Space heating systems

Module 5

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Introduction

One of the key requirements of any home is to have an efficient heating system.
The following modules examine various heating technologies including operating efficiencies, heat generation, distribution systems and space heating Controls.

Module 5.1

Space Heating Systems

- On completion of this module learners will be able to:
  - Explain the principle of primary and secondary heating systems
  - Identify typical primary and secondary systems

Primary and secondary heating systems

The Annual Heat Demand for a house will determine the required power output of the heat generator to be installed. It can be met from two main types of heating systems; primary and secondary.

- **The primary (main) heating system** is that which heats the largest proportion of a dwelling. It is a heating System which is not usually based on individual room Heaters (although it can be), and often provides hot water as well as space heating.

Typical examples of **primary** heating systems:

- Wet - water based (hydraulic systems)
- Dry - warm/forced air systems
- Radiant - underfloor heating
- Electric storage

The secondary heating system (Localised heaters): is based upon a room heater.

Typical examples:

- Open fireplace
- Gas fire (either in chimney, catalytic or balanced flue type)
- Electric fuel effect fire
- Wood pellet, log, multifuel or oil fired stove
- Any other fixed appliance heating the living room
- Electric heaters are assumed where storage heaters are used as the primary heating source.

Types of Central Heating Systems

Wet Central Heating Systems

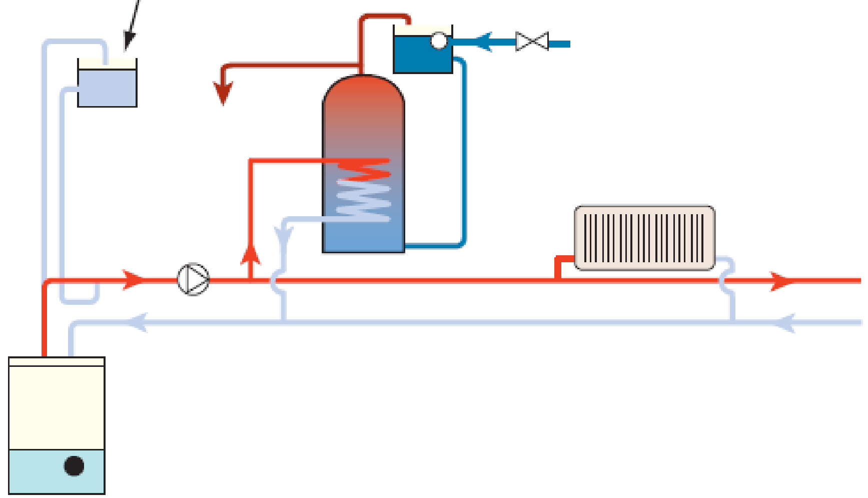
- The word wet refers to the fact that the heat generated by the boiler is transported around the house by water via a network of pipes to a heat Emitter.

- This is the most common approach to central heating in northern Europe.

- There are two main adaptations of the basic Wet system; **Open-Vented** and **Sealed**.

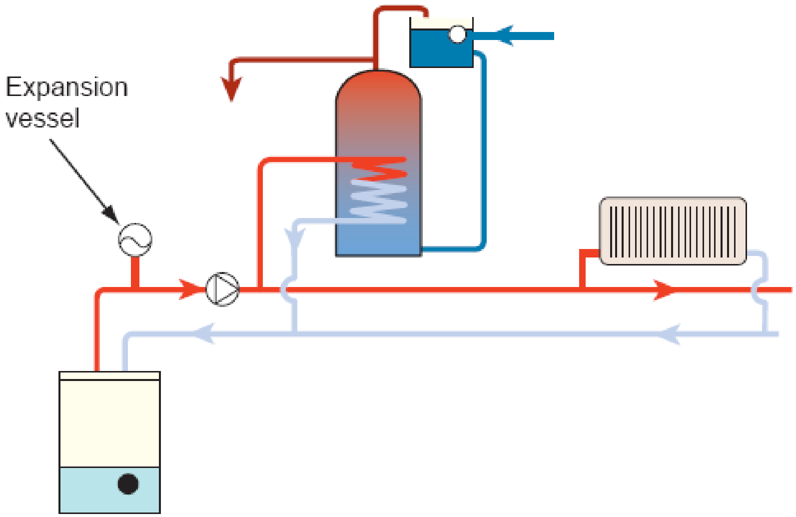
Open-vented [2]

- ‘Open vent’ refers to the separate vent pipe which is open to the atmosphere. The system also needs a feed- and expansion cistern to allow for changes in water volume with temperature.



Sealed Systems [2]

- The feed-and-expansion cistern is replaced by an expansion vessel incorporating a diaphragm to accommodate variations in water volume



Underfloor Heating

Underfloor heating is a well-established technology frequently used in new heating installations; radiant floor heating is a system of continuous pipe loops laid within a floor that carries low temperature water into specific rooms or "zones", dispersing the heat through the floor surface.

Underfloor Heating Cont.

Advantages of Underfloor heating: Since the system provides low temperature radiant heating the vertical room temperature profile is constant; this can provide one of the best levels of thermal comfort. Floor space is not taken up with space heaters. The system is classified as very low temperature hot water (VLTHW) and will take full advantage of high efficiency condensing boilers, Heat pumps, as well as Solar heating panels. Unlike other forms of heating it does not cause draughts, air dryness or dust circulation. By nature of the way in which floor heating works, less air is moved about and therefore there is less dust deposited

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Underfloor Heating Cont.

Disadvantages of Underfloor heating: The floor mass above the underlying thermal insulation where it consists of concrete screed in which the pipes are laid may result in a slow thermal response time. So it is best used in homes or buildings that will be in use for fairly long periods. Floor finish requires careful selection to ensure against the effect of unwanted thermal insulation.

Dry (Forced Air) Central Heating System

- This type of heating system typically uses a single large furnace and a network of ducting to transport the heat throughout the building.
- The main benefit of using this system is that a centralised air conditioning system can be attached to it
- This system is seldom seen in northern Europe, as people seldom require air conditioning in homes due to the temperate climate, most new dwellings have a wet central heating system installed

Module 5.2

Space Heating System Fuel Types

- **On completion of this module learners will be able to:**
  - Explain the principle of delivered and primary energy
  - Demonstrate an understanding of renewable vs. non-renewable sources of energy

Delivered energy

Delivered energy, in kWh/year: This corresponds to the energy consumption that would normally appear on the energy bills of the dwelling for the assumed standardised occupancy and end-uses considered.

Primary energy

Primary energy, in kWh/year: This includes delivered energy, plus an allowance for the energy “overhead” incurred in extracting, processing and transporting a fuel or other energy carrier to the dwelling.

TRAINENERGY

Primary Units

The conversion from a primary energy resource (coal, oil, gas, biomass) to a delivered energy is depended on the efficiency of the process. Examples are given below (based on Irish figures) demonstrating the ratio of units for primary versus delivered energy

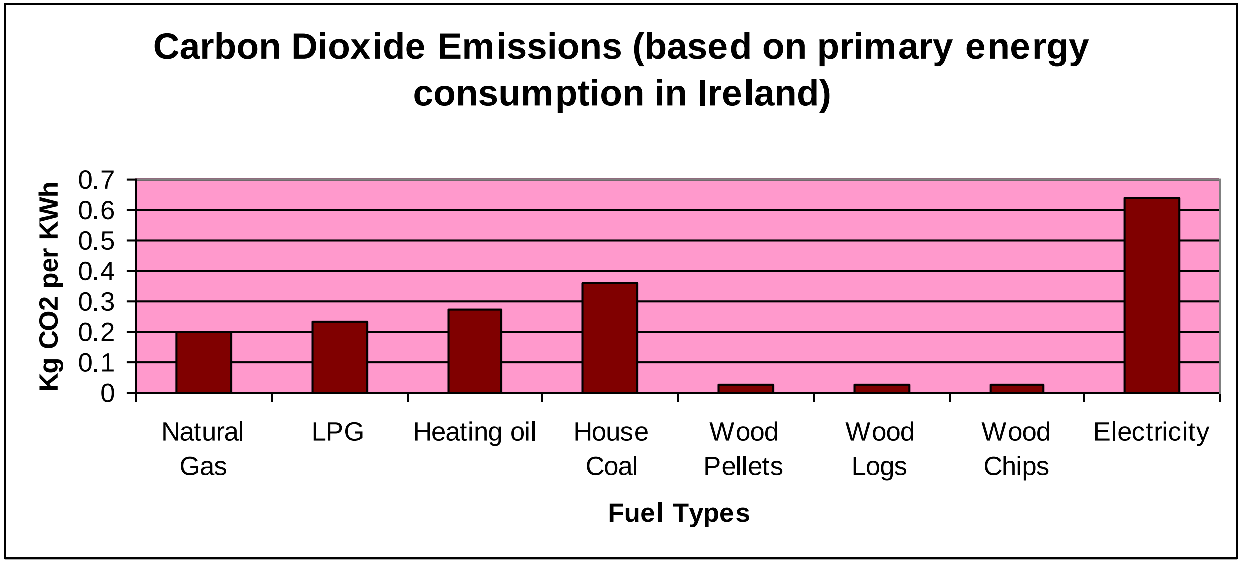
- With oil and gas, for example, energy is used pumping the oil and gas out of the ground, refining and transporting it to the home. The primary energy factors for oil and gas are 1.1… in other words one unit of energy used in a house involves a total of 1.1 units of primary getting it there (1 unit taken from the oil/gas reserve and 0.1 units getting it there).

- Much more primary energy is needed to deliver electricity to the household because of losses in the power stations and from the cables and transformers that carry the electricity from the power stations to the household. The primary energy factors for electricity is 2.7… in other words one unit of energy used in the dwelling involves a total of 2.7 units of primary getting it there (1 unit taken from the coal/oil/gas reserve and 1.7 units turning it into electricity)

Carbon dioxide (CO2) emissions

An increasing concentration of greenhouse gases in the atmosphere has resulted in an **intensifying of the greenhouse effect**. CO^2 emissions are recognised as the most important contributor to this problem.

At the end-use sectional level, tracking of primary energy consumption is necessary in the development of carbon dioxide stabilisation polices.



Source – DEAP [3]

Residential Final Energy Usage - Fuel Mix 2006

% of Total	House Coal	Heating Oil	District Heat	Wood	Natural Gas	Electricity
Austria	1.8	24.2	11.5	23.2	19.8	19.4
Denmark	0.0	12.8	33.8	18.1	15.0	20.1
Germany	1.5	28.2	5.7	7.5	38.0	19.0
Ireland	16.7	38.1	0.0	0.7	21.1	23.4
Netherlands	0.0	0.9	2.0	2.6	73.2	21.2
UK	1.5	7.5	0.1	1.1	66.3	23.5
Poland	31.1	4.1	23.4	12.9	17.0	11.5

Source- SEAI Energy policy statistical Report 2008 [8]

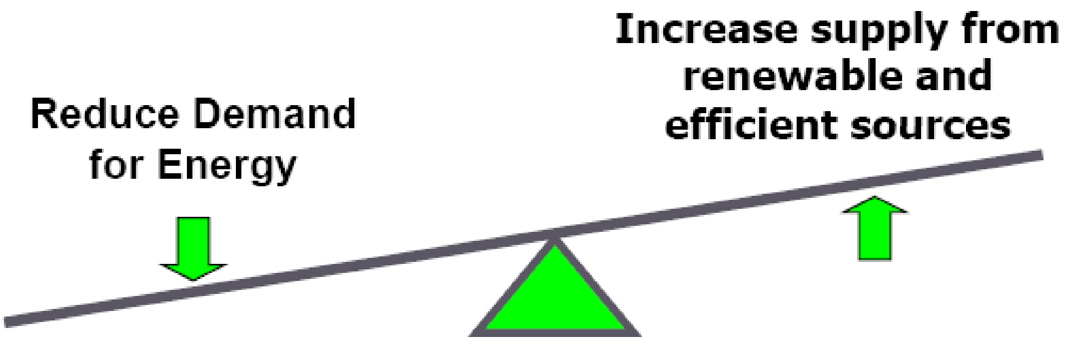
Residential Energy Consumption

- Space heating in homes represents a large energy demand, consumption for space heating in the European Union represents approximately **60%** of the total energy consumption in residential sector buildings [see module 1.1.1].
- That makes the heating sector an obvious target for reduction in fossil fuel use.

Heating Policy Strategy

The EU have carefully considered best courses of action to achieve their goals of reducing fossil fuel dependency, reducing overall energy consumption, and reducing CO^2 greenhouse gas emissions.

Their overall heating policy strategy highlights that a **reduction of heat demand** for dwellings would reduce the consumption of fossil fuels while **switching to renewable fuels** would achieve the remaining reduction.



Heating Policy Strategy Cont.

The European Union has made a commitment to raise the share of renewable energy to 20% by 2020 (compared to 1990)[4]. EU countries are developing national action plans with a view to meeting their own targets. Examples:

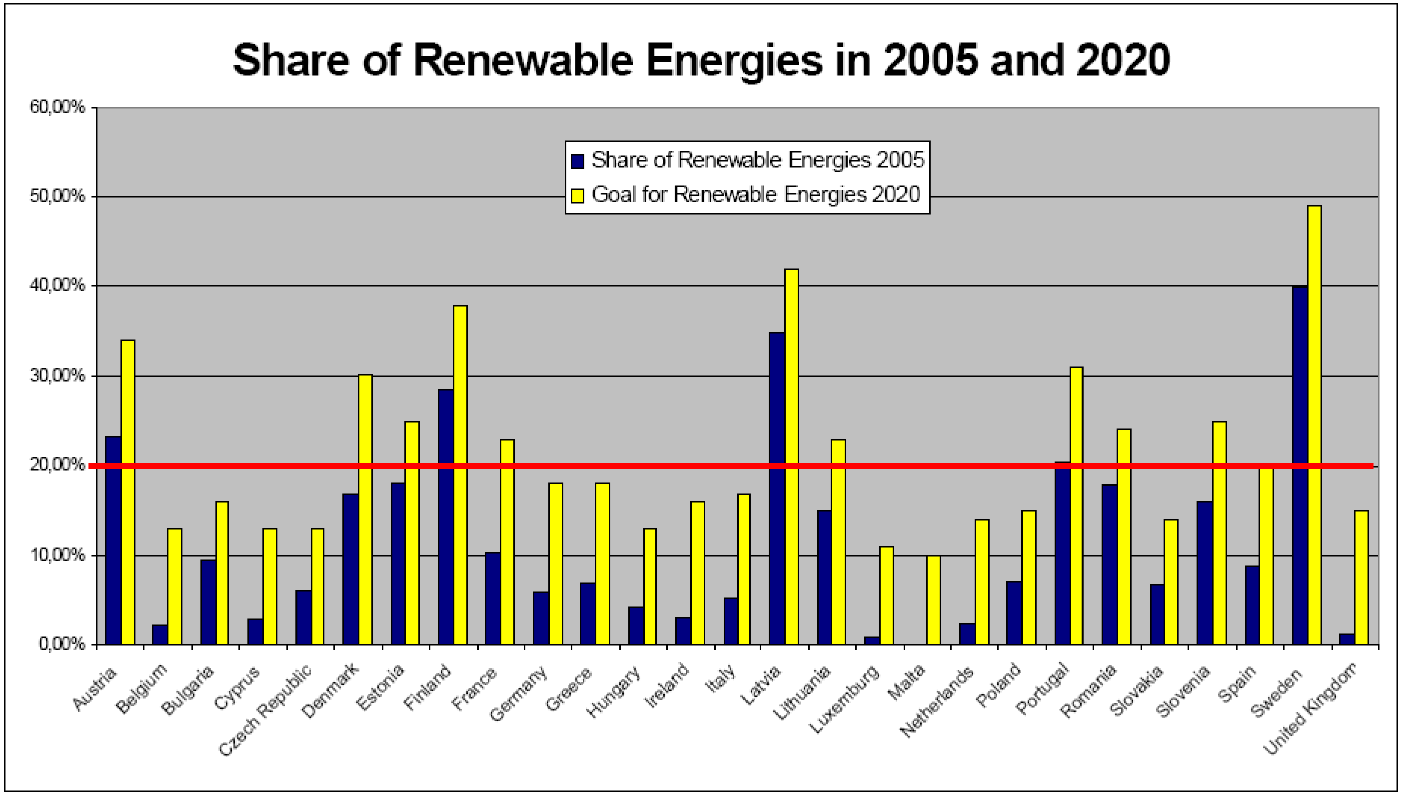
In **Germany**, all owners of new buildings must cover part of their heat demand from renewable energy sources [7]. The share is specified according
to which energy source is used:

- Solar radiation, at least 15 percent
- Biogas, at least 30 percent
- All others, at least 50 percent.

In **Ireland**, a mandatory minimum renewable energy requirement in all new homes, based upon the following levels of provision [1]

- 10 kWh/m2/annum contributing to energy use for domestic hot water heating, space heating or cooling, or
- 4 kWh/m2/annum of electrical energy, or
- a combination of these which would have equivalent effect.

Heating Policy Strategy Cont.

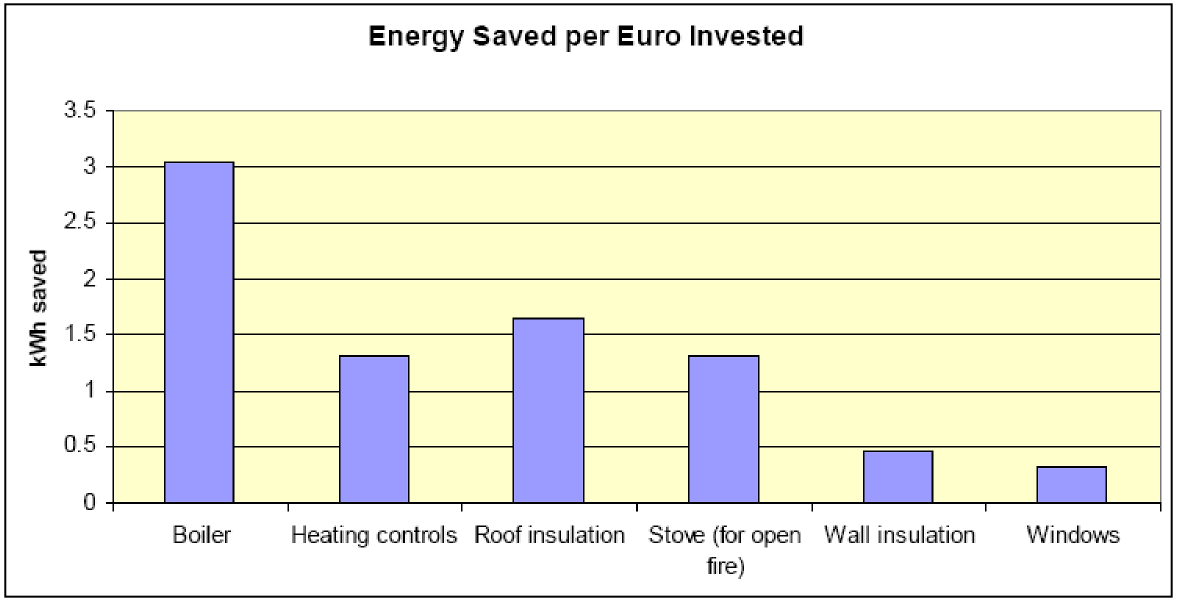


Source:ESTIF [15]

Optimising the performance of the heating system in a new building

- Size and select the most efficient heat generation system possible
- Site and design the most sustainable building possible
- Ensure the building is insulated and sealed efficiently
- Size and select the most efficient heat generation system possible
- Select the most efficient and practical heat emission system
- Ensure efficient control of both space heating and Domestic Hot Water (DHW)

Optimising the performance of the heating system in an Existing building



Source- Efficiency in Domestic Heating Systems [5]

When householders decide to improve the thermal comfort conditions within an existing dwelling, it is important that a comprehensive assessment is carried out on the dwelling to ensure their finances are invested wisely. The chart above shows how best to optimise these improvements in relation to payback.

Selecting the Type of Fuel

There are a number of **factors to consider** when selecting the type of fuel for a dwelling. All fuels need to be able to satisfy an end-users requirement in terms of:

- Environmental impact
- Affordable cost
- Availability
- Is specialist equipment or facilities are required i.e storage
- Is it user friendly

Fossil Fuels

- As fossil fuels are used up, new reserves of fossil fuels will become harder and more expensive to source until **it will become uneconomical to source energy from fossil fuels.**
- These fuels contain a **high percentage of carbon and hydrocarbons.**
- The burning of fossil fuels results in the production of carbon dioxide (CO^2). This is a major cause of the phenomenon known as '**Climate Change**'.

Fossil Fuels Cont.

There are three main types of fossil fuels: coal, petroleum, and natural gas. Another fossil fuel, liquefied petroleum gas (LPG), is principally derived from the production of natural gas.

- Coal
- Oil
- Natural Gas
- Liquid Petroleum gas (LPG)

Fossil Fuels Cont.

- **Natural Gas** is the **cleanest of all the fossil fuels**. Composed primarily of methane, the main products of the combustion of natural gas are carbon dioxide and water vapour.
- **Coal and Oil** are composed of much more complex molecules, with a higher carbon ratio and higher nitrogen and sulphur contents. This means that when combusted, coal and oil release **higher levels of harmful emissions**, including a higher ratio of carbon emissions, nitrogen oxides (NOx), and sulphur dioxide (SO^2). Work is already in progress to establish bio-fuels as a partial or complete replacement for kerosene (the oil used by most domestic oil boilers).

Fossil Fuels Cont.

- **LPG**, a mixture of gaseous hydrocarbons produced from natural gas and oil extraction as well as oil refining. Natural gas's carbon footprint comes out marginally lower than LPG's, although the difference borders on insignificance.

Renewable Sources

Climate change concerns coupled with high oil prices and increasing government support are driving increasing renewable energy commercialisation.

Renewable Technologies – Space Heating

- Solid Biomass boilers/Stoves: Wood logs, wood pellets and wood chip
- Solar Thermal Systems
- Heat Pumps

Solid Biomass

- Solid Biomass is considered to be a **zero carbon fuel**. As the tree grows, carbon dioxide is absorbed through photosynthesis and then released to the atmosphere during rotting or combustion. This release is taken up by new plant growth. There is no net release of CO^2 if the cycle of growth and harvest is sustained.
- However, there are **some net CO^2 emissions** from the utilisation of biomass. These are emissions from fossil fuels used in biomass cultivation, harvesting and transport. In general, they are small compared to the CO^2 avoided by replacing fossil fuels with energy from biomass

Solid Biomass Cont.

Modern wood boilers use up to **90%** of the energy contained in the wood for heating, similar to good oil and gas Boilers [10]. Many modern boilers also include automatic ignition and heat exchanger cleaning, automatic ash removal and ash compression (wood has a very low ash content, so ashes only have to be removed a few times a year). Some manufacturers even offer remote monitoring and boiler control.

Solid Biomass Cont.

Logs [9]: Burning wood logs is usually restricted to rural, wooded areas with urban dwellers finding supply limited and seasonal. Also, because the fuel is usually loaded manually and daily attention is required. One advantage is that, other than keeping the logs dry and clean, there are no special storage requirements.

Solid Biomass Cont.

Pellets [9]: these are free flowing and high density, so are ideal for automated domestic systems where fuel storage space is limited. The high density also makes them useful for larger applications with limited storage space, such as conversion of coal-fuelled system to wood-fuel where the original fuel bunker cannot be expanded.

Solid Biomass Cont.

Chips [9]: these are less free flowing than pellets so they require more specialized equipment to feed them automatically into a heating system. They are also less dense,
so require a larger storage space. However, they are favoured for larger systems because they are cheaper than pellets and the lower fuel cost more than offsets the increased capital cost.

Note: For further information on Solid Biomass see module 9.3

Heat Pump

- A heat pump is a heating medium that can acquire low temperature heat and **upgrade** it to a higher, more useful temperature by using the simple refrigeration process. This low temperature heat can come from basically any ambient source, i.e. outside air, water, or thermal ground resources.

Heat Pump Cont.

- Heat pumps are **not strictly a renewable source** of energy but since geothermal systems take 70% of the energy they use from the earth, the environmental benefits are obvious.
- However, the performance of heat pumps should be balanced by the fact that the efficiency of electricity generation in Ireland is less than 37% efficiency, this means that for every unit of electricity used, **2.7 units of primary energy has been burned**.
- Therefore a heat pump with a COP of 4:1, driven by electricity generated by a thermal power plant has a **primary energy efficiency of 160%.** This is significantly better than the 90-100% achieved by a gas/oil condensing boiler.

Note: For further information on Heat Pumps see module 9.2

Solar Thermal Systems

- Active solar thermal energy systems use solar collectors positioned on south-facing roofs to harvest heat, this is energy derived directly from solar radiation and can be harnessed to deliver heat for hot water and heating systems. Whilst solar thermal is primarily associated with hot water systems **it can be integrated into space heating systems** to support another heat source.

- Solar space heating systems are particularly suitable for new build as the technology is most efficient when used to supply **low temperature distribution systems** such as under floor heating. Lower operating temperatures increase the availability of “collectable” solar energy

Note: For further information on Solar Thermal systems see chapter 9.1

Module 5.3

Equipment Operating Efficiencies

- **On completion of this module learners will be able to:**
  - – Compare condensing versus traditional boilers
  - – Understand how a boiler performance is scored

Seasonal Efficiency of Domestic Boilers

- Over the years, the development of boiler technology has seen efficiency levels grow massively. Boiler efficiency is defined as how much of the heating value of the fuel is being converted to useful heat.
- **Condensing boilers** absorb more heat from combustion gases, allowing the water vapour to condense and therefore providing increased efficiency. Any hydrocarbon fuel burned in a boiler, whether it is propane, natural gas, or fuel oil, produces water vapour during the combustion process.
- **Conventional boilers** are non-condensing boilers with materials that cannot tolerate the corrosive properties of condensing flue or stack gases. Conventional boilers operate around 80 percent efficiency, compared to over 90 percent efficiency for condensing efficient boilers.
- Other factors also influence boiler efficiency, including boiler shell losses, piping losses, and cycling losses.

Seasonal Efficiency of Domestic Boilers Cont.

Sizing

- **Proper sizing** directly relates to overall boiler efficiency. Short-cycling (frequent on-off cycles) and the greater shell losses of an oversized boiler can dramatically decrease the efficiency of the heating plant.
- It is always important to **calculate heating loads** within a facility in order to properly size a boiler especially for boiler replacements, where existing boilers may be 2-3 times oversized.
- Designers often will select **multiple smaller sized boilers** to best accommodate fluctuating heating loads and provide redundancy.

Seasonal Efficiency of Domestic Boilers Cont.

SEDBUK [11]

- SEDBUK (Seasonal Efficiency of a Domestic Boiler in the UK) was developed under the UK Government's energy efficiency best practice programme with the co-operation of boiler manufacturers and provides a basis for fair comparison of different models of **oil and gas boilers**.
- Conforms with EU Directives - The method of calculation is based on full load and 30% part load efficiency test results as required for the purpose of the boiler efficiency directive (Council of the European Communities Directive 92/42/EEC)
- The SEDBUK rating is the average annual efficiency achieved in typical domestic situations, making sensible assumptions about climate, control, pattern of usage and other similar factors.
- The boiler's performance is then scored which enables the boiler to be placed in a banding system using a scale from "A" to "G." "A" banded boilers being the most efficient and usually termed 'condensing' boilers.

Seasonal Efficiency of Domestic Boilers Cont.

Energy Efficiency Bands

Band	SEDBUK range
A	90% and above
B	86% - 90%
C	82% - 86%
D	78% - 82%
E	74% - 78%
F	70% - 74%
G	below 70%

Seasonal Efficiency of Domestic Boilers Cont.

Irish Regulations

The **HARP** (Home-heating Appliance Register of Performance) database is a product efficiency database for oil and gas home-heating appliances that are used in **Ireland** [12]. It is an adapted version of the "**SEDBUK**" database.

- Since the 31st day of March 2008, part L (conservation of fuel and energy) of the **Irish Building Regulations** requires that **oil and gas** fired boilers in new dwellings must meet a minimum seasonal net efficiency of **86%** and where oil and gas fired boilers are being installed as replacements in existing dwellings, those boilers must meet a minimum seasonal net efficiency of 86% where practicable [1].

Module 5.4

Standardised Operation Conditions

- **On completion of this module learners will be able to:**
  - Explain thermal comfort conditions
  - Identify typical standardised terms used to calculate energy performance of a building – heating schedule, living area internal heat capacity.

Comfort conditions

The factors that affect the thermal comfort conditions in the rooms of a building comprise:

- Air temperature
- The temperatures of the surfaces in the room
- The air velocity in the room due to ventilation draughts
- Extremes of humidity (above 70% or below 35% relative humidity)
- The amount of clothing worn by the occupants
- The level of activity of the occupants

Dwelling Energy Assessment Procedure

- **Dwelling Energy Assessment Procedure** (DEAP), which is the Irish official procedure for calculating and assessing the energy performance of dwellings. The procedure takes account of the energy required for space heating, ventilation, water heating and lighting, less savings from energy generation technologies. For standardised occupancy, it calculates annual values of delivered energy consumption, primary energy consumption and carbon dioxide emissions, both totals and per square metre of total floor area of the dwelling.

- The procedure is compliant with the methodology framework set out in the EU **Energy Performance of Buildings Directive** (EPBD) [13]. The DEAP calculation framework is based on IS EN 13790, and draws heavily on the calculation procedures and tabulated data of the UK Standard Assessment Procedure (SAP) which is used for energy rating of dwellings in the UK.

Heating schedule

- Whilst people vary in the way that they react to a given thermal environment; conditions that feel comfortable to one person will not necessarily be satisfactory for another. **For the purpose of calculating energy rating for dwellings in Ireland** (DEAP), standard **heating hours** and **internal temperatures** are based on the requirements of a typical household.

- The heating hours and required internal temperatures in DEAP are based on the requirements of a typical household. The schedule is as follows.

Weekdays: 07.00 to 09.00 and 17.00 to 23.00
Weekends: 07.00 to 09.00 and 17.00 to 23.00

Heating schedule Cont.

This **standardised schedule** for the purposes of the energy rating calculation used in Ireland represents a total heating period of 56 hours per week.

The required (set-point) **internal temperatures** during heating periods are:

- Living area: 21ºC
- Rest of dwelling: 18ºC

Living Area: 21ºC

- The living area is the **largest public room** (irrespective of usage by particular occupants), together with any rooms not separated from that room, and including any cupboards directly accessed from that room.
- Living area does **not**, however, **extend over more than one storey**, even when stairs enter the living area directly.
- **Kitchens** (including rooms like kitchen diners) are not considered to be public rooms on their own. However if there is no door between the room identified as the largest public room and the kitchen then the kitchen should be included when calculating the living room area.

Internal heat capacity

The term thermal mass is used to refer to a building’s capacity to store heat within its external insulation envelope. A more precise term is **internal heat capacity**. To give a few examples, in a masonry cavity wall with insulation in the cavity, the inner leaf contributes thermal mass, but the external leaf does not. Likewise, if a concrete ground floor has insulation under the slab, the slab contributes thermal mass, but if the insulation is over the slab, it does not. Internal walls of dense concrete will contribute significantly to the building’s thermal mass, but lightweight stud partitions will not.

Internal heat capacity Cont.

- A building's internal heat capacity can affect its space heating requirements in the following two ways. Firstly, a building with higher heat capacity will cool down more slowly outside of heating periods, and will hence have a higher mean internal temperature. This will tend to increase the space heating requirement. Secondly, a building with higher heat capacity will make better use of internal and solar gains, which will tend to reduce the space heating requirement.

- These two effects are pulling in opposite directions, and the question of whether increased heat capacity in a dwelling is beneficial or detrimental depends on which is the more important in the particular circumstances. Factors affecting their relative importance include the building's insulation level, the amount of heat gains and the occupancy patterns.

Module 5.5

Space Heating System Controls

- **On completion of this module learners will be able to:**
  - Describe the range of controls commonly used in space heating systems and what they do.
  - Demonstrate that not only will heating controls help the environment through lower CO^2 emissions, it will also benefit homeowners through greater home comfort levels and reduced home heating costs.

The Benefits of controls

- Can reduce fuel consumption and CO[2] emissions by 18 per cent.
- Ensure the right comfort conditions are maintained avoiding higher than necessary room temperatures.
- Turning down a room thermostat by 1°C reduces space heating consumption by 6-10 per cent.
- An easy to use programmer that is adjusted to match the householder’s occupancy pattern helps reduce wasteful heating when no one is at home.

Individual Controls

- **Time Switch** - A simple time control that will only switch one circuit. It should be chosen so that it is easy to understand and reset, especially when there is a change to the householder's domestic routine.

- **Programmer** - This can switch two or more circuits separately. A full programmer allows fully independent time setting for **space** (living and sleeping circuits can be timed separately) and **hot water** heating.

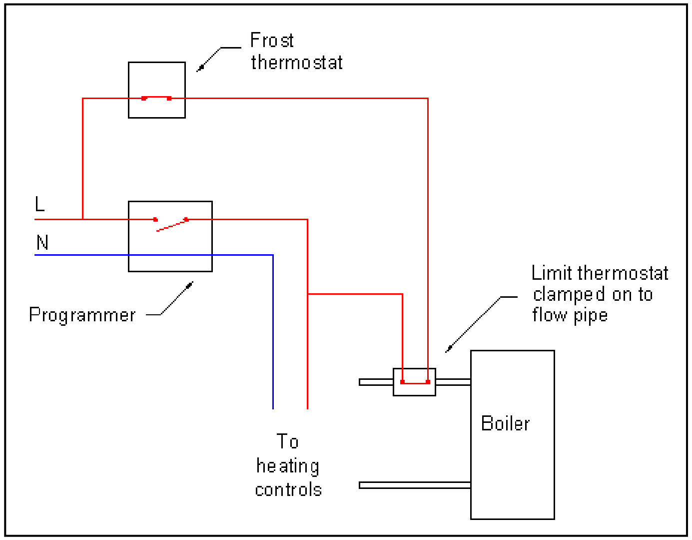
Individual Controls Cont.

- A **Room Thermostat**, be it mechanical or digital, simply allows the user to set a set-point temperature which will be maintained whenever the time-clock is timed to be on. It operates by sensing the air temperature, switching on the heating when the air temperature falls below the thermostat setting, and switching it off once this set temperature has been reached.
- **Programmable room thermostat** - This device combines a time-switch and room thermostat and allows the occupant to set different time periods with different target temperatures for space heating.

Individual Controls Cont.

- The **Frost thermostat** is essential if the boiler is fitted outside the building or if the premises are left empty for a long time. It is located in an unheated space (boiler room, garage or attic) which is wired into the control scheme in such a way that the programmer, when in the off position is overridden when there is a sharp drop in temperature (2-3^{o}C).

- A **pipe thermostat** is generally incorporated as shown in the diagram, to prevent the system running all night long.



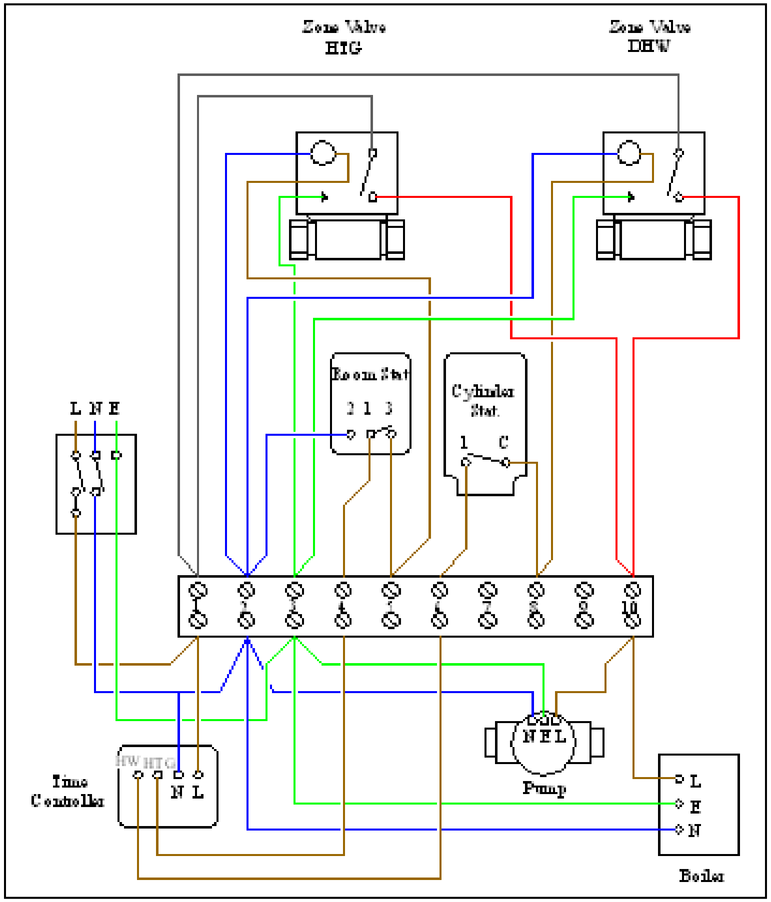
Individual Controls Cont.

- **Thermostatic radiator valve (TRV)** - TRVs are used to limit the temperature in individual rooms (except in rooms with a room thermostat).

- **Motorised valves** – Two and three port used to provide zone control eg. allowing lower temperatures to be set for sleeping areas.

Individual Controls Cont.

- **Boiler Interlock:** The essence of a good heating control is to ensure a boiler does not operate unless there is a demand; this is defined as boiler interlock.
- Boiler interlock is not a physical device but an arrangement of the system controls
- so as to prevent the **boiler cycling** (boiler firing when there is no demand for heat).

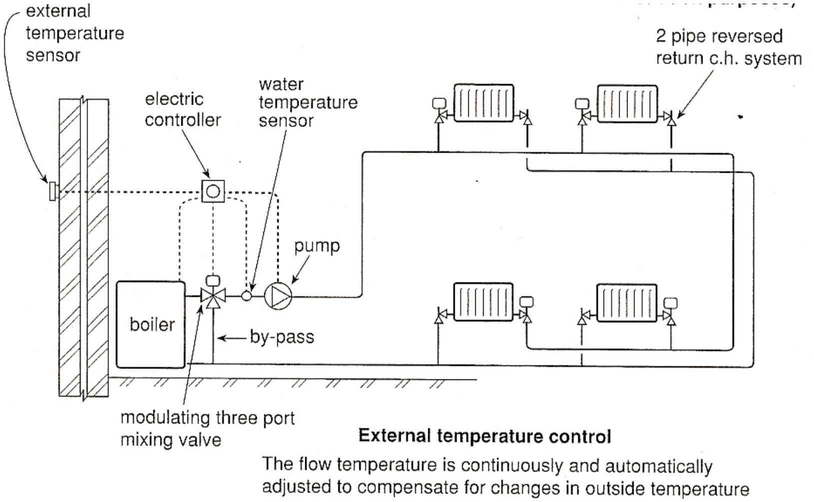


Boiler interlock in a system with two, 2-port valves (this shows the general logic)

Individual Controls Cont.

- **Weather compensator** - This is a system that varies the boiler flow temperatures dependant upon the inside load requirements and the outside weather condition.

- Weather compensation is particularly beneficial in conjunction with condensing boiler systems.



Heating system incorporating weather compensation controls

Individual Controls Cont.

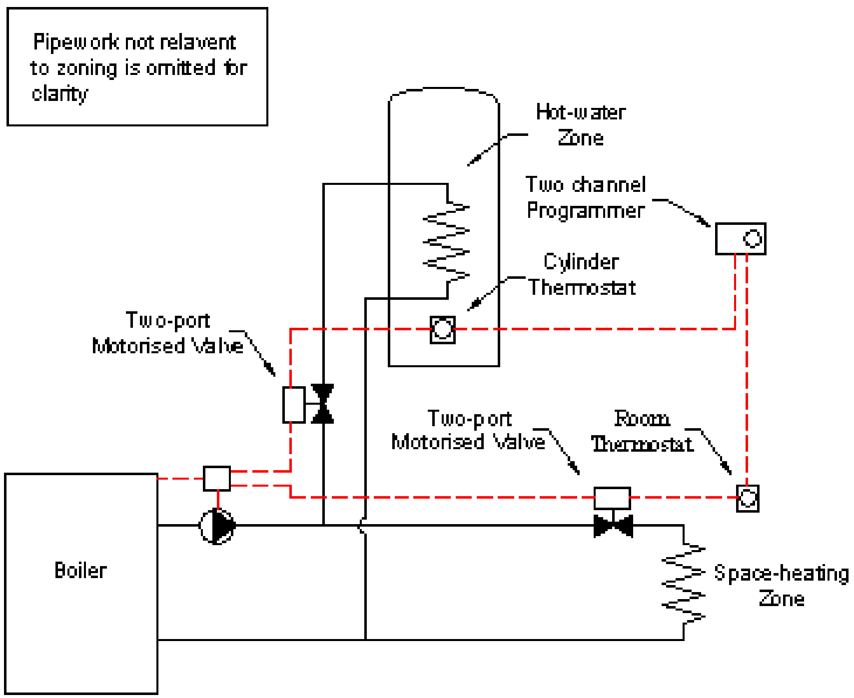
- **Load compensator -** This device regulates the water temperature in the heating circuit in direct relation to the temperature measured inside the dwelling.

- **Boiler energy manager -** This device improves boiler control by using a selection of features previously detailed, such as load and weather compensation, boiler interlock, zone control, etc. It is an extremely efficient way to operate the heating system in a dwelling.

Zoning Heating Systems

Under **current Irish legislation** [1], it is a necessary requirement to manage the output of space and water heating via the following control systems.

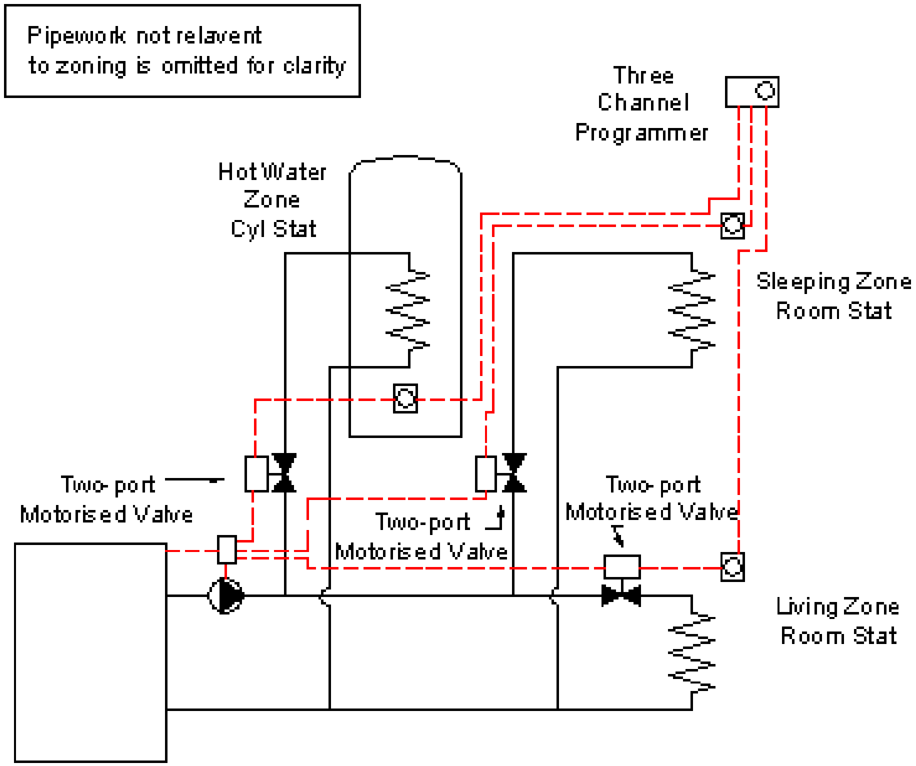
- Independent time and temperature control
- As a minimum requirement, heating systems should be split into two independently controlled zones (less than 100 m^2).
- Incorporating a space heating zone and a hot water zone.



Typical zoning arrangement for a dwelling with a floor area less than 100m^2 (satisfies Irish zoning regulations)

Zoning Heating Systems Cont.

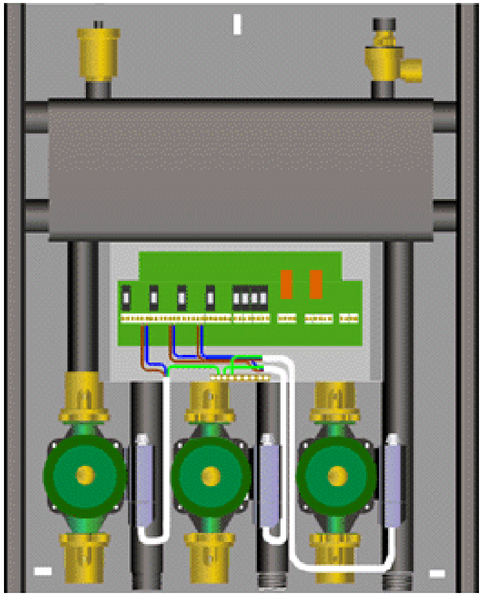
- Current Irish regulations [1] suggest that **for homes over 100m^2** heating system should be split into at least two zones
- Namely the bedrooms (cooler) and living areas (warmer).



Typical zoning arrangement for a dwelling with a floor area greater than 100m2 (satisfies Irish zoning regulations)

Zoning Heating Systems Cont.

- *Multiple pumps are an alternative to motorised valves*
- *This means independent speeds may be selected to closely match a particular zone's water velocity requirement.*



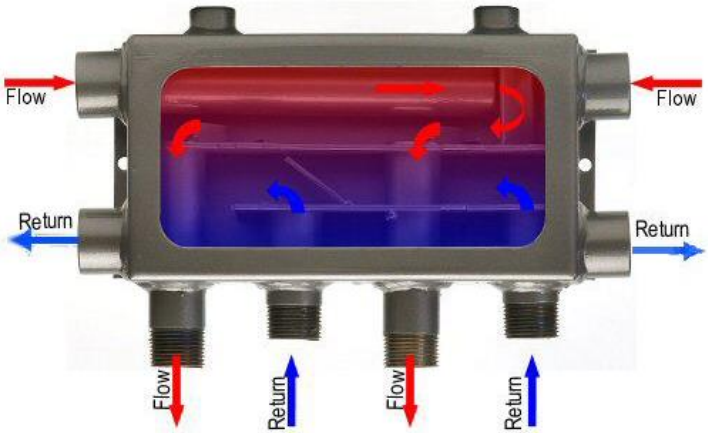
Example of using multiple circulating pumps as an alternative to motorised valves Source: SystemLink [14]

Zoning Heating Systems Cont.

Example of a Multiple Circulating Pump Installation

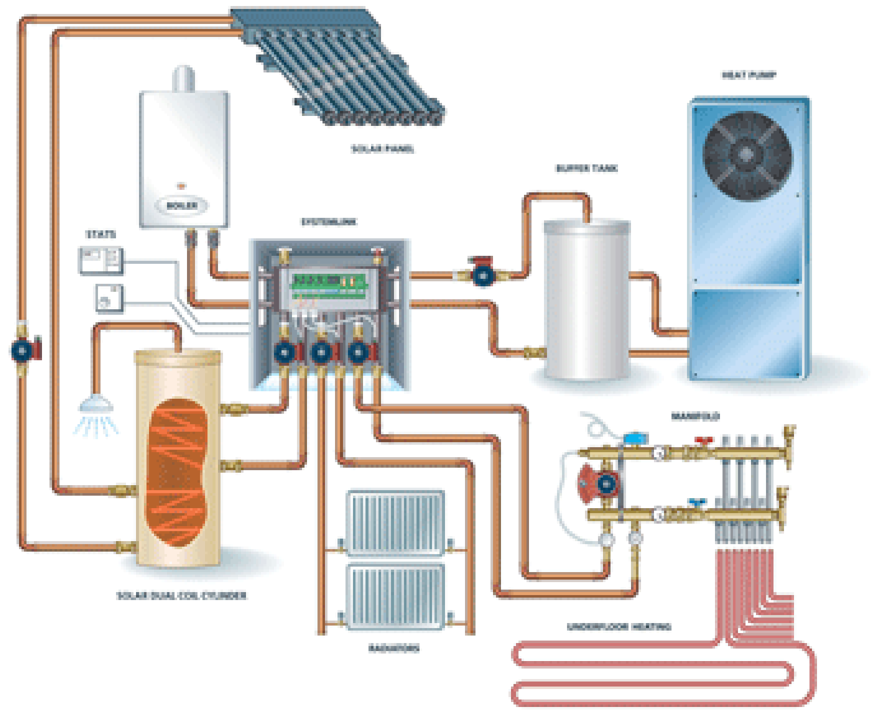
Operating Principles of **SystemLink**
SystemLinks is a patented distribution manifold for use in zoned heating systems. It encompasses all the requirements for correct system installation.

Zones and boilers circuits are independent of each other: When the pump in a particular zone or boiler circuit is inactive, no water moves in that circuit. Allowing each zone or boiler circuit can be planned as an individual module without needing to consider its effect on the rest of the system.
Neutral point created: Automatically creates a neutral point within the unit.
Electrical controls: with push-fit wiring terminals, connections for zone thermostats, time controls, zone pumps boiler power and automatic boiler control (including boiler interlock).



The figure shows the operating principle
Of the systemlink manifold [14]

Zoning Heating Systems Cont.



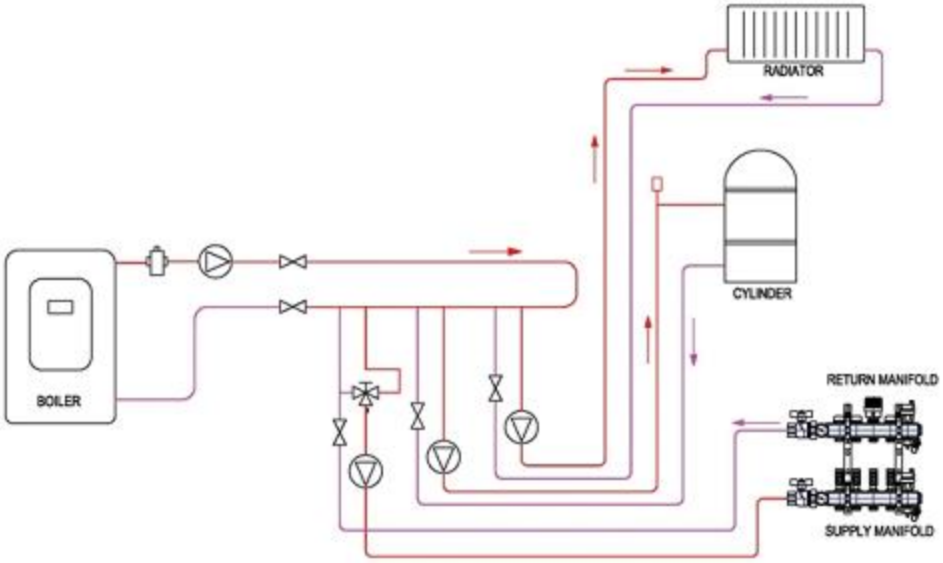
Example of Combining solar panel (for dhw), heat pump, buffer tank, gas/oil boiler, underfloor heating, radiators and dhw cylinder. Source: Systemlink [14]

Zoning Heating Systems Cont.

Example of a Multiple Circulating Pump Installation

Operating Principles of **Primary Loop System**
Primary loop installations have been standard practice in commercial buildings for many years and offer great versatility in terms of efficient operation, ease of maintenance, controllability, and easy installation.

- Allows independent time and temperature control of different zones
- Permanent by-pass circuit
- Positive pressure on the system at all times.
- To ensure independent time and temperature control, the flow and return connections to the individual zones should be spaced at a distance of not more that 15cm C/C with a minimum of 20cm of straight pipe up stream and downstream of these connections.



The figure shows a typical primary loop system for an installation with a radiator circuit, a domestic hot water circuit and an underfloor heating circuit.

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