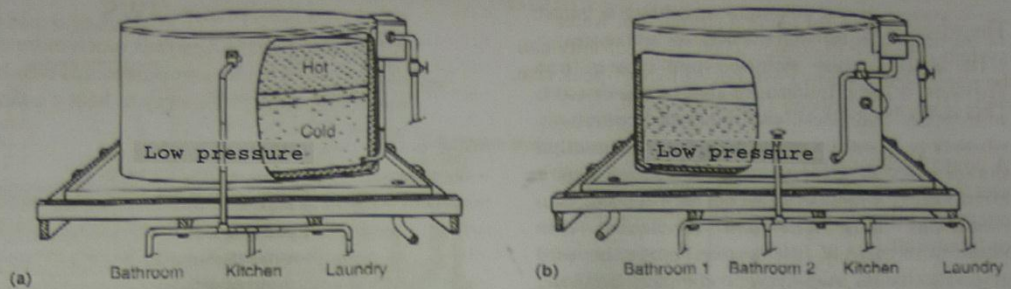
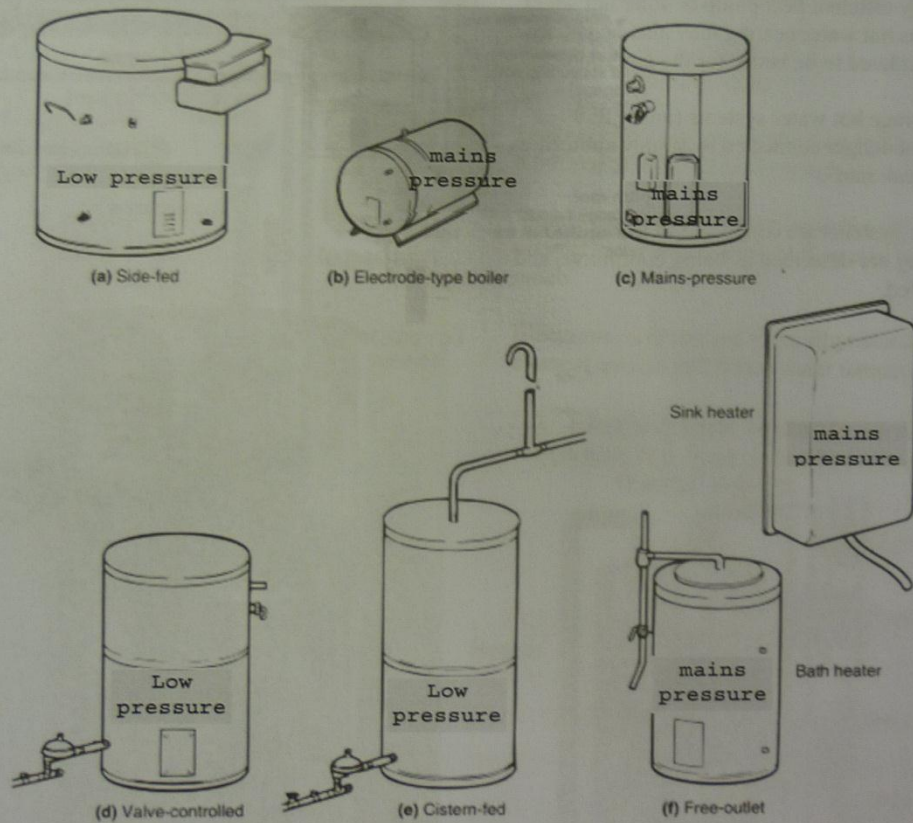


FIG. 21.8 Low-pressure water heaters: (a) displacement type; (b) falling-level type

Most storage hot water systems are now mains pressure units. However, many gravity fed systems are still in use. These are described as “low pressure” and “vented” systems.

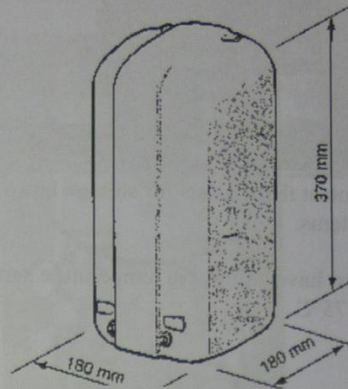
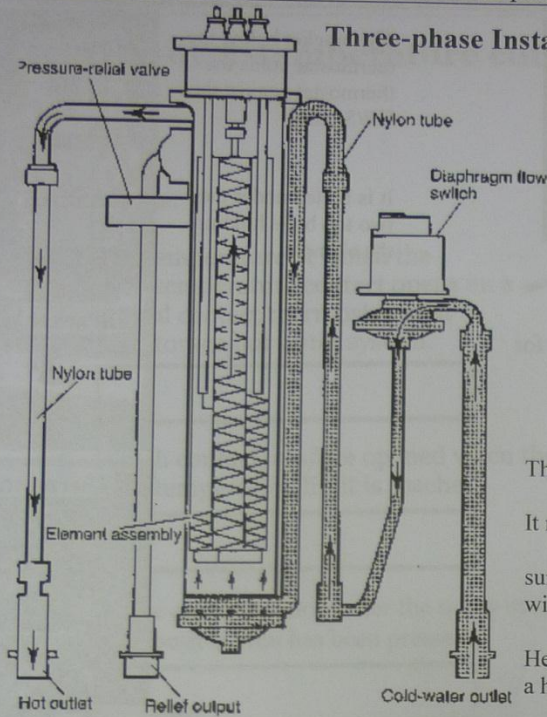
The falling level type uses an inlet solenoid to delay the inlet of cold water. This allows the stored hot water to remain hot until the tank level is low, at this point, a level sensor activates the inlet solenoid.



10 Types of hot-water systems

State Electricity Commission of Victoria

### Three-phase Instantaneous



Three actives and earth only are wired to this HWS.

It may have a selector switch with two settings:

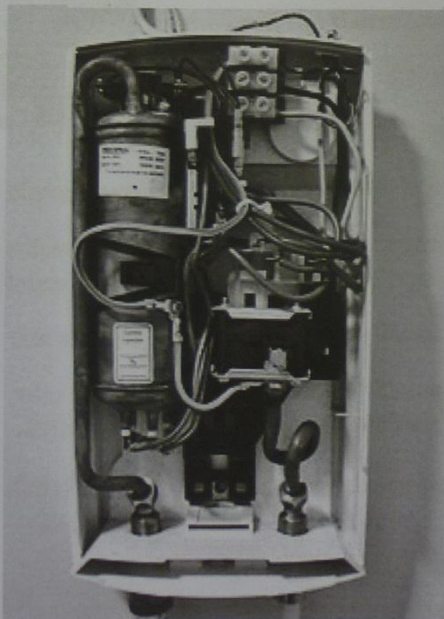
- summer 15A per phase
- winter 18A per phase

Heating elements are switched on by the flow switch if a hot water tap is opened enough.

Simple flow switch control switches off elements to prevent water overheating if flow rate is reduced too much.

Electronic versions use triacs (thyristors) to control element current and hence water temperature.

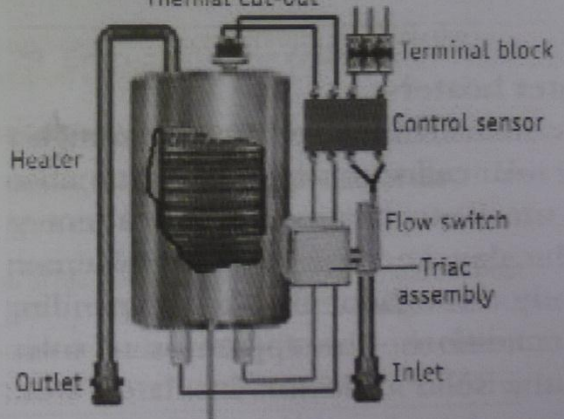
### Three-phase Instantaneous

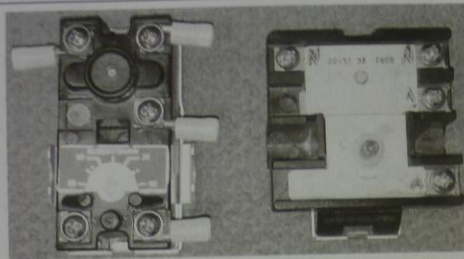


### Single-phase instantaneous

(suitable for a single tap low flow rate only)

#### Thermal cut-out



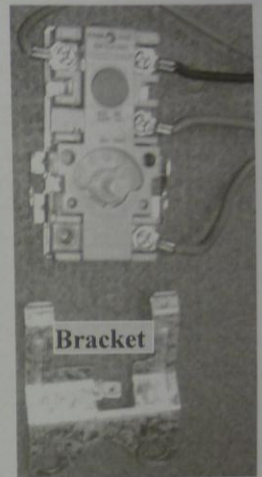


Contact thermostats for storage hot water systems.

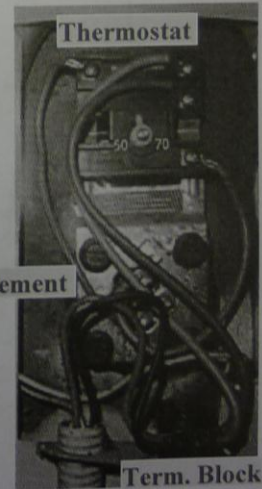
Most have adjustable temperature settings for 50-75°C

The bracket below the thermostat holds the thermostat against the HWS tank.

It is bolted under the two top bolts holding the element.



Bracket



Thermostat

Element

Term. Block

## Test the over-temperature cut-out of a thermostat.

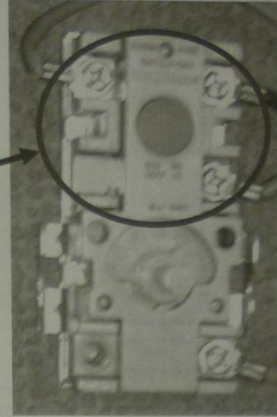
### Aim:

To determine:

1. The temperature at which the over-temperature contact opens on a typical contact thermostat used in a storage hot water system.

2. Which contact/s is/are opened when the over-temperature limit is reached.

3. Do the contacts reclose after the safety over-temperature contact has cooled and the reset push-button has been pressed.



### Method:

Insert a thermometer in the thermostat/lamp load box from the K1.1.12 store.

Connect a supply voltage of 24 V a.c. to the load through the thermostat.

Use the bypass switch provided to bypass the thermostat for this test only.

### Never bypass a thermostat contact on an unvented HWS.

Allow the lamp to heat the metal nearby and record the temperature at which the lamp is switched off by the double-pole cut-off switch.

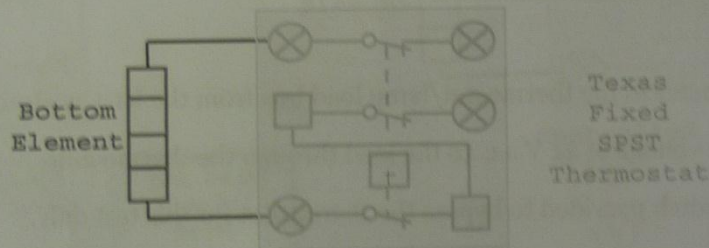
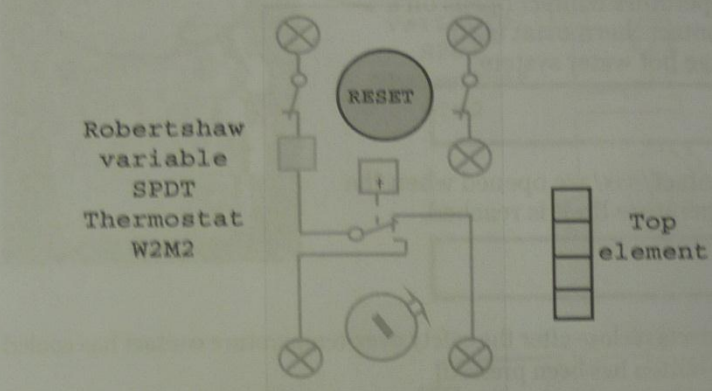
Use an ohmmeter to determine which contact/s has/have opened.

After the unit has cooled press the reset button, and check the continuity of the contacts to see that they have reclosed.

**Conclusion.** Comment on the operation of the thermostat and over-temperature cut-out switch.

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## The internal circuit of a twin element water heater, and supply connections.

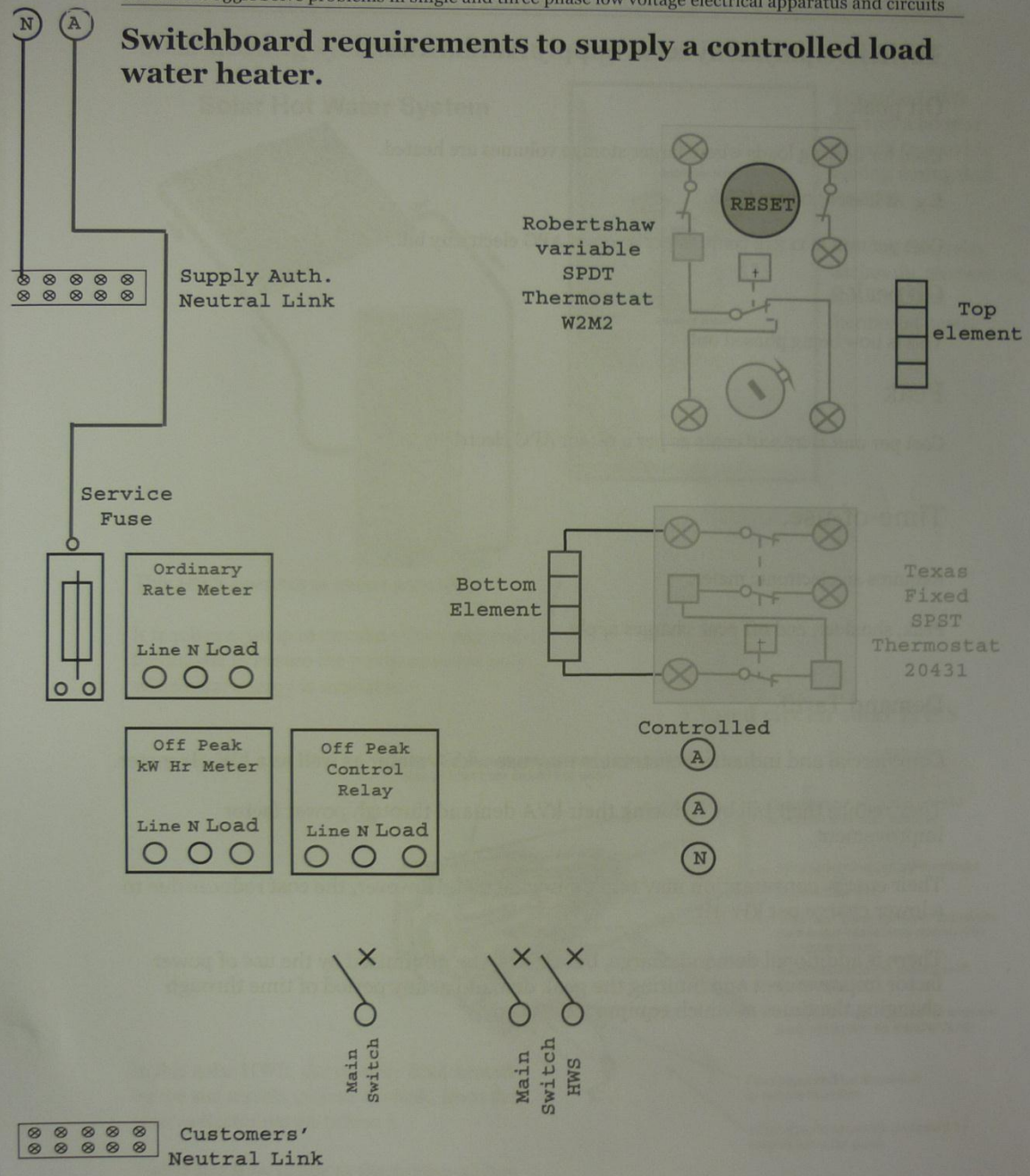


- Controlled A
- A
- N

### Dual Element HWS



## Switchboard requirements to supply a controlled load water heater.



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## Tariffs employed by local Supply Authorities

### Off peak 1

Used for heating loads where larger storage volumes are heated.

E.g. At least 250 litre HWS.

Cost per unit is 11.312 cents as per a recent APG electricity bill.

### Off peak 2

This is now being phased out.

### Peak

Cost per unit is 27.328 cents as per a recent APG electricity bill.

### Time-of-use.

Requires an electronic meter.

Peak, shoulder, and off peak charges apply.

### Demand Tariff

Commercial and industrial customers may use a kVA meter as well as a kW-Hr meter.

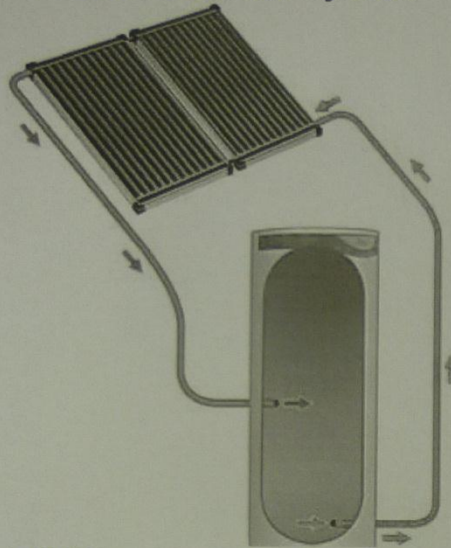
They reduce their bill by reducing their kVA demand through power factor improvement.

Their energy consumption may remain unchanged. However, the cost reduces due to a lower charge per kW-Hr.

There is additional demand charge, but this can be minimised by the use of power factor improvement and limiting the peak demand at any period of time through changing the times at which equipment is used.

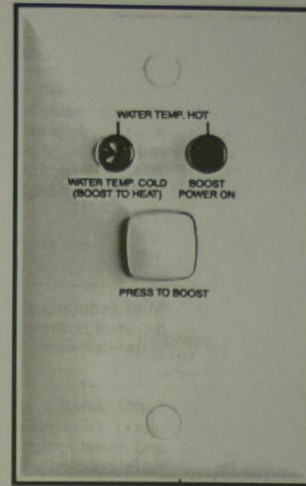
## Solar heating systems and their integration into an installation.

### Solar Hot Water System



This HWS operates at mains pressure.

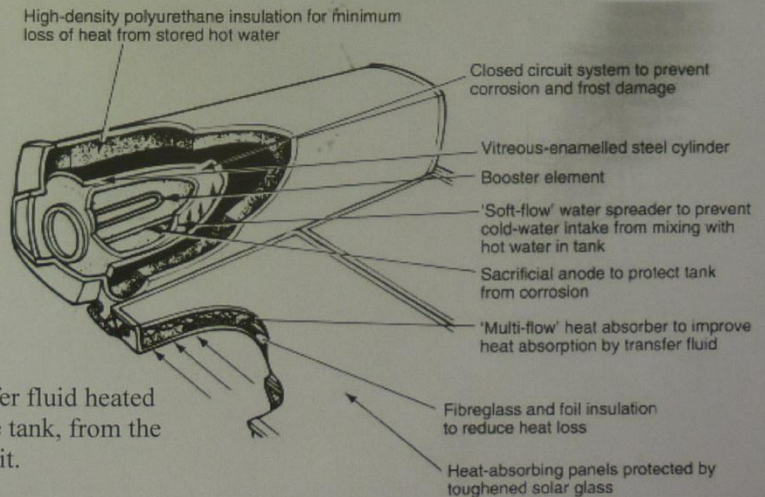
It requires a pump to circulate the water and a thermostat to ensure the pump operates only when solar energy is available.



Any solar HWS requires a booster element to provide heating during dull weather.

The one shot relay latches the element on only until the thermostat opens.

### Closed circuit solar HWS



In this solar HWS, the transfer fluid heated by the sun travels up into the tank, from the solar collector panels below it.

This water flow is due to the thermo-siphon principle. No circulating pump is required.