Module Heating

1. Introduction

The energy consumption for space heating in the European Union represents about 52 % of the total energy consumption in service sector buildings – in the residential sector it is even more with 57 %. Without doubt the most savings are achievable by insulation improvements in the building shell, but also replacing old boilers by new condensing boilers with efficiencies of > 100% could reduce the energy bill for heating by about 5 %. This improvement is caused by an about 35 % better efficiency of new boilers in comparison to existing ones. This average factor can range widely depending to the installed technology. [EUROACE]

Beyond the pure economic advantages of modern heating technologies, especially the improved comfort and the security of energy supply are good reasons for respective investments. The range of measures covers the burner, the boiler, automatic control systems and efficient insulation of boiler and piping pumps, improvement in the hydraulic system and the radiator systems. Additionally the warm water supply often is combined with the heating system. The use of renewable energy sources as well as combined heat and power supply are also relevant topics especially for heating and are covered in the technical modules on co-generation and solar hot water and heating .

2. Inventory of systems

As a first step towards identifying applicable energy savings measures, a GB Partner should establish an **Inventory** of the heating system and warm water supply and major operating parameters. The Inventory is established in 3 phases.

a. System Description

The following system elements should be included in the inventory:

- Burner
- Boiler
- Hot water storage tank with loading and circulation pump
- Hydraulic system with mixer valves, line regulation valves and heating pumps
- Radiators and (thermostatic) valve
- Automatic control system for burner, boiler, valves, pumps and radiators

As far as possible existing plans and system description should be used and checked referring to changes possible.

b. Measurement of parameters

Often the heating system is the system with the best data collecting. Thus, all relevant data should be compiled, which are especially:

	Burner	Boiler	Hot water system	Hydraulic system
Installation	Installed power [kW]	Installed power [kW]	Volume hot water storage tank [m³]	Total installed pump power [kW]
Consumption	Fuel consumption [kWh/a]	n. a.	hot water consumption [m³/a]	electricity consumption of operation current
Temperature	n. a.	Max. boiler temperature [°C]	Max. tank temperature [°C]	Supply and return temperature
Operating hours	Full load operating hours [h/a]	n. a.	n. a.	operating hours of pumps
Other information	• Fuel supply? • Modulating burner?	• Low temperature boiler? • Condensing boiler?	• Central / decentral hot water supply?	• Electronic controlled pump power?

Additionally, the specifications referring to the automatic control system are most relevant to evaluate the efficiency of the system. Here, the following questions are the most relevant ones:

- Which system components can be controlled?
- How can they be controlled?
- Are the parameters fixed or automatically defined?
- Who can influence the parameters?

c. Indicators of system performance

After compilation of the above mentioned data, the calculation of the specific indicators helps to evaluate the efficiency of the installed system. The following indicators are customary. Typical values for these indicators are given in the following table.

Indicator	Typical value	Target value
1. Heating energy consumption related to gross floor area[1]	Example Office Building, Germany:[2] 77 kWh/m²	Example Office Building, Germany:[2] 11 kWh/m²
2. full operation hours (rate of energy consumption divided through the installed power)	Example Germany[3]: Including hot water supply: 1600 – 2000 h/a Without hot water supply: 1400 – 1800 h/a	Example Germany[3]: Including hot water supply: More than 2000 h/a Without hot water supply: More than 1800 h/a
3. Installation year of burner and boiler	Life cycle burner: < 15 years Life cycle boiler: < 25 years	Life cycle burner: < 10 years Life cycle boiler: < 15 years

[1] Own calculation based on [Greeneffect 2005]

[2] Numbers for Germany are given in [ages, 1999], values may be different in other building types.

[3] Values may be different for other countries.

4. Measured exhaust gas losses (will be measured by the chimney sweeper once a year and has to be documented)	n.a.	Example from German regulations: Oil or Gas driven boilers: 4 to 25 kW: < 11 % 25 to 50 kW: < 10 % more than 50 kW: < 9 %
5. Measurement and integration in automatic controlling system of - Indoor/Outdoor temperature - Heating system temperature	Measurement: partly yes Integration in controlling system: no automatic controlling system installed	Measurement: yes Integration in controlling system: yes

With the benchmarking (comparison of specific heating energy consumption to typical values for similar buildings) it will be possible to make an estimation whether the energy consumption is high, normal or low. Based on this information, the following steps should be adhered.

The use of the indicators is helpful under the following condition:

1. Total heating energy consumption related to gross floor area of office buildings; is the most useful indicator for typical office buildings;
2. Full operation hours of burner and boiler is important to indicate the efficiency of the boiler and the degree of over-dimension;
3. The age of the burner and boiler is important to indicate the function of the burner, losses and efficiency of regulation possibilities;
4. Exhaust gas values have regionally different limit values which may give an indication of the burning quality and the efficiency of the boiler;

3. Assessment of energy saving technical measures

Energy savings are possible in several steps:

1. Optimisation of regulations
2. Improvement of the heating supply system
3. Coaching for better user-behaviors
4. Selection of energy efficient products (Burner, pumps, radiators, valves)
5. Insulation of heating network, boiler and valves
6. Installation of renewable energy systems like wood boilers (further details you will find in Annex II)

Of course, the feasibility of particular measures and the extent to which they might save money depends upon the size and specific nature of your operation. Only an assessment of the system and of your company's needs can determine which measures are both applicable and profitable. This could be done by a qualified energy consultant or by qualified in-house engineering staff.

The assessment conclusions will identify the measures which are applicable to your heating system, and will include an estimate of the savings, the cost of the measure, as well as the simple payback time. Assessment results are confidential in house data, not reported to the Commission.

The following tables show the potentially significant energy savings measures which might be applicable to your heating system. In each table the measures as well as the saving potentials are presented.

Step 1: Selection of energy efficient product – (if replacing old plants)[4]

Pos.	Description of measure	Saving potential
1	Installation of a fan assisted low temperature boiler	Up to 20 %
2	Installation of condensing boiler to reduce burner- and supply-losses	Up to 32 %
3	Installation of well dimensioned circulation pumps with electronic power regulation	Up to 5 % and additionally savings in electricity
4	Installation of thermostatic radiator valves	Up to 10 %
5	Installation of an CHP-system which is producing heating energy for the base load and electricity for own consumption (corresponding to technical module Co-Generation)	no heating savings but profits by producing electricity
6	Installation of renewable energy systems like biomass boilers (see Annex II), solar systems for hot water production (corresponding to technical module on solar hot water and heating)	Up to 50 %

Step 2: Optimisation of the regulation

Pos.	Description of measure	Saving potential
1	Limitation of the settings at the thermostatic valves on radiators	up to 5 %
2	Optimisation of the regulation at the boiler (outdoor-temperature regulation)	up to 15 %
3	Improvement of the regulation at the secondary supply system (pumps, temperature, mixing valves etc.)	10 – 20 %
4	timer control operation of hot water supply system	5 – 10 %
5	Activation of night and weekend drawdown	up to 15 %
6	Hydraulic regulation of radiators by installing preadjustable valves	Up to 10 %

Step 3: Improvement of the heating supply system

Pos.	Description of measure	Saving potential
1	Providing of well insulated supply system (especially in the basement rooms)	up to 10 %
2	Reducing the temperature of the hot water boiler to 55 – 60 °C	up to 5 %
3	Improvement of hydraulic system (hydraulic adjustment)	up to 20 %
4	Optimise the division of the heating circuits (depending on the heating demand of parts of the building); for example north and south division	Up to 20 %

Step 4: Coaching of better user behaviour

Pos.	Description of measure	Saving potential
1	Turning down the thermostat valve when leaving	Up to 5 %
2	Increased awareness concerning airing methods	5 to 10 %

[4] [LEEAC]

5. Action Plan

Your company's Action Plan for reducing heating energy, as proposed in the form below, should indicate:

- the measures you have decided to implement, and the time scale for implementation;
- the reasons for excluding the other measures.

The Action Plan for heating energy efficiency is presented to the Commission. After approval of all relevant action plans your organisation will be recognized as a GB Partner.

Energy Savings Measures	Feasibility [1]	Specific Actions [2]	% Covered [3]	Time table [4]	Expected savings [5] (MWh/year)
Selection of energy efficient product					
Installation of a low temperature boiler or a Condensing boiler					
Installation of well dimensioned heating pumps with power regulation					
Installation of thermostatic valves					
Installation of an CHP-system					
Installation of renewable energy systems					
Optimisation of the regulation					
Limitation of settings at thermostatic valves					
Outdoor-temperature regulation					
Improvement of regulation at secondary supply system (pumps, mixing valves)					
Limitation of hot water circulation pump by timer					
Activation of night-drawdown					
Activation of weekend-drawdown					
Improvement of the heating supply system					
Insulation of supply system in the basement					
Reducing the temperature of the hot water boiler					
Improvement of hydraulic system					
Optimise the division of the heating circuits					
Coaching of right user behaviour					
Turning off the thermostat valves					
Increasing awareness on airing methods					

(1) **Feasibility.** Indicate obstacles to application by one or more of the following codes:
NA Not applicable for technical reasons
NP Not profitable
NC Not considered, because evaluation would be too expensive
If this field is left blank, the measure is considered to be both applicable and profitable.
(2) **Specific Actions.** Several specific actions may be adopted to implement one energy saving measure.
(3) **% Covered.** If the Partner's proposed commitment do not cover the total heating systems, this column should be used to indicate the proportion of the systems for which the specific actions will be implemented. This can be evaluated according to the most convenient indicator: number of systems; power; energy consumption. Specify the indicator used, as by: "%"; "%kW", %kWh"
(4) **Time table.** The time scale at which the action will be implemented. This might be a specific period or date, or might depend on some other action.
(5) **Expected savings** in MWh/year. This will often be an estimate, based on generally accepted practice.

5. Reporting

The Report to the Commission specifies progress made in carrying out the Action Plan, and will comment on any new or amended initiatives. The following reporting form should be used. The two left hand columns are copied from the Partner's Action Plan as approved by the Commission.

Approved Action Plan		Report for year 20xx
Actions decided upon to implement energy savings measures	Agreed upon time scale for action	Progress on action, as percentage achieved, and comments where appropriate (1)
Selection of energy efficient product		
Action 1		
Action 2		
…		
Optimisation of the regulation		
…		
user specific saving potentials		
…		

(1) The **percentage achieved** could refer to an indicator such as the proportion of systems in the scope of the Action Plan for which the specific action has been completed.

Partners may find it useful to produce the following Synthesis of the results of commitment to the GB Programme. They are invited (but not required) to submit the Synthesis to the Commission.

Report synthesis		
	Since commitment	This year
Percentage of actions in Action Plan completed		
Estimated total investment for Plan (000 EUR) (1)		
Estimated change in non energy O&M costs (000 EUR) (1)		
Estimated energy savings (MWh) (2)		
Number of workplaces		

(1) **Investment and O&M** (operation & maintenance) costs are estimates of changes in costs, with respect to what would have been spent without Partner commitment to the Challenge. This may be, for instance, additional investment for higher performance equipment, or increase/decrease in maintenance costs.
(2) **Energy savings** are estimated by calculating the implementation of the measures as well as increasing/decreasing number of equipments.

References:

[EUROACE] Towards Energy Efficient Buildings in Europe; Final Report June 2006

[ages] Forschungsbericht der ages GmbH, Münster, “Energie- und Wasserverbrauchskenn-werte in der Bundesrepublik Deutschland”, 1999

[dena] Bauen für die Zukunft, wirtschaftlich, energiebewusst, komfortabel, 2002

[Taschenbuch für Heizung + Klimatechnik] Recknagel, Sprenger, Schramek, 2002

[LEEAC] Lancashire Energy Efficiency Advice Centre, www.leeac.org.uk

Annex 1

The assessment should, for each of the measures in tables 1, 2 and 3, evaluate applicability and profitability. This might take a form similar to the following table.

Energy saving measures	Assessment results				
	Specific proposed action	Estimated annual savings	Investment cost	Annual O&M cost	Estimated payback time (months)
Selection of energy efficient product					
Action 1					
Action 2					
Optimisation of the regulation					
…					
…					
user specific saving potentials					
…					

Annex II Wood Heating

Basic Information

There are many reasons that speak for heating non-residential buildings with wood. Apart from the fact that such systems are eco-friendly and have proved themselves in technical terms, they constitute an economically viable solution. Wood fuels are domestic raw materials with a highly reliable supply and stable prices.

Modern wood heating systems operate just as well as conventional oil or gas systems; they are just much less common. Consequently, more communication is required when carrying out a wood-heated project. All the relevant people, i.e. the building contractor, potential users of the building, neighbours and the applicable local authorities, have to receive detailed information on the project in good time. Wood heating systems have some important requirements regarding the building, so it is a great advantage if a new building is being erected and these requirements can be taken into consideration during the planning stage. Good communication between the architect and planners plays a vital role here.

Basically wood heating systems can be classified in automatic and non-automatic (manual) operating systems. The manual systems have to be feed by hand (log wood) and are practical for heating of smaller buildings. For the heating of larger buildings only automatic heating systems should be installed. Modern automatic wood heating systems offer a comparable heating comfort than conventional heating systems based on oil or gas.
Wood boilers are able to modulate very well. According to this they are abele to produce as well as hot water during summer as well as heating energy during winter by own system. All in all the annual efficiency will be about 70 to 75 %.

Selecting the fuel for automatic heating systems

Wood-pellets, wood-chips
Wood pellets and chips are the two most suitable fuels for automatically fired heating systems in large buildings.
Pellets are a standardised fuel that is made by pressing dry shavings or saw dust. The production process does not use chemical additives – only high pressure and steam. Depending on the moisture, the energy content of pellets is between 4.7-4.9 kWh/kg – 2 kilos of pellets therefore have a slightly lower calorific value than a litre of extra light fuel oil (10.0 kWh).
Chips are small pieces of wood that are 5-50 mm long (measured in the direction of the fibre). There may also be some longer twigs and finer material among them. The quality of the chips depends on the raw material, the chipping process (sharp chipper blades) and the manipulation processes. The energy content of dry chips (water content 25%) is around 3.7 kWh/kg.

Pellets or chips
Pellets and chips have various advantages and disadvantages that have to be weighed up. Which fuel is used will depend very much on local conditions.

Parameter of wood fuels

	Wood chips	Pellets
Heating value	3,7 kWh/ kg	4,8 kWh/kg
	744 kWh/ m^3	3080 kWh/ m3
Density	200 kWh /kg	650 kg /m3
storage space	require more storage space	less storage space required
Price	Lower fuel costs	higher fuel costs
	can be available locally	ess benefits for local economy
Labour demand for plant operation	higher labour demand for plant operation & maintenance more ash amount	less effort for plant operation and maintenance
Fuel quality	high and uniform fuel quality is important but difficult to ensure	standardised fuel – higher operational reliability

To allow fuel flexibility boilers can be selected, that can be operated both with dry chips and pellets. Than It is necessary that the feed system is suitable for handling both fuels. As chips (unlike pellets) are not generally blown in, the store should be designed to enable the fuel to be delivered by tipper truck.

Fuel storage

Wood chips

Wood chips can either be stored in the existing building in a room next to the boiler or in a separate store outside the building. The latter could be an underground store or over ground silo from where the fuel is fed to the boiler by conveyor. Stores for chips should be well ventilated to let the wood dry and prevent mould.

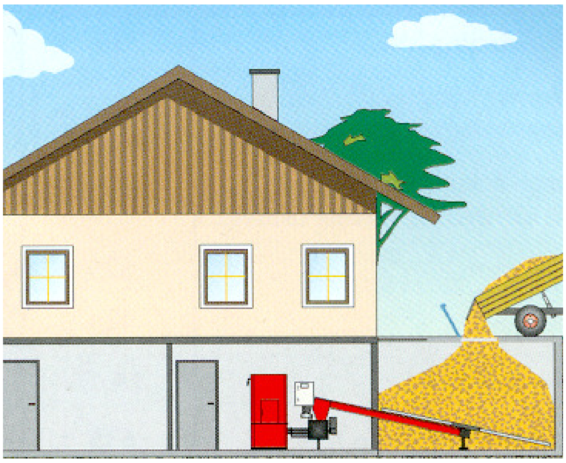

Figure 1: Storage room outside the building building

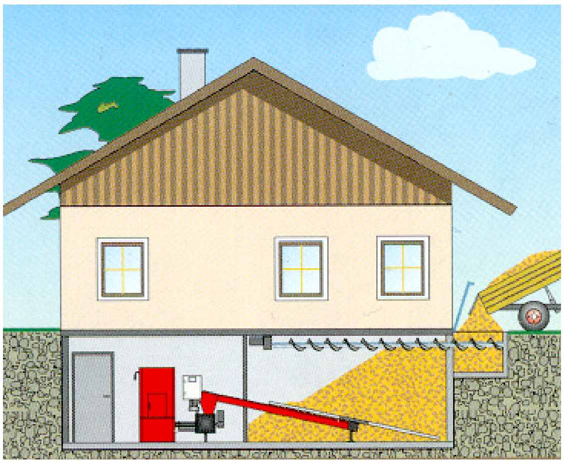

Figure 2: Storage room outside the

The fuel is usually transported from the store to the boiler by a rotating spring and a screw conveyor.
Due to the rotating spring blade the storage room should be in the shape of a square.

Pellets

The pellets can either stored in a room near to the boiler or in an external underground tank outside the building. In underground stores for pellets, it is important to ensure that no moisture can get in.
The pellets are usually transported to the boiler via a rigid screw conveyor, a flexible screw conveyor or a flexible pneumatic tube system (max. 15m distance between storage room and boiler).

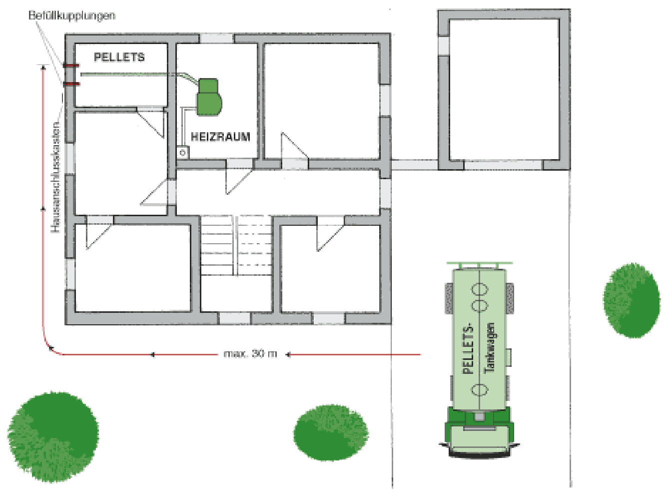

Figure 3: Example of a store location in a smaller building (pellets are pumped into the storage)

Specifications for store and boiler room
Both, the boiler room and the storage room have to meet the national technical regulations and the regulations of fire protection. When planning the boiler room, sufficient space should be allowed for daily operation, maintenance and repair work.
The average boiler room for a 150kW boiler should be between 20 - 25 sq m.
The size of the fuel store depends on many factors: anticipated fuel requirements, reliability of deliveries, space available, delivery vehicle capacity etc.

Fuel supply

Wood chips are generally delivered by truck or tractor trailer that tips the fuel into the opening in the store. Around the opening should be enough space for the delivering vehicle to manipulate (turn around).
Pellets are usually delivered in tankers which pump the pellets into the storage room via tube system (regular tube length 30m). As 1 cubic metre of pellets has four times the calorific value of 1 cubic metre of dry chips, the frequency of deliveries is much lower than for chips. As a result, pellet heating systems may be a better solution in urban areas where the traffic plays an important role.

Noise

Biomass boilers that are not installed properly may cause noise pollution. Sources of noise are primarily the air and flue gas fans and the fuel feed system. To prevent noise problems the technical guidelines for noise protection have to be taken into consideration.
Delivering and unloading the fuel can also cause noise. Problems can be avoided by selecting a suitable fuel store location and having fuel delivered at times when only a few neighbours are at home.

System care and maintenance

The amount of work involved in maintaining an automatic wood-fuelled heating depends on various factors, such as whether the boiler has an automatic cleaner for the heat exchanger and an automatic ash discharge, whether remote monitoring of the system is possible, whether chips or pellets are used etc. Typical activities to be carried out include:

- Visual inspection of the boiler
- Rectifying minor problems
- Purchasing the fuel
- Removing the ash

The time required naturally depends on the size of the system and fuel consumption – i.e. fewer hours for smaller systems. The maintenance work for state-of-the-art boilers using pellets or high quality chips does not exceed 30 minutes a week. Carrying out an annual service is vital for long-term trouble-free operation.

Wood ash is not dangerous and is frequently used as a fertiliser. In urban areas it can usually be disposed of with domestic waste. Local regulations should be observed.

It is recommended to make an ongoing servicing contract with the installer company.