Deliverable 4.2

List of energy saving measures

This deliverable contents an overview of the energy saving measures, who are available in the benchmark tool. Every measure is in this deliverable described on one page.
The graphic below shows the measures and the frequency (percentage) they are advised by the consultants in the 100 companies.
The top three of the advised measures are:

1. A26 Low energy lighting	7,99%
2. A25 Drawing up a lighting plan	7,73%
3. A4 Optimizing ventilation	7,22%

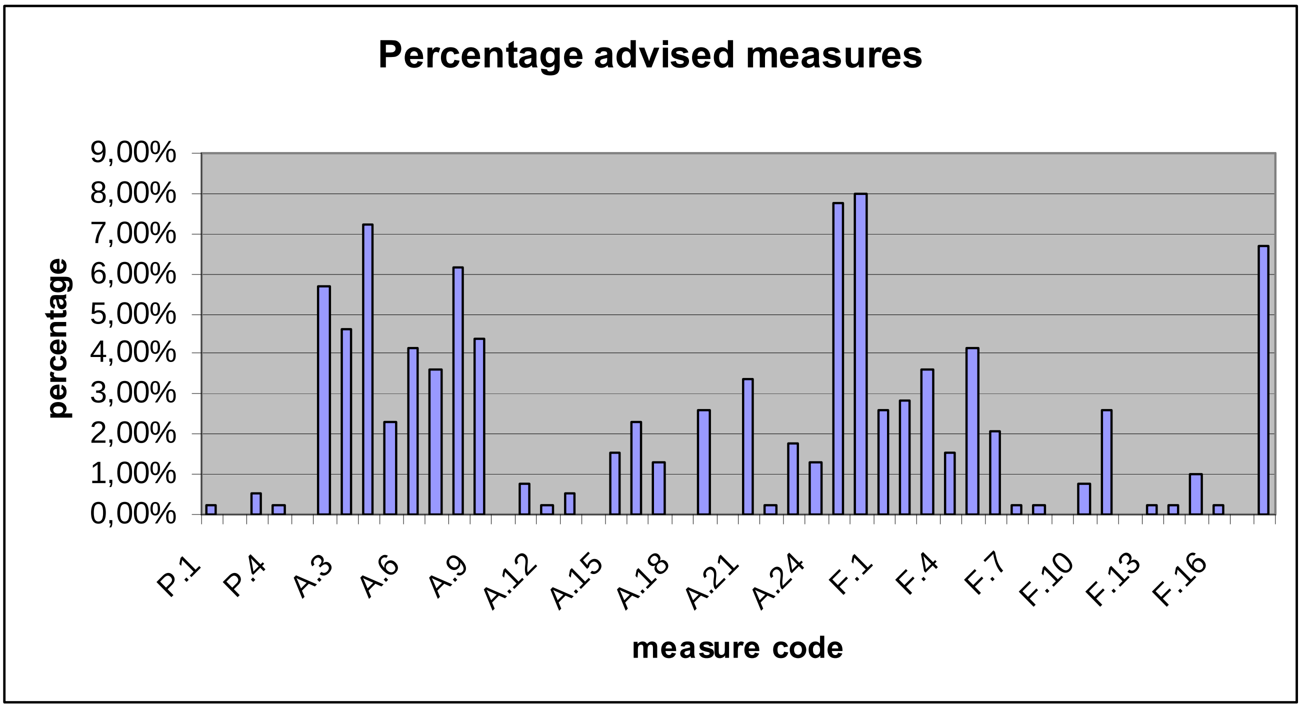

Table:
Overview of the measures and the frequency they are advised in the 100 companies.

Numbering	Description measure	Frequency
P.1	Energy efficient press drive	0,26%
P.2	Gas-heated (IR-) drying	0,00%
P.3	Reusing residual warmth of dryer and/or linked-up equipment	0,52%
P.4	Optimize air household of dryers	0,26%
A.1	Building orientation	0,00%
A.2	Insulation	5,67%
A.3	Limiting sun radiation	4,64%
A.4	Optimizing ventilation	7,22%
A.5	Frequency control ventilators	2,32%
A.6	Preventing loss of ventilation	4,12%
A.7	Heat recovery from ventilation air	3,61%
A.8	Good Housekeeping heating	6,19%
A.9	Controlling temperature per room	4,38%
A.10	Support ventilators	0,00%
A.11	Application of high efficiency air heaters	0,77%
A.12	Application of radiation heating	0,26%
A.13	Application of low temperature heating system	0,52%
A.14	Hot-tap water production at tap point	0,00%
A.15	High efficiency boiler or combination HE/IE boiler	1,55%
A.16	Weather dependent control	2,32%
A.17	Optimizing unit	1,29%
A.18	Cascade/ boiler order connection	0,00%
A.19	Insulation pipes, valves and appendages	2,58%
A.20	Vaporization cooling	0,00%
A.21	Good Housekeeping space cooling	3,35%
A.22	Point exhaustion	0,26%
A.23	Application low-energy humidifying system	1,80%
A.24	Good Housekeeping humidifying	1,29%
A.25	Drawing up a lighting plan	7,73%
A.26	Low-energy lighting	7,99%
F.1	Reuse of residual heat of vacuum pumps and compressors	2,58%
F.2	Central system with cascade switching vacuum pumps and compressors	2,84%
F.3	Low-energy compressors	3,61%
F.4	Suck in country air	1,55%
F.5	Good Housekeeping compressed air	4,12%
F.6	Installing valve per user/user group	2,06%
F.7	Seperate high and low pressure net	0,26%
F.8	Optimizing pipe diameters and size buffer barrel	0,26%
F.9	Float-steered water divider (instead of time-steered)	0,00%
F.10	Good Housekeeping vacuum	0,77%
F.11	Insulation cold pipes	2,58%
F.12	Use of free cooling	0,00%
F.13	Low-energy refrigerators	0,26%
F.14	Weather dependent control of cooled water	0,26%
F.15	Good Housekeeping cooled water	1,03%
F.16	Use of condenser heat	0,26%
F.17	Optimization dust/shred exhaustion	0,00%
EA.1	Building Management System	6,70%

Press drive

P.1 Energy efficient press drive

Indication efficiency on electricity use	Average pay-back time	Decision moment for application
2-10%	3-5 years	New building/renovation X Replacement/capacity extension X Directly practicable

Description

Frequency regulated drives: losses in the drive of motors can be avoided by using frequency regulated alternating current motors.
Optimization press drives: savings on the drive energy of the presses are possible by:

- better bearing sealings
- application of modified rubber kinds on the rolls
- optimally tuned grease intervals

Motors with high performance: in the market are motors with a higher performance. On the average these type of motors delivers almost 3 % more mechanical power than a conventional motor with the same electrical power. These so-called HR motors can be applicated well for the drive of the printing presses and can also be provided with a frequency regulation.

Applicability

Above-mentioned measures are generally applicable for small, medium and big companies. Only when buying a new press you have to pay attention to these measures. You have to discuss with the manufacturer about the applicability of the measures, the degree of energy efficiency and the lower or higher maintenance costs. Frequency regulation deserves especially attention because when a strong changing demand for performance takes place in the operational management.

Economic data

In all cases it is a higher investment in relation to a conventional situation. The efficiency possibilities, which are performed by the manufacturer, will show in the higher price of the printing press. So these efficiency possibilities demand a higher investment in relation to conventional presses, which have to counterbalance the lower energy use and possible savings on maintenance costs.
The application of HR motors requires a higher investment of almost 22 Euros till 45 Euros per kW power. With a company time of 4.000 hours this investment is paid back in four years.

Relation to other measures

No relation to other measures.

Drying

P.2 Gas-heated (IR-) drying

Indication efficiency on electricity use	Average pay-back time	Decision moment for application
unsure	3-7 years	New building/renovation X Replacement/capacity extension X Directly practicable

Description
By changeover of electrically preheated air to gas-heated preheating and of electric IR-drying to gas-heated IR beamers, energy can be saved. This means a saving of 100% on electricity use by drying, but of course an extra use of gas. Net 60% of primary energy can be saved, but this has to be determined from case to case.

Applicability
The measure is applicable on a dryer, which is placed behind a rotation press, but also on smaller drying systems, like with laminate companies. In most cases a changeover from electrical IR-beamers to gas-heated IR beamers is technically possible, but will finally be determined by the financial feasibility. This means in practice that the measure will be applied at an expansion or replacement.

Economic data
The applicability and costs of gas-heated drying cannot be indicated in advance. Before start buying the pay-back time has to be determined per case, by comparing the yearly energy consumption and costs.

Relation to other measures
No relation to other measures.

Processing/Drying

P.3 Reusing residual warmth of dryer and/or linked-up equipment

Indication efficiency on gas use	Average pay-back time	Decision moment for application
30-45%	3-7 years	New building/renovation X Replacement/capacity extension X Directly practicable X

Description
Reuse of warmth can be applied to the following processes:
1. Drying with warm air, where only fluid has to be removed (a.o. laminate companies), the temperature lies at about a 100 degrees Celsius and an afterburner installation is missing.
2. Drying with warm air, where solvents have to be removed. These solvents, containing dry air, mostly are guided through an afterburner installation (linked-up equipment), in which the solvents are burned (rotation-heatset, flexo and engraving printing companies). The temperature of the removed air can rise in existing installations till more than 300 degrees Celsius.

The residual heat can usefully be used for especially space heating in rotation-heatset companies; dry air preheating in laminate companies and production of thermal oil in packaging printing companies.

Applicability
In both above-mentioned drying processes warm air is being transported out. In the drying processes of laminate companies, where an after burner installation lacks, the outlet and suck in channels of the dry air, lie close together, so when placing a cross-stream heat exchanger, the warmth from the outlet can be transferred to the central air supply, when it is present.

In rotation-heatset companies dry air is passed and transported through an outside placed afterburner installation. By placing a heat exchanger in this outlet channel, heat can be recovered and used for instance space heating. The use of this heat for the preheating of dry air is not yet applicated in seperate dryers/afterburners because of the difficult practical applicability. The last does take place with integrated dryers/afterburners. Also then heat remains for use elsewhere.

In packaging printing companies the temperature of the outlet air lies after the afterburner at 100 degrees Celsius till 150 degrees Celsius. This is lower as with rotation-heatset companies. Nevertheless also here is the possibility for heat recovery for space heating or heating of thermal oil.

Of all the above-mentioned dry processes and heat recovery possibilities primarily applies that the drying process has to be optimized with regard to temperature, air flow and recirculation possibility (see measure P4).

After that the feasibility of reuse has to be assessed per situation, mostly by an external expert.

Economic data
To transfer the rest heat of the dry air via a cross stream heat exchanger to the incoming dry air an investment of about 900 Euros is needed, when you have a capacity of 500 m3

air per hour. The yearly saving lies at about 3.000 m3 of gas or 25.000 kWh, concerning a company time of 2.000 hours.
The investment of heat recovery of heatset-rotation companies lies at 75.000 Euros. The saving is completely depending on the possibility to use the heat for especially space heating. With an air flow of 10.000 m3/h, which is cooled down 150 degrees Celsius, during the heating season (3.000 hours per year), more than 170.000 m3 gas can be saved on heating.

Relation to other measures

Firstly the measures P.2 and P.4 must be tested on feasibility and when need be performed, because these measures influence the profitability of measure P.3.

Processing/drying

P.4 Optimize air household of dryers

Indication efficiency on gas use	Average pay-back time	Decision moment for application
10%	<3 years	New building/renovation X Replacement/capacity extension X Directly practicable X

Description

In general in drying processes environmental air is being heated, by which air is taking up moisture and provides the vaporization of solvents. Because the warming of air costs energy, the air flow has to be primarily minimized.

Beside it by recirculation of dry air in the drying-units a further saving of energy consumption of drying techniques can be made.

When behind a press a drying unit is placed, which works on the basis of warm dry air, the air flow has to be minimized so that sufficient drying still takes place. Precondition is that also an ample margin must be between the concentration of flammable solvents and the Lower Explosion Level value.

On the one hand the saving is made by the heating of lesser air and on the other hand a better burning in the after linked equipment.

Applicability

Diminishing of the amount of dry air is a generally applicable measure. Partial recirculation of dry air is realizable, certainly in existing drying-units.

The applicated drying-unit must work on the basis of hot air. In these situations where solvents vaporize, a seperate study by a specialised agency is mostly needed. This study delivers a detailed costs and benefits.

Economic data

The costs of recirculation of dry air in existing situations will strongly differ. With the acquisition of new installations, this will be an important aspect, where additional costs will stay limited. Also here the pay-back time is short.

The financial feasibility is dependent on the used solvents and the air flow. The costs of a feasibility study concerning a rotation press, with as a result the pay-back time, is about 4.500 Euros.

Relation to other measures

In existing situations firstly the possibility of recirculation of dry air should be studied, before recovery of residual heat from the dry air (measure P.3) takes place. In new building situations both measures are possible.

The measure is dependent on the used solvents, so that changes in these influence the measure. Afterburning of dry air in rotation-offset with heatset is a seperate measure.

Building

A.1 Building orientation

Indication efficiency on energy use	Average pay-back time	Decision moment for application
dependent on situation	nil	New building/renovation X Replacement/capacity extension Directly practicable

Description
Take care of a favourable position regarding sun radiation. Rooms with the biggest window surface must favourably be situated facing north. At the south flank of the building should be as less window surface as possible.

Applicability
The measure applies only for new buildings situations and when the design can be fit in the zoning plan.

Economic data
For this measure no further investments are needed. There can be saved on possibly procured cooling potential, cooling energy, (outside) sunblind and extra ventilation potential.

Relation to other measures
Relation with measure A2 (Isolation) and A3 (limiting sun radiation). Furthermore this measure has a direct influence on the living comfort in the building.

Building

A.2 Insulation

Indication efficiency on energy use	Average pay-back time	Decision moment for application
15-20%	3-5 years	New building/renovation X Replacement/capacity extension Directly practicable

Description

The insulation of roofs with an extra insulation layer. The insulation of walls, floors and the insulation of skylights. The application of preferably HR, HR+, HR++ glazing. The application of a heat shield behind the radiator. Extra insulation reduces the heat passage and by an architectural construction by which a building is warmed up less fast in summer and better holds its warmth during winter.

Applicability

The insulation of the building skin gives a better comfort, by which as well heating as cooling energy decrease. Beside it a good insulated building asks for less heating and cooling capacity. The after insulation of roofs should preferably be implemented at the same time as a roof renovation and the placing of HR++ glazing, in combination with replacement of window frames. Generally can be put that the stated measures because of insulation demands in the "building provisions" should be taken along obligatory in new building and renovation.

Economic data

A window frame with double glazing costs about 150 Euro per m2. When this is implemented with HR++ glass, the extra costs are about 60 Euro per m2. Isolation of walls and roof costs about 10 till 30 Euro per m2. However, in the case of after insulation in existing situations, the costs can be higher because of a bigger complexity of the work. If this is combined with renovation, on average the extra insulation will pay itself back within 5 years.

Relation to other measures

Take care when replacing central heating boilers and /or refrigerators. Because of the after insulation of the building, lesser capacity is needed as in the old situation. A new heat loss calculation and/or cooling capacity calculation have to be made. By insulation of the building for heating one can work with a lower water temperature, by which amongst others the effect of a HR boiler make far better use.

Building

A.3 Limiting sun radiation

Indication efficiency on energy use	Average pay-back time	Decision moment for application
40% on electricity for cooling	< 3 years	New building/renovation X Replacement/capacity extension X Directly practicable

Description
The application of sunblinds or the application of heat protecting foil on glass. The latest preferably on the outside of the glass. Both measures provide that at warm days the warmth cannot enter the building. One can also think about the planting of trees to shade the building.
The capacity of air conditioning equipment can considerably be restricted by the installation of adequate sunblind. As additional advantage sunblind increases the comfort at the workplace.

Applicability
Applicability anywhere. The sunblind can be best on the outside of the windows in order to prevail that the warmth absorbed by the sunblinds, will be given up to the air in the offices.

Economic data
Installation of a sunblind demands an extra investment in one, but mostly more sunblinds. The costs vary between about 100 Euros per meter for relatively simple sunblinds (vertical shade, outside Venetian blinds) till about 150 Euros for electrically operated drop-out screens.
When the company has air conditioning, the sunblind pays itself back in a short time. When there is no air conditioning, no pay-back time can be given, but the investment is then done for comfort upgrading.

Relation to other measures.
In new building situations the building orientation primarily deserves attention. (Measure A1.) Installing sunblind can be done independent of other energy saving measures. When HR++ glass is installed (Measure A.2), substantial less warmth will be let through as with normal double glazing.

Building

A.4 Optimizing ventilation

Indication efficiency on energy use	Average pay-back time	Decision moment for application
20-25% (gas)	1-5 years	New building/renovation X Replacement/capacity extension X Directly practicable X

Description
The measure contains a number of sub-measures, by which unnecessary ventilation is avoided:

1. Tuning the air flow critically to the room-contents, the number of working persons and the concentration of dangerous substances (MAC values)
2. Regulating ventilation based on "enthalpie" (temperature and humidity)
3. Minimizing the share of fresh air on cold days
4. Implementing summer/night ventilation

Sub 1. In buildings and part of buildings one can easily determine which minimal airflow is legally needed. This is determined by the number of workers and/or the Maximal Acceptable Concentration of a certain substance in the air (MAC values).
Sub 2. For a good wash through of the air in a room it is needed that the air flow is minimal twice the contents of the room to be ventilated. Usually this is more than the legal minimum and a big part of the air can be recycled. The extent to which air can be recycled can be regulated automatically by choosing the energetically most favourable situation between inside and country air. When temperature, as well as humidity of the air plays a role, one speaks about the "enthalpie" ruling.
Sub 3. When one has to heat during the heating season, this has to take place with an as low as possible (legal minimum) share of country air, because of the limiting of the energy consumption. Mostly this share is determined too high. Control by measurement of the amount of air is regularly needed.
Sub 4. Summer/night ventilation can be applied in order to remove the heat built-up by day in a room by night, by which the use of a cooling installation can be avoided. Summer/night ventilation can be fully automated.

Applicability
All sub-measures are applicable when an air treatment compartment is available. Summer/night ventilation can also take place by using a clock-controlled ventilator. The above-mentioned measures have to be reckoned with while designing an air treatment compartment within new building/renovation. The foundations of the financial feasibility will be necessary. Mostly there are no technical barriers. Summer/night ventilation can easily be applied in existing situations.

Economic data
An optimized ventilation system pays itself back within five years.

Relation to other measures

Measures leading to a lower need for ventilation can have influence on the humidity in a room when the humidifier is integrated in the air treatment compartment. This measure can more easily be applied when measure A.23 (low-energy humidifying system) is implemented.

Ventilation

A.5 Frequency control ventilators

Indication efficiency on energy use	Average pay-back time	Decision moment for application
20% electricity	3-7 years	New building/renovation X Replacement/capacity extension X Directly practicable X

Description

In order to remove excess warmth in the summer months, amongst others, extra ventilation is done. In the winter period less air is enough. The quantity of ventilation can also be adapted to the degree of capacity utilization of a department. In order to control this efficiently, ventilators can be provided with a frequency control.

Applicability

When there is a changing need for mechanical ventilation. The measure is generally applicable within any air treatment compartment, provided that the motors are suitable for speed control. Specific motor types can not be frequency controlled.

Economic data

Speed control of the ventilators demands an additional investment in a small control unit per ventilator. A control unit varies between 700 Euros and 1000 Euros per ventilation motor. The investments for frequency control are paid back for a medium long period.

Relation to other measures

No relation to other measures.

Ventilation

A.6 Preventing loss of ventilation

Indication efficiency on energy use	Average pay-back time	Decision moment for application
Depending on situation	< 5 years	New building/renovation X Replacement/capacity extension X Directly practicable

Description

Preventing undesired loss of energy (warmth, cold, humidity) by amongst others:
- installing gang doors next to sliding doors
- automatic sliding doors
- installing door-springs
- draught-screens and draught exclusion
- air curtains in draught sensitive openings

Applicability

Applicable anywhere where undesired ventilation- and/or humidity loss of air-conditioned rooms takes place or to prevent draught.

Economic data

Generally speaking these measures in order to limit the loss of ventilation can be done profitably. The costs for steering the doors are, dependent on the regulation, 100 - 500 Euros. For draught-screens the investment is 500-1000 Euros and for a gang door in an overhead door 250 Euros.

Relation to other measures

This measure can be performed independent of other measures. It is preferable to give this measure priority, because this has a good effect on measures, which are related to heating, ventilation and cooling.

Ventilation

A.7 Heat recovery from ventilation air

Indication efficiency on energy use	Average pay-back time	Decision moment for application
5% (gas)	3-7 years	New building/renovation X Replacement/capacity extension X Directly practicable

Description
The use of heat from the exhausted air of a ventilation system. Heat recovery can be applied when the room is provided with a mechanical air supply and exhaust. The highest efficiency can be achieved with a heat wheel. A heat wheel is a rotating package, in which heat and damp of the outgoing ventilation air is absorbed in order to be given off to the incoming ventilation air. The efficiency of a heat wheel can rise to more than 85%.
Another technique that can be applied is a so-called twin-coil system. This system includes a heat exchanger in the air supply pipe and one in the air exhaust pipe, which are connected with eachother in a closed circuit, where a liquid takes care of the heat transport. A benefit of this system is that a certain distance may exist between the air pipes for the ingoing and the one for the outgoing ventilation air. With a twin-coil system an efficiency of 40% till 50% is possible.
As an alternative for the mentioned techniques a cross electric power heat exchanger can be used.

Applicability
The measure is applicable when an air treatment casing is available. For application of a heat wheel the supply and exhaust pipes have to lie close to eachother. The application of a heat wheel is quite simple. The applicability of a twin-coil system is a bit bigger, because this technique is also applicable when the air pipes lie at some distance of eachother. At the market systems are available for a ventilation capacity starting from 10.000 m3 / hour.

Economic data
When it is presumed that in existing situations a heat wheel is only applied when the air refreshing system is fit for it, it only requires the investment an installation of the heat wheel. A heat wheel for 10.000 m3 per hour costs, inclusive casing, motor and control about 7.000 Euro.
For as well existing as new building situations, the pay-back time of this measure starts from three years. The supplier of the air treatment casing can make a good efficiency calculation. In order to pay back a twin-coil system within five years, the minimal air capacity must lie within the order of 10.000 m3 per hour.

Relation to other measures
Basically the installation of a heat recovery system can be independent of other energy efficiency measures. It is preferable to carry out measure A.4 first. The possibility to recycle the ventilation air is preferable to the application of a heat recovery system. Nevertheless the recirculation is only possible when the exhaust air is not polluted.

Heating

A.8 Good housekeeping heating

Indication efficiency on energy use	Average pay-back time	Decision moment for application
10% gas consumption	nil	New building/renovation X Replacement/capacity extension X Directly practicable X

Description
The heating system and the regulation can be can be optimized by the following measures:

1. controlling the adjustment of clock and temperature
2. weekend and day/night reduction
3. critical (as low as possible) temperature adjustments
4. not obstructing the heat emission of radiators
5. good positioning of thermostats
6. adjustments not accessible for anyone
7. boiler switched off out of company-time

Applicability
The first five mentioned measures are more or less a condition for any heating-system for a good and optimal operation. The last two measures are dependent on the situation, but often applicable.

Economic data
These measures can be seen as good housekeeping. It is often possible to take along these points in a service agreement by which the spending of time and costs are minimal.

Relation to other measures
This measure also provides an improvement of comfort and has a relation with other climate installations (ventilation, cooling and humidification). For instance through a not critical adjustment it can be possible that the room is cooled and heated simultaneously.

Heating

A.9 Controlling temperature per room

Indication efficiency on energy use	Average pay-back time	Decision moment for application
5% (gas)	< 5 years	New building/renovation X Replacement/capacity extension X Directly practicable X

Description
In existing situations it is advisable to provide radiators with thermostatically controlled taps for a good control of the room temperature. With these the heat emission can be better tuned to the individual heat demand of workers and department and is the contribution of sun radiation and internal heat development compensated. This optimization leads to a reduction of heat consumption for heating.
In big rooms one can choose for a room thermostat, which controls the water supply to the radiators, in stead of thermostatically controlled taps per radiator.

Applicability
Thermostats and thermostatically controlled taps are generally applicable. But to keep down costs, it is advisable not to provide all radiators with their own thermostats in big rooms with many radiators. The control can also take place from the central supply by a room thermostat.

Economic data
The costs of a thermostat or thermostatically controlled tap are about 50 till 100 Euros a piece, including installation. In new building situations thermostatically controlled taps are installed with extra charges of 25 Euros.

Relation to other measures
The installation of thermostats and thermostatically controlled taps can be performed independent of other energy efficiency measures.

Heating

A.10 Support ventilators

Indication efficiency on energy use	Average pay-back time	Decision moment for application
1 % gas consumption	< 5 years	New building/renovation X Replacement/capacity extension Directly practicable X

Description
Support ventilators (also temperature levellers) provide a better air circulation in a room by bringing down hot air from under the roof again to floor level. Above-mentioned systems save gas for heating because they realize a more constant temperature in a vertical way.

Applicability
This measure is especially applicable in warehouses and other, relatively high rooms (>6 metres), where air is heated by an air heater and the heat concentrates under the roof. The higher the temperature gradient is, the more interesting the measure is.

Economic data
With an investment of about 250 Euros per 100 square metres floor area, gas reduction and a comfort improvement can be realized.

Relation to other measures
No relation to other measures

Heating

A.11 Application of high efficiency air heaters

Indication efficiency on energy use	Average pay-back time	Decision moment for application
10 % gas saving	< 5 years	New building/renovation X Replacement/capacity extension X Directly practicable

Description

Similar to high efficiency boilers there are also high efficiency air heaters, by which smoke gasses are cooled till under the dew point. This type of air heater has a high efficiency quality mark and can be recognized as such. Air heaters are especially applicable in production rooms and warehouses.

Applicability

This measure is especially applicable with renovation, replacement and new building. In other situations the pay-back time can be more than five years because of the higher value after depreciation.

Economic data

In regard to conventional air heaters a high efficiency air heater is paid back within five years. The extra investment is about 20 Euros per kW. The saving is about 10 % of gas consumption with regard to a conventional heater.

Relation to other measures

Mostly air heaters can be applicated in combination with support ventilators/temperature levellers (measure A10.)

Heading

A 12. Application of radiation heating

Indication efficiency on energy use	Average pay-back time	Decision moment for application
10 % gas saving	< 5 years	New building/renovation X Replacement/capacity extension X Directly practicable

Description

Radiation heating supplies heat in the shape of infrared rays on work places. Because radiation brings extra comfort to these places, the air temperature can go down. A radiation panel on gas mostly consists of a black pipe, covered at the upper side with a reflector. The smoke gasses go through the black pipe. The heat is supplied by radiation.

Applicability

Applicable for workplaces in rooms of 4 metres or higher, of which the door regularly is open and where only is worked at fixed places. It is applicable for instance for a packaging table in a warehouse, or for temporary heating after night reduction. And can also well be applicated in buildings with a bad insulation.

Economic data

In stead of one (or some) central air heater(s) a smaller central air heater is combined with some radiation units. The investments and installation costs are a lot higher through that. On the other hand a considerable less amount of capacity is needed to heat the room (in some cases the installed capacity is halved). Through the lower air temperature heat losses through open doors and ventilation are lower. Radiation heating almost directly gives comfort after switching on, and so has less burning hours as air heating, which needs a warming time. With regard to conventional warming techniques, like radiators and air heaters, a gas saving of almost 30 % is reached. In new building situations or renovation the investment is mostly lower than more conventional techniques.

Relation to other measures

Dependent on the use of the room concerned, one has to reckon with the measures A10 and A11.

Heating

A.13 Application of low temperature heating system

Indication efficiency on energy use	Average pay-back time	Decision moment for application
minimal 10 %	< 5 years	New building/renovation X
		Replacement/capacity extension
		Directly practicable

Description
Low temperature heating systems work with water temperatures beneath 60 degrees Celsius, through which the heat conversion is low-energy and can easily be connected with for instance sun collectors and heat pumps. Usually low temperature systems are fed by a high efficiency boiler. Because the heat emission is less, one has to choose bigger sizes when using radiators.

Applicability
Because the heat emission in the rooms has to take place by floor heating, bigger radiators or bigger heating elements in air treatment compartments, the application of these low temperature heating systems has to be combined with new building, renovation etc.

Economic data
The low temperature heating system, with a high efficiency central heating boiler as source of heat, makes it possible to use the heat of condensation (happens at 57 degrees Celsius) of the smoke gasses. This inclusive the lower pipe losses provide a 10 % saving. The use of a low temperature heating system, in combination with heat pumps and/or sun collectors, can lead to substantial higher savings. Moreover the low temperature heating system can be made fit to use its own residual heat. The extra investment is about 35 Euros per kW heating capacity.

Relation to other measures
The performance of this measure can take place during new building or renovation. Gearing to insulation measures of the building (measure A.2) is needed, because the application of a low temperature heating system is more simple and comfortable as the building is better insulated.

Heating (hot-tap water)

A.14 Hot-tap water production at tap point

Indication efficiency on energy use	Average pay-back time	Decision moment for application
10 % gas saving for hot- water production	< 5 years	New building/renovation X Replacement/capacity extension Directly practicable X

Description

Because of the mostly small hot-tap water need, the hot-tap water production should preferably be placed at the tap point. By this transport losses are prevented and a circulation pipe does not have to be kept on temperature when there is no demand for hot tap water. Additional advantage is that the chance for the creation of the legionella bacterium will be minimized. When no gas connection exists, one can choose an electrical flow apparatus. This apparatus has no boiler capacity and only warms when there is a demand.

Applicability

This measure is applicable when there is a small use of hot water per day and a limited number of tap points in the company.

Economic data

The economic benefit is achieved by the limitation of pipe losses. On the one hand the investment needed will be limited because no transport pipe is needed for the hot water and on the other hand an extra investment is needed for gas connections.

Relation to other measures

The measure can be combined with the hot water supplies in the building, for instance a high efficiency combination boiler, when the tap point is in the neighbourhood.

Heating (boiler)

A.15 High efficiency boiler or combination high efficiency / improved efficiency boiler

Indication efficiency on energy use	Average pay-back time	Decision moment for application
10 % gas	3-7 years	New building/renovation X Replacement/capacity extension X Directly practicable

Description

The biggest part of the year a high efficiency boiler performs better than a conventional boiler or an improved efficiency boiler, because the condensation heat of the smoke gasses is used. This is the case till the supply water temperature of 65 degrees Celsius. Peaks in the heat demand are accompanied by a higher water temperature (85 degrees Celsius). In order to take care of these peaks, next to the already installed high efficiency boiler an improved efficiency boiler can be installed. This is cheaper and performs with a high supply water temperature as well as a high efficiency boiler. For the central heating it is usual to invest in a high efficiency boiler, when the boiler should be replaced. Compared with older types of boilers with a high efficiency boiler one can realize an important reduction. Conventional boilers have an efficiency of about 70%, while high efficiency boilers can make an efficiency of 90% for room heating. In between is still the improved efficiency boiler, which has an efficiency of 80%. These efficiencies are at top value.

Applicability

High efficiency boilers are well applicable in central heating systems. The temperature of the central heating water to be supplied may not be adjusted higher than 70 degrees Celsius, because this costs efficiency for the high efficiency boiler. In connection with the condensation of the smoke gasses, the brick smoke gas exhaust pipe must be equipped with an internal mantle. Furthermore a condensation exhaust pipe to the sewer has to be installed.

Economic data

Compared with a conventional boiler or an improved efficiency boiler, a high efficiency boiler demands an extra investment. This investment depends on the capacity of the boiler. For instance the extra investment of a 70 kW high efficiency boiler, compared to an improved efficiency boiler, is about 2.300 Euros (about 32 Euros per kW). When a replacement takes place, this extra investment is paid back in medium term.

Relation to other measures

A high efficiency boiler should preferably be combined with a low temperature heating system (measure A.12). When performing this measure, it is advisable to realize measures A.16 till A.19:

A.16. Weather dependent regulation
A.17. Optimizing unit
A.18. Cascade/boiler order connection
A.19. Insulation of pipes, valves, fittings.

Heating (boiler)

A.16 Weather dependent control

Indication efficiency on energy use	Average pay-back time	Decision moment for application
5 % gas	3- 5 years	New building/renovation X Replacement/capacity extension X Directly practicable X

Description
A weather dependent control is combined with the heating boiler (or heating group in bigger installations) and controls the supply water temperature of the heating water, based on the outside temperature.
In this way is realized, that in any period of the year the central heating water is no further heated as absolutely needed. In the weather dependent control a pump connection is also built in, by which the pump automatically switches off when there is no demand for heat.

Applicability
A weather dependent control can be applied to any boiler or heating group. Only in those situations where the influence of the outside temperature is not present, another control can be considered.

Economic data
The required investment varies, depending on the type of boiler and the capacity. An extra investment is between the 10 and 30 Euros per kW boiler capacity. The reduction on gas consumption is 5%.

Relation to other measures
When carrying out this measure, it is advisable to carry out the measures A.17 till A.19 simultaneously.
After the completion of the constructional insulation measures, the so-called heating line in the weather dependent control can be lowered. The building demands lesser heat after all.

Heating (boiler)

A.17 Optimizing unit

Indication efficiency on energy use	Average pay-back time	Decision moment for application
5-15 % gas consumption	3-7 years	New building/renovation X Replacement/capacity extension X Directly practicable X

Description
Next to the measures, time switch, weather dependent control, etc., the central heating control can be expanded with an optimizing unit. This unit itself sets the moment when heating has to start based on the outside- and inside temperature. Likewise the moment to stop heating is set. In proportion to a simple time switch and weather dependent control, a reduction of 5 – 15% can be reached.

Applicability
Introduction of an optimizing package for the central heating boiler, with the above-mentioned controllable parameters, is generally applicable for all central heating systems, but only has the mentioned reduction effect when temperature reduction may be realized after working time.

Economic data
The investment for an optimizing control is dependent on the number of parameters which belong to this measure. A multi-control with boiler steering, return control, pump control and a clock group costs about 900 Euros.
The investment will be paid back within three till seven years, dependent on the number of times night heating is possible.

Relation with other measures
When this measure is carried out during new building or replacement of the old central heating boiler, it is advisable to evaluate the simultaneous carrying out of measure A.15 (high efficiency boiler) and A.18 (cascade connection).

Heating (boiler)

A.18 Cascade/ boiler order connection

Indication efficiency on energy use	Average pay-back time	Decision moment for application
5 % gas saving	3 - 5 years	New building/renovation X Replacement/capacity extension X Directly practicable

Description
A cascade connection is applied in a connection of two or more central heating boilers. In accordance with the heat demand two or more boilers are in operation. This is regulated by the boiler order connection. Advantage is that in case of heat demand the boilers do not switch on simultaneously and then switch off. In case of little heat demand one boiler will be out of order and will also automatically be switched off on the waterside with a butterfly valve in the water return pipe. One can especially save on boiler losses. There is a tendency to install more small boilers in cascade, instead of one big central heating boiler.

Applicability
Minimal two big central heating boilers should be connected with the same heat distributor.

Economic data
The investment is dependent on the size and the number of boilers and is mainly determined by the purchase and installation of the valves and in the water return pipe. It is advisable to invite a clear tender beforehand. The gas saving can increase to 5%.

Relation to other measures
Measure has a direct relationship with measure A.15 (High efficiency boiler or combination high efficiency/ improved efficiency boiler).

Heating (boiler)

A.19 Insulation pipes, valves and appendages

Indication efficiency on energy use	Average pay-back time	Decision moment for application
3 % gas	< 3 years	New building/renovation X Replacement/capacity extension X Directly practicable X

Description
By insulation of heating pipes, valves and appendages, unnecessary heat loss is limited. Especially the pipe parts in the boiler house and in the crawl space are often not fully insulated.

Applicability
Insulation is applicable everywhere, where unwished throw out of heat must be avoided. This also counts for warehouses amongst others.
The applicability of improvement of the insulation depends on the quality and size of the existing insulation. The insulation of valves and other appendages is considerably simplified by the availability of special shaped pieces.

Economic data
The costs of pipe insulation are dependent of the size of the pipes and the wished degree of insulation. An insulation thickness of 25 mm means a price of 7 Euros per metre pipe, including installation. The costs of insulation of appendages are between 20 and 70 Euros per stretching metre, dependent of the diameter. On the average improvement of insulation can be paid back in the short term.

Relation with other measures
Improvement of the insulation of heat transporting pipes can be performed apart from other energy efficiency measures. The pay-back time is shorter when the water temperature is lower, for instance after realisation of a low temperature heating system.

Cooling

A.20 Vaporization cooling

Indication efficiency on energy use	Average pay-back time	Decision moment for application
100 % on cool energy	3-7 years	New building/renovation X Replacement/capacity extension Directly practicable

Description

Vaporization cooling occurs when water abstracts the vaporization heat from the surrounding area. This can be achieved by the spraying of water into the outgoing ventilation air. Because of this the current of air cools and through a heat exchanger the fresh (warm) air from outside cools down. The country air can be cooled down for about 10 degrees. Because all water vapour is carried along with the outgoing ventilation stream, the ventilation has no influence on the relative humidity in the building.

Applicability

The measure is applicable from ventilation quantities of 6.000 m3 per hour. The installation must be designed especially for this way of cooling. Furthermore country air has to be supplied and carried off.

Economic data

Vaporization cooler with a capacity of for example 15.000 m3 per hour and a cool capacity of 36 kW saves with a company time of 1.000 hours per year about 10.000 kWh. The water consumption for cooling amounts almost 30 litres per hour. The system for vaporization cooling is cheaper as a mechanical one. Furthermore one can save on energy costs compared to a mechanical one. (in the example 2.000 Euros a year). Vaporization cooling goes hand in hand with a growth of water consumption, which the supplier has to make clear.

Relation to other measures

Before this measure is applied, other measures will have to be taken into consideration for the limitation of the cooling burden, like:
A.2: Roof insulation
A.3: Sun blinding
A.4: Optimizing ventilation

Cooling

A.21 Good housekeeping space cooling

Indication efficiency on energy use	Average pay-back time	Decision moment for application
10 % on cool energy	<3 years	New building/renovation X Replacement/capacity extension X Directly practicable X

Description

The cooling system can be optimized and improved with a number of simple good housekeeping measures, like:

1. Control engineering connection of heating and cooling,
2. Minimizing country air supply with switched on cooling
3. Accepting higher working temperature
4. Take a margin between the turning on of heating and cooling.

Sub 1. The heating and cooling system often have seperate regulations. It is possible to combine these regulations in one regulation system, by which the simultaneous cooling and heating is avoided.
Sub 2. See also measure A.4.
The generating of coldness costs a lot of energy. On hot days should be avoided that cool air is carried off outside through the air treatment and is maximal recirculation preferable. Of course the minimal ventilation within the framework of working conditions should be taken into consideration.
Sub 3. By allowing a higher temperature in a room, one can save cold energy. This can be achieved by regulating the thermostat higher.
Sub 4. The regulations of the heating system and should be regulated in such a way that one can speak of a "dead zone". Within this zone there is no heating and cooling, so that no energy gets lost. For example: heating till 20 degrees centigrade and cooling starting from 24 degrees centigrade.

Applicability

The measure is applicable everywhere, where cooling is available. When heating and cooling are joined in one air treatment compartment, control engineering adaptations are mostly not needed or relatively easy to achieve. With seperate systems the mutual tuning will be made-to-measure.

Economic data

The costs of the measure (excepting option 1) will be minimal. The measures mostly can be performed by the technical service or an installer (service agreement) and are paid back in the short term.

Relation to other measures

This measure has a relationship with heating measure A.8

Cooling

A.22 Point exhaustion

Indication efficiency on energy use	Average pay-back time	Decision moment for application
dependent on situation	< 5 years	New building/renovation X Replacement/capacity extension X Directly practicable X

Description

By exhausting heat at the source one can avoid that the room heats and should be cooled unnecessary. On cold days the heat can be used by making a valve in the exhaust pipe, which blows heat in (for example warehouse) or out at a previously regulated temperature.

Applicability

The measure is applicable everywhere, as long as the exhausted air contains no pollutants.

Economic data

This measure is strongly dependent on the set-up equipment. When heat is produced by production equipment, point exhaustion generally can be paid back within five years. Often a study is needed to select the best economic, technical and energetic situation.

Relation to other measures

The measure is preferable to the deployment of a cooling system (A.20) and the use of summer/night ventilation (part of A.4).

Humidifying

A.23 Application low-energy humidifying system

Indication efficiency on energy use	Average pay-back time	Decision moment for application
5% electricity	Strongly dependent on situation	New building/renovation X Replacement/capacity extension X Directly practicable

Description

For several modules in the graphic media industry it is important that the atmospheric humidity has a constant value or is kept above a minimum value.
A low-energy method of humidifying is the very fine spraying of water under high pressure or with the help of compressed air or by spraying with ultrasonic technique. This way of humidifying can be applicated in as well air treatment compartments as directly in the room. As well with ultrasonic spraying as with spraying under high pressure or compressed air, very fine drops are shaped.

Applicability

Humidifying by spraying of water is well applicable in printing businesses. With water spraying the vaporization heat from water is withdrawn from the air, by which a small degree of (adiabatic) cooling takes place. In a shop with a high internal heat production this is of course advantageous, because this leads to a reduction of the cooling demand. Humidifying with steam has, next to the high energy consumption, as disadvantage that the air is heated by the heat damp. With water spraying preferably osmosis water should be used.

Economic data

In a new building situation the installation of a water spraying system generally costs less than the installation of a conventional steam system. With new building this measure is paid back directly or in the short term. In existing situations the replacement of steam humidifying by humidifying of water will take substantial costs, because a whole new system has to be installed. In that case the measure pays itself back in the mid-term till long-term.

Relation to other measures

In a situation where humidifying by a steam system with boiler is already used, energy efficiency can also be gained by improvements of the system, like an economizer and a smoke gas condenser. For existing situations generally speaking one can save energy in a more cost effective way as when one switches to water humidifying.

Humidifying

A.24 Good housekeeping humidifying

Indication efficiency on energy use	Average pay-back time	Decision moment for application
till 40% efficiency possible	< 3 years	New building/renovation X Replacement/capacity extension X Directly practicable X

Description

The humidifying system can be optimized by performing a number of good housekeeping measures:

1. Reducing the relative humidity
2. Formulating temperature and relative humidity demands per room
3. Air circulation during humidifying season and switch-off outside the season.

Sub 1. By a reduction of the relative humidity from 55 to 50% an efficiency of 40% on humidifying energy can already be achieved.

Sub 2. The production process can differ per room. Because of this the demands for temperature and relative humidity will also differ. It is important to make these demands visible and to regulate the humidifying system this way.

Sub 3. For a good spread of humidity and a constant relative humidity in the total room, an air circulation is important. This can be achieved with several systems, as described in measures A.4, A.5 and A.9. Furthermore unnecessary loss of humidity is avoided by recycling the air as much as possible.

Applicability

The measure is applicable everywhere where humidifying is adopted.

Economic data

The costs are minimal because most tunings are possible with existing regulations. The efficiency can rise till 40% of the consumption of the humidifying system. In absolute sense the biggest efficiency can be achieved with electrical steam humidifiers.

Relation to other measures

No relation to other measures.

Lighting

A.25 Drawing up a lighting plan

Indication efficiency on energy use	Average pay-back time	Decision moment for application
10 - 40% electricity consumption	3 - 7 years	New building/renovation X Replacement/capacity extension X Directly practicable

Description
In many companies lighting is not optimal. The fittings often do not hang at the places where the light is needed (the workplaces). At many places the number of fittings can be driven back by a better placing and adopting of low-energy light fittings. At the same time by enlargement of the number of light switch groups the lighting can be better tuned to the presence of employees. In some rooms presence switches can be applied (for example in dressing rooms, warehouses etc.). Experiences in various printing businesses show that in individual cases savings can rise to 40%.

Applicability
An improvement of the lighting is applicable at all natural moments (new building, replacement, renovation and capacity enlargement). By a better tuning to the lighting demands of the several workplaces, the comfort on the shop floor will also grow. It is advisable to draw up a lighting plan together with your fitter or consultant.

Economic data
This measure contains several activities, which can be performed for little costs, like the tuning of the place and quantity of fittings at the workplace and the placing of presence switches. The pay-back time for these measures is short.
For higher extra costs still more energy can be saved, like the application of a central control system and/or new light fittings (HF). The lighting installations can be made dependent of:
- Automatic detection of the daylight intensity (with the help of light sensors)
- The presence of persons (with the help of movement sensors)
- The application of sweep pulses.

If these options are combined with measure A.26 (low-energy lighting), the measures mostly can be paid back between three and seven years.

Relation to other measures
The lighting plan preferably should be carried out in connection with other lighting improvements, like high reflecting fittings, high frequent strip lighting and low-energy light bulbs. See measure A.26.

Lighting

A.26 Low-energy lighting

Indication efficiency on energy use	Average pay-back time	Decision moment for application
30 - 40% electricity efficiency	3 - 7 years	New building/renovation X Replacement/capacity extension X Directly practicable

Description
Concerning low-energy lighting two aspects are of vital importance:
1. The type of fitting
2. The bulb that is used

The power of light per fitting can strongly be improved by installing high-reflecting mirror fittings. Because these fittings are provided with aluminium or silver-plated mirror, the light yield is 25% higher than of a comparable white fitting. Because of the higher light yield, for the same lighting demand fewer fittings are needed and electricity consumption decreases. For working environments with dust or humidity there are special industrial designs with a transparent protective hood. By using striplight with high-frequency electronic pre-connection device (TLD-HF), instead of conventional strip lighting, considerable energy efficiency can be realized. The efficiency of TLD-HF tubes is about 10-15% compared with conventional striplights. Combination with a mirror fitting then leads to a further efficiency. In most cases light bulbs can be replaced by low-energy light bulbs. The efficiency per bulb is very high, about 75%. However, the application degree of bulb/low-energy bulb fittings is low, about 5% of the total lighting.

Applicability
High-reflecting fittings can be used in all fittings. It is of importance that the maintenance frequency is sufficient, so that the average reflection does not fade too much. High-frequency striplight is generally applicable. The life span of TLD-HF tubes is higher than that of conventional strip light tubes (at least twice higher). Low-energy light bulbs can only replace light bulbs. The fittings of other lamps are not fit for low-energy light bulbs.

Economic data
High-reflecting fittings demand an extra investment compared to comparable white fittings. Because of the higher light yield the number of high-frequency fittings can be smaller, which can limit the extra costs. The price of a TLD-HF tube is twice the price of a conventional tube. However in existing situations, mainly the costs of replacement of the fittings are determining.
The investment for high-reflecting fittings is, in combination with HF-lighting strongly dependent of the situation. When using an even number of fittings and one tube per fitting (instead of two), the pay-back time of the extra investment in new building and renovation is about five years.
The purchasing costs of low-energy light bulbs are considerably higher than for light bulbs, about 4 till 10 euros per bulb. However the life span of a low-energy light bulb is higher, so

that over a longer period, the difference in purchasing costs between one low-energy light bulb versus more light bulbs becomes smaller. Because of the high efficiency in electricity consumption, the pay-back time of a low-energy light bulb will be short.

Relation to other measures

The application of TLD-HF tubes can be seen as part of a total plan for the improvement of lighting. It is advisable to tune this measure especially to the improvement of the lighting plan (A.25). The application of low-energy light bulbs can be applicated independently of high-reflecting fittings and high-frequency striplight.

Compressed air/vacuum

F.1 Reuse of residual heat of vacuum pumps and compressors

Indication efficiency on energy use	Average pay-back time	Decision moment for application
3%	3 - 7 years	New building/renovation X Replacement/capacity extension X Directly practicable X

Description
More than 90% of the electricity, which is supplied to compressors and vacuum pumps, becomes available in the shape of heat. This heat can usefully be used to heat production spaces or warehouses. By providing the engine room with an exhaust pipe, with in it a switchable valve, dependent of the heat demand, the heat can be blown into a room to be heated or be exhausted externally.

Applicability
A central placing of compressors and vacuum pumps is needed. Generally speaking heat recovery is well possible. Heat recovery for heating of a room is quite simply realizable especially with screw compressors, provided with a right-angled casing. For this the compressors have to be provided with a heat recovery casing (a recovery casing has one entrance with the compressor, and two exits, of which one goes tot the room to be heated and the other to the outside, when there is no heat demand). Another possibility is the heat supply with a heat exchanger to another medium. This medium can bring heat to other locations. It is also possible to use the heat to prepare hot-tap water.

Economic data
The costs for heat recovery of compressors and vacuum pumps can not be given in advance. This depends among others on the quantity of channel work and the question if heating takes place by way of the air (for direct heating of rooms) or by way of water (for heating of tap water or central heating water heating). The investment in a heat recovery casing amounts about 1.400 till 2.800 Euros for a compressor of 30 kW.

Relation to other measures
Use of heat of vacuum pumps and compressors is the easiest way to realize, when a central placing of vacuum pumps and compressors exists.

Compressed air/vacuum

F.2 Central system with cascade switching vacuum pumps and compressors

Indication efficiency on energy use	Average pay-back time	Decision moment for application
15 % electricity	3 - 7 years	New building/renovation X Replacement/capacity extension Directly practicable

Description

Printing presses and working machines generally make use of compressed air and/or blow or vacuum air. Many printing presses and machines are provided for their own compressors and vacuum pumps. The energy consumption of several seperate compressors and vacuum pumps, which usually operate in partial load, is nevertheless higher than that of one central system where different users are connected to.
When the company goes over to installation of a central system with more compressors and vacuum pumps, a cascade switching is mostly applied. The use is then dependent of the consumption of compressed, vacuum or blow air by the central system. In cascade compressors and vacuum pumps are switched on or off and operating in partial load is as much as possible avoided.

Applicability

The choice for a central system is mostly not only realized for energy efficiency, but also because of climate and sound aspects. A central system is generally applicable. In existing situations the application of a central system is dependent of the possibilities to fit in (sometimes a seperate technical room must be created). In new buildings the application of a central system is well possible against little extra costs.
Application of a central system diminishes the sensitivity to breakdowns of the presses or machines. A central system can also offer a positive effect for the working environment, because the placing of compressors and vacuum pumps in the working environment (like mostly applied in an individual system) causes heat development and sound inconvenience.
For the application of a central system it is nevertheless important that the users have the same working pressure, since otherwise energy loss takes place because of pressure regulations. If for example for one user a high pressure should have to be realized, this user should have to be connected to a seperate system.

Economic data

In existing situations a substantial investment is required because of compressors and/or vacuum pumps, pipe networks and sometimes constructional adaptations, by which the pay-back time is longer than 5 years. In new buildings application of a central system demands an extra investment in piping. On the other hand lesser compressors are needed. Newly bought presses can be installed without compressors. This leads to a new building where, generally speaking, the extra costs are small.

Relation to other measures

When a central system is installed, it should be designed according to the latest state of technique. This implies that the following measures could also be integrated:

- Recovery of compressed air heat (F.1)
- Low-energy compressors (F.3)
- Suck in cold country air (F.4)
- Minimal working pressure (F.5)
- Automatic compressed air valves per machine (F.6)
- Good Housekeeping vacuum (F.10)

Compressed air

F.3 Low-energy compressors

Indication efficiency on energy use	Average pay-back time	Decision moment for application
25 % electricity	3 - 7 years	New building/renovation X Replacement/capacity extension Directly practicable

Description
For the delivery of compressed air can be chosen between different types of compressors. The most common are sucker and screw compressors. The former type is mainly used by smaller users. However screw compressors have a better efficiency than sucker compressors. The efficiency of screw compressors is about 25% higher.

Applicability
Screw compressors are as well usable as sucker compressors. However for the smaller models not always an appropriate type of screw compressor is at the market. When the compressed air system is also used for humidification, one has to pay extra attention to the production of oil free compressed air.

Economic data
Screw compressors are more expensive in purchase than sucker compressors. This extra investment is nevertheless lesser deciding in case of bigger compressor capacities. When the sucker compressor has a sound casing, the investment costs are almost the same to the screw compressor, which always has a casing. When a choice can be made between screw and sucker compressors (without casing), the average pay-back time of the screw compressor is mid-term till long-term.

Relation to other measures
It is important to tune this measure well to measure F.2 (central system), because in both measures it is a question of a substantial investment in compressors.

Compressed air

F.4 Suck in country air

Indication efficiency on energy use	Average pay-back time	Decision moment for application
5 % electricity	< 3 years	New building/renovation X Replacement/capacity extension X Directly practicable X

Description
Usually compressed air compressors are situated in a hot engine room, which sometimes is ventilated badly itself. However for compressors counts that compression of cold country air costs lesser energy than compression of hot (inside) air. Compressed air compressors preferably have to suck in country air. With a suck in temperature, which is 15 degrees centigrade lower, an energy efficiency of 5% can be gained.

Applicability
In general the suck in of cold country air is quite easy to adopt. In certain cases the place of the compressors can be so much unfavourable, that suck in of cold country air is problematic. This depends on the specific situation in a company. In case of frost should be switched over to a mixture with country air to prevent the danger of freezing.

Economic data
Suck in of cold country air requires some costs for the construction of channels (material costs and installation are quickly 140 till 180 Euros per metre). These costs are strongly dependent of the specific situation in a company (length of channels, wall to go through). In general the costs are paid back within three years, because compressed air rooms have an outside wall, where grids to the country air are part of.

Relation to other measures
This measure can be performed independent of the other measures having to do with compressed air systems.
This measure is connected with possible measures concerning ventilation of the rooms.

Compressed air

F.5 Good housekeeping compressed air

Indication efficiency on energy use	Average pay-back time	Decision moment for application
till 20 % electricity consumption	< 1 year	New building/renovation Replacement/capacity extension Directly practicable X

Description

The energy consumption by compressed air equipment can be reduced by the following good housekeeping measures:

1. Regular check on leakages
2. Reducing the compressed air pressure
3. Compressors switched off after company time.

Sub 1. Practice shows that in compressed air installations a substantial part of the energy gets lost by leakages in the system. These are caused by, among others, damaged hoses, affected couplings or packings and worn-out valves.
When the system is regularly checked on leakages, for example every month, after working time, when the system is on pressure without users, leakages can easy be detected and repaired.
Sub 2. In some cases compressed air is put on a pressure, which is over the level which users minimally need. In these cases a reduction is possible by reducing the working pressure of the compressors a bit. At a working pressure of 6 bar overpressure, 1 bar pressure reduction yields 5% energy efficiency.

Applicability

Checking on leakages is a simple and effective measure, which belongs to the standard maintenance work. By inventory of the compressed air users can be decided if working pressure reduction is permitted.
It can occur that a producer of a printing press does not guarantee the working of his machine anymore with a reduced working pressure, or that he even demands a higher working pressure. The applicability is also dependent on the compressed air network. This has to be well laid out. With a lower pressure a bigger diameter is needed to transport the same quantity of compressed air.

Economic data

The check of the compressed air installations on leakages demands almost no investments.
By finding a leakage in time, a substantial efficiency on electricity costs can be gained. Among other things a leakage caused by an opening with a diameter of 1 mm costs 30 Euros electricity costs a year, while an opening of 6 mm diameter quickly costs 900 Euros (with 6 bar overpressure and 8.760 company hours a year).
With that the costs for inspection are relatively quickly paid back.
The reduction of the working pressure can be carried out without costs. And so the pay-back time is short.

Relation to other measures

Basically the introduction of these good housekeeping measures can take place at any time. It is advisable to start with these measures, because they influence the pay-back time of other compressed air measures.

The height of the electricity reduction, which can be gained by reduction of leakages, is also dependent on the working pressure of the compressed air. When reducing the working pressure the leakage losses will also get smaller.

Compressed air

F.6 Installing valve per user/user group

Indication efficiency on energy use	Average pay-back time	Decision moment for application
about 17.000 kWh per valve (diameter 6 mm, 6 bar)	< 2 years	New building/renovation X Replacement/capacity extension X Directly practicable X

Description
By installing valves is prevented that the compressed air network is kept on pressure for machines which are not in use.
A part of the standstill consumption of a compressed air system follows from the construction of among others printing presses and machines. The push back to the source often is radically or impossible. It is simpler to eliminate this consumption by installing automatic block valves per machine, steered by the steering of the press. As soon as the machine is out of order, the valve has to be closed.

Applicability
The applicability of compressed air valves per machine is dependent on the lay-out of the compressed air network and the construction of the machines. Basically the installation of compressed air valves per machine is generally applicable, but it is not always that simple. This depends mainly on the number of connections per machine. In an ideal situation there is one branch form the main network per machine. In case of two or more branches it gets more complicated. In order to judge the applicability, one may the best consult with the supplier.

Economic data
A reduction in the standstill consumption can be gained by an extra investment in one (or more) block valves per machine. Dependent on the design (among others the diameter) this comes to 70 till 225 Euros per valve, with extra costs for steering and installation.
In existing situations the investment is paid back in the short term, when 1 valve per machine will do. The reduction which is realized is identical to that of a compressed air leakage (see under measure F.5).

Relation to other measures
Despite of the use of compressed air valves per machine the check on leakages still is necessary.

Compressed air

F.7 Seperate high and low pressure net

Indication efficiency on energy use	Average pay-back time	Decision moment for application
	4-7 years	New building/renovation X Replacement/capacity extension Directly practicable

Description
When a variation in printing exists, for example for compressed air of 8 bars and blown air of 2 bars, it can be worth to have two systems operational beside one another. Alternative is to temporarily increasing the compressed air pressure when the user of the highest pressure has only a little working time.

Applicability
Technically the measure is widely applicable. In practice the implementation will only take place when more users demand a higher pressure as the users which work with a low pressure. When this is not the case, these users will be supplied with compressed air individually.

Economic data
Dependent on the company time and possible pressure reduction by a seperate net, the pay-back time will differ per situation. One has to consider an extra investment in compressors, which will be paid back within seven years, with a long enough company time.

Relation to other measures
This measure starts from a central system (F.2). At the same time measure F.1 (recovery of heat) should be considered.

Compressed air

F.8 Optimizing pipe diameters and size buffer barrel

Indication efficiency on energy use	Average pay-back time	Decision moment for application
till maximal 30 % electricity reduction	3-7 years	New building/renovation X Replacement/capacity extension X Directly practicable

Description

The zero charge loss of a compressed air installation can be reduced by:
- optimizing pipe diameters
- optimizing proportions of buffer barrel

Pipes with enough diameters cause the slightest loss of pressure. A buffer barrel, which is big enough, can absorb peaks in the compressed air consumption with lesser energy consumption as when peaks have to be absorbed by compressors. By growth of the number of compressed air users the original pipe dimensioning and the size of the buffer barrel are often not sufficient anymore. This causes among others the commuting of the installation.

Applicability

The measure is applicable for installations which often operate in zero charge. It is advisable to take this measure by calculating the necessary installation before realization.

Economic data

In a not optimum situation of pipe diameters and buffer barrels, about 30% of the total electricity consumption of a compressed air installation is meant for the tick over. The maximal reduction potential is even to this. The required investment is dependent on the situation.

Relation to other measures

This measures assumes the application of a central system (F.2)

Compressed air

F.9 Float-steered water divider (in stead of time-steered)

Indication efficiency on energy use	Average pay-back time	Decision moment for application
1.500 kWh electricity	< 3 years	New building/renovation Replacement/capacity extension Directly practicable X

Description
In order to prevent corrosion of equipment and pipes, the moisture should be removed off the compressed air. A part of the moisture is condensing and accumulating in a water divider. The draining away of this moisture can be done by opening a time-steered valve. Nevertheless when there is no moisture, compressed air is drained away. Preferred is a float-steered water divider.

Applicability
This measure is applicable in all compressed air installations and can be carried out in combination with maintenance.

Economic data
The adjustment demands a maximal investment of 225 Euros.

Relation to other measures
No relation to other measures.

Vacuum

F.10 Good housekeeping vacuum

Indication efficiency on energy use	Average pay-back time	Decision moment for application
varies per situation, till about 40% on energy consumption	< 1 year	New building/renovation Replacement/capacity extension Directly practicable X

Description
Minimizing pressure loss in pipes:
1. Minimizing leakage losses
2. Switch-off after company time
3. Maintenance
4. Switch-off machines which do not demand vacuum
5. Replace older pumps
6. Never reduce more than necessary.

Sub 1. A circular pipe gives lesser pressure fall in the pipes and provides lesser pressure changes. By this the vacuum pump can be adjusted to a higher pressure. When a pipe network is designed for central vacuum generation, it is wise to see if the pipe can be extended to a circular pipe. For this extra pipes are needed. The precise investment is dependent on the company lay-out.

Sub 2. Just like with a compressed air system, leakage control in a vacuum network is important. In each pipe network a bit of air will enter the pipes. Regularly should be determined how much this is. The frequency is chosen in consultation with the company. In case of central vacuum generation with a pipe network this is at least yearly. In case of decentralized generation and short pipes it can be done as well in the normal maintenance of the installation, to what the vacuum pump is coupled.

For a system with low pressures (on average till a high vacuum, < 10 mbar) applies that for a good working of the system it is essential that the system is leak proof.

Sub 3. A vacuum pump can be switched-off best when there is no demand for vacuum. Anyway this means that the pump is off outside company time. This can be done by hand. When it appears that the pump is switched on regularly outside company time, it is profitable to connect the pump to a time switch.
Sub 4. A vacuum pump can be sensitive for failures. It should be maintained regularly. This is especially important when condensed vapours are exhausted. When there is not enough maintenance, the working of the pump goes backwards and the energy consumption increases.
Sub 5. Shut off machines from the vacuum pipe, when no vacuum is demanded. Generally the vacuum is not continuously demanded for every machine, like with printing presses or packaging machines.
Sub 6. Old pumps often are very inefficient compared with new pumps. During the last fifteen years the existing types of pumps are strongly improved, while besides more

efficient pumps have come to the market, based on new working principles, like the claw and screw pump.

Sub 7. The further reducing of the end pressure as strictly necessary demands unnecessary much energy. The buying of a pump which can gain lower end pressures as demanded, also leads to higher costs.

Applicability
The measure is applicable for all vacuum systems.

Economic data
A time switch with week programme costs 15 till 30 Euros.
Because most good housekeeping measures are simple and can be carried out without extra costs, the pay-back time is short.

Relation to other measures
With the combined compressed air and vacuum measures (F.1 and F.2)

Cooled water

F.11 Insulation cold pipes

Indication efficiency on energy use	Average pay-back time	Decision moment for application
10% electricity	< 3 years	New building/renovation Replacement/capacity extension Directly practicable X

Description
The insulation of the cool medium pipes is a relatively easy measure, which can bring in substantial energy efficiency. In the meanwhile pipe insulation is a standard application. However, the insulation is not always of sufficient high quality (i.e. vapour dense application, which can lead to cold bridges by condensing.

Applicability
Improvement of the insulation of the cool medium pipes is almost always possible. The high temperature pipe, starting from the compressor till the expansion, is mostly not insulated. The quality of the existing insulation will be decisive.

Economic data
The costs of insulation of cool medium pipes with vapour restraining material ("Armaflex") are dependent of the wished insulation thickness and the pipe size (diameter and length). As a rule a price of 45 Euros per m2 external pipe surface, with an insulation thickness of 13 mm, can be followed. When the pipes are difficult to reach, the costs will increase. Compared to conventional insulation vapour restraining insulation material is not much more expensive. Generally speaking improvement of insulation is paid back in short term.

Relation to other measures
Insulation and insulation improvements can be carried out independent of other energy efficiency measures.

Cooled water

F.12 Use of free cooling

Indication efficiency on energy use	Average pay-back time	Decision moment for application
40% electricity	3 – 7 years	New building/renovation X Replacement/capacity extension X Directly practicable

Description
With not too low temperatures a big part of the year can be cooled with country air. For the cooling of the printing presses (ink and cooling cylinders) cooling-water is used. Dependent on the wished temperature levels and the needed cooling capacities, it is possible to cool this water not by refrigerators, but with the help of free cooling. With insufficient cooling the cooling compressor switches on.

Applicability
Cooling towers are applicated with bigger cooling capacities (starting from 40 kW). In 90% of the cases the cooling capacity is limited and there will be chosen for an air cooled condenser. The applicability of free cooling throughout the year is dependent of the temperature of the cooling water and of the country air. This means that free cooling can not be applicated with high outside temperatures, but can be during a big part of the year. As the temperature course of the cooling water lies higher, the possibilities of free cooling can better be used. For example with 14 degrees Celsius water can be cooled with free cooling for about 4.000 hours a year.

Economic data
The electricity efficiency for cooling can come to about 40%.
Because in 90% of the graphical companies the set up capacity is too small for application of a cooling tower, free cooling will take place by placing an air cooled condenser in the water circuit. The investment is about 900 Euros per kW.
The investment for free cooling with the help of a cool tower depends of the existing installation. When the existing installation has an open (wet) cooling tower, only a heat exchanger with valves, some piping and a regulator are needed. When the cooling installation has direct condensers/coolers, like in split-level installations, a separate cooling tower is demanded. The pay-back time strongly depends on the production hours per year. When the production time of the cooling is high (more than 6.000 hours), free cooling is very profitable. In that case, with a sufficient big capacity, adaptation of the existing installation (starting from about 1.000 kW) is economically interesting.
In new building situations the installation of a cooling tower is attractive when the cooling demand is big (starting from 600 till 1.000 kW). Then the investment is about 300 till 400 Euros per m3/h. Then the extra investment can be paid back in short term.

Relation to other measures
Also together with measure F.13 (low-energy refrigerators) substantial energy efficiency on cooling can be achieved. Nevertheless a cooling tower cannot completely replace the refrigerators, but will only undertake a part of the cooling weight. Although there is some

overlap, the interaction between these two measures stays limited. The two measures can also be carried out next to eachother.

Cooled water

F.13 Low-energy refrigerators

Indication efficiency on energy use	Average pay-back time	Decision moment for application
25% electricity	3 – 7 years	New building/renovation X Replacement/capacity extension X Directly practicable

Description

The newer types of refrigerators are more low-energy than the older refrigerators. This energy efficiency is caused by the application of centrifugal and screw compressors and an electronic regulation of the expansion and condenser pressure. This electronic regulation allows a better tuning of the refrigerant temperature (humidifier temperature) to the asked cooling weight, and also of the condenser temperature to the country air temperature.

Applicability

The low-energy refrigerators are as good as applicable as the older types. A good control of the refrigerators to the cooling demand and the open air temperature will help the working of the refrigerators.

Economic data

When buying a new refrigerator, the extra costs of a new type with centrifugal or screw compressor are relatively small. When buying new refrigerators in general automatic improvement of the energy output will take place. Nevertheless it is advisable to examine the energy output in the tender phase and to give importance to it in the choice of the refrigerator.

Possible extra costs are paid back in the short term. The costs of a good electronic regulation make up extra costs when buying a refrigerator.

In existing situations the measures are paid back in the long term.

Relation to other measures

Application of free cooling of the cooling water (measure F.12) can undertake a part of the cooling weight of the refrigerators. Despite this measure the application of a refrigerator will be needed. So the measures can be carried out together as well as independent of each other.

Cooled water

F.14 Weather dependent control cooling

Indication efficiency on energy use	Average pay-back time	Decision moment for application
10% cooling energy	3 – 7 years	New building/renovation X Replacement/capacity extension X Directly practicable

Description

Compression cooling works with the help of a refrigerant which vaporizes when absorbing heat. By compression the temperature of the refrigerant rises. Usually this heat is given off in an air cooled condenser. The heat throw out only succeeds when the temperature of the cooling medium is higher than the outside temperature. On a winter day the outside temperature is considerably lower as on a summer day. By controlling the cooling system in such a way that the condensation temperature and pressure are tuned to the outside temperature, substantial efficiency can be made.

Applicability

Especially for cooling systems which are used also in winter for process cooling (presses) the measure can be recommended. This measure does not apply for the smaller "office air conditioning systems".

Economic data

Especially for cooling systems, which are designed for summer conditions, but also are used in winter, the pay-back time will be within the range of three till five years.

Relation to other measures

When free cooling (F.12) is used, the refrigerator will be in operation for less hours and the pay-back time gets longer. In general first the possibility of free cooling has to be assessed.

Cooled water

F.15 Good Housekeeping cooled water

Indication efficiency on energy use	Average pay-back time	Decision moment for application
25%	< 3 years	New building/renovation Replacement Capacity extension X Directly practicable

Description

- Reducing condensation temperature
- raising humidifier temperature
- raising cooled water temperature at lower outside temperature
- optimizing unfreezing cycle
- improving heat throw out condenser by choosing good positioning and regularly cleaning.

All these measures have to do with set point tunings and good housekeeping. With a critical tuning the measures bring in a substantial efficiency. With the measures is realized that the cooled water temperature does not have to be lower than absolutely necessary. Usually the temperature of the cooled water is controlled at 6ºC supply, 12ºC draining. It is advisable to make an inventory of the cooling demanders and their temperature level and to tune the temperature of the cooled water to this. Subsequently the refrigerator must be tuned to this.

Applicability

The measure is applicable everywhere where a cooled water network is present.

Economic data

The carry out of the measure refers to the tuning of especially the temperatures. In combination with maintenance this is applicable with relatively small costs.

Relation to other measures

This measure raises the applicability of F.12, use of free cooling because with the higher temperature one can cool longer with country air.

Cooled water

F.16 Use of condenser heat

Indication efficiency on energy use	Average pay-back time	Decision moment for application
dependent on situation	3 – 7 years	New building/renovation X Replacement/capacity extension X Directly practicable

Description
Heat, which is thrown out by the coolant, can be used usefully for example space heating in the heating season. Outside the heating season the heat has to be removed outwards. An option is to transfer the heat by means of a heat exchanger to the central heating system.

Applicability
The measure is applicable when the company has the disposal of cooling condensers and when there is a demand for low-quality heat at the moment when cooling takes place. In printing businesses the applicability has to be sought especially in using the heat for space heating. This can be done directly (placing of second condenser in warehouse) or indirectly by means of a heat exchanger in the heating circuit or air pre heater in an air treatment casing. Application is interesting starting from bigger cooling capacities (>50 kW).

Economic data
On behalf of this measure the cooling system and the heating system have to be adapted. Consequently this measure is economically only profitable with new building/replacement, when realized at natural (replacement) moments. The pay-back time is fully dependent on the situation and lies usually between three and seven years.

Relation to other measures
No relation to other measures.

Dust/shred exhaustion

F.17 Optimization dust/shred exhaustion

Indication efficiency on energy use	Average pay-back time	Decision moment for application
8% gas	< 5 years	New building/renovation X Replacement/capacity extension X Directly practicable X

Description

In this production shreds etc. can be exhausted mechanically. The exhaustion of this air costs energy, because conditioned air is exhausted. By adapting the design of these exhaustions and exhausting as goal-oriented as possible, can be prevented that too much air is exhausted.

Moreover the air can, after removal of the shreds, with the help of a filter system, be led back to space, so that the air balance is not disturbed. In combination these measures bring in a substantial efficiency.

Applicability

The measure is everywhere applicable where central shred exhaustion is present. The recirculation of the exhausted air demands adaptations of the system. A filter module, together with some channels, has to be installed.
Moreover it is important that, by using this measure, the total space ventilation is assessed simultaneously.

Economic data

Inappreciable charge is made for optimizing the exhaustion system. For tuning the exhaustions with regularity some man-hours are required. For recycling the exhausted air has to be invested in a filter module and in channels. These investments are strongly dependent on the specific situation in a company. Whether it concerns a new building situation or an adaptation of an existing company has hardly an effect on the height of the investments. On average the investments will be paid back within five years.

Relation to other measures

This measure is a seperate measure. Heat loss has to be limited by other forms of unwished ventilation.

Electricity/natural gas general

EA.1 Building Management System

Indication efficiency on energy use	Average pay-back time	Decision moment for application
10% energy efficiency dependent on situation	3 – 7 years	New building/renovation X Replacement/capacity extension X Directly practicable

Description

A Building Management System is a coordinating system, which centrally regulates the various building systems and functions in a building. With this can be thought of heating, lighting, ventilation, air conditioning, compressed air, etc. The Building Management System takes care for an optimal tuning of the various systems to the circumstances in the rooms between themselves and for example the weather.
Experience shows that with a Building Management System unnecessary ventilation, heating, cooling, etc. can be prevented.

Applicability

Only for the bigger companies an application of a Building Management System will be attractive. In many cases, a Building Management System improves, next to the energy efficiency effects, also the comfort and indicates failures. Furthermore it offers a good opportunity to control efficiencies (monitoring, for example of boilers) and the administration of maintenance can be included.

Economic data

The set-up of a Building Management System is expensive affair. Mostly a Building Management System can be built up modularly. A very simple version costs about 7.000 Euros. However systems of which the investment is in the order of 40.000 Euros are more real.
The possibilities vary with the price. Possibilities are central control of the air treatment; central switching of the light; central operation of the sun blinds and windows; central registration of energy use; alarm device, etc. In order to get a detailed quotation, it is advisable to consult the possibilities with a consultant or installer.
Dependent on the set-up and complexity, a more investment of the energy control functions of this measure can be paid back in short till long term.

Relation to other measures

When this measure is carried out, all control engineering matters with regard to heating, cooling and ventilation have to be integrated.