**Annex 5 -**

**Consultancy report on options to expand AMS-II.C "Demand-side energy efficiency activities for specific technologies"**

Consultant Report v02 28/08/2011

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| **AMS-II.C. Demand-side energy efficiency activities for specific technologies** |

In this report:

- AC – Air Conditioning
- CFL – Compact Fluorescent Lamps
- COP – Coefficient of Performance (of air conditioners)
- ECM – Energy Conservation Measure
- Energy Conservation = EE+RE
- EE – Energy Efficiency
- EER – Energy Efficiency Rate
- EU – EU energy labeling system for appliances and equipment
- RE – Renewable Energy
- UEC – Unit Energy Consumption

## New options of the methodology

Currently, the methodology applied two options for emissions reduction determination:

**Option 1 – device power and device operating hours**

Baseline electricity consumption is determined as the product of "*power of the device*" and "*operating hours of the device*".

$$EL_{BL} = P * o$$

This report strongly recommends to significantly limit the application of Option 1, because of possibility of over-estimation of the "power of the device". The report recommends to replace the "*operating hours of the device*" by "*operating hours of the facility served by the device*".

**Option 2 – unit energy consumption per product or service**

Baseline electricity consumption is determined as the product of "*specific energy consumption of the system in the baseline*" and "*the output*".

$$EL_{BL} = UEC * Q_{pj}$$

"The output" may be product manufactured in industrial facility or service (like water flow from pumping station).

The report recommends additional options for determination of emissions reduction, as follows:

**Option 3 – change of operating hours**

For stand-by saving projects different formula should be applied than Option 1:

$$EL_{BL} = P_{pj} * o_{BL}$$
$$EL_{pj} = P_{pj} * o_{pj}$$

**Option 4 – direct monitoring of energy consumption in baseline and PA**

The example of such project may be "*Energy management system in office building*". The system monitors energy consumption in baseline and in PA.
This Option does not require any formulas for baseline or PA energy consumption.

**Option 5 – determination of saving in %, using EU energy labeling system**

EU labeling system includes class (like "A"), and unit electricity consumption, which allows determination of saving in %.
This option is applicable only in case when the project appliance or equipment is labeled according to EU labeling system.
The example may be sales increase of efficient appliances having EU energy label, while the baseline is appliance class "A".
Another example is new industrial plant applying efficient motors labeled according to EU labeling system, while the baseline motor is class "A".

$$SAV = (1 – UECpj/UECbl)$$

SAV = energy saving, %
UECpj – project unit energy consumption, as indicated on label of the project model, according to EU labeling system, kWh/service
UECbl – baseline unit energy consumption as indicated on label of the baseline model class "A", according to EU labeling system, kWh/service

$$ER = SAV * EL * EF$$

EL – project energy consumption, kWh/y:

- for households, from national energy statistics in households
- for not households, as monitored.

**Option 6 – determination of saving in %, using default saving values**

The formula does not require determination of baseline electricity consumption.
The example for such project may be "*Air conditioning control in office buildings*" as described below.

$$ER = SAV * EL$$

SAV – default saving as in the methodology tables, %
EL – project activity electricity consumption as metered
For this project, the methodology includes default values of saving in %, depending on the device type. The methodology includes also other default parameters, like daylight hours and default numbers of rooms which may use daylight.
In this option, office building operating hours are monitored (in Option 7, also the office operating hours are default value).

**Option 7 – determination of saving in %, using default saving values and default operating hours**

This Option is applicable for lighting only.
The formula does not require determination of baseline electricity consumption.
The example for such project may be "*Lamps replacement*", as described below.
The methodology includes table "*Default values for baseline lamps and ballasts*", allowing determination of energy saving in %.

$$ER = SAV * o * P * EF$$
$$SAV = (1 – LpWBL/ LpWpj)$$

SAV – energy saving, %
o – default operating hours, from the methodology tables for various sectors
P – project lamp and ballast power, as indicated on nameplates.

LpWBL – baseline lamp + ballast efficacy (energy efficiency), default value from table "*Default values for baseline lamps and ballasts*" below
LpWpj – project lamp + ballast efficacy.

The methodology includes also table "*Default values for project lamps and ballasts*", capping the manufacturer's data to the default values, especially for project ballast.
For this Option, the operating hours are default values for various sectors considering daylight hours, regardless the actual operating hours of the energy consumer.

**<u>Option 8 – determination of saving in %, using computer simulation program</u>**
For EE in building envelope and solar houses, available well recognized computer simulation program (like DOE2) may be used for determination of energy saving in %.

**ER = SAV * EL**

SAV – energy saving in %, as determined by the computer simulation program
EL – project energy consumption, kWh/y:

- for households, from national energy statistics for space heating and air conditioning in households
- for not households, as monitored.

Computer simulation program may be used only for EE in building envelope and for solar houses, and only for determination of energy saving in %.

## Energy consumption in households

The report recommends to use national energy statistics of host country, to determine energy consumption of appliances and systems in households, rather than "sample", "survey", "telephone survey", "tests", "indicators", "computer simulation programs" and values applied for test standards, which may result in over-estimation of baseline emissions and emissions reduction.
If such national statistics is not available, the methodology is not applicable to the relevant projects.

## Optimization system for pumping station

"Optimization system for pumping station" is described in this report, section "*Additional recommended changes of the Methodology sections / Applicability*".

**<u>Baseline energy consumption</u>**

Option 2 is applied to determine baseline energy consumption, as follows:

$$E_{BL,y} = UEC * Q_y / (1 - l_y)$$

UEC – unit energy consumption in baseline, kWh/m3
Qy - total quantity of water supplied in project year 'y', m3/y

**UEC = MIN(UECm, UECbill)**

UECm – measured unit energy consumption in kWh per m3 of water flow in baseline, kWh/m3
UECbill – unit energy consumption based on baseline electricity bills and water bills, kWh/m3

**UECm = ELmBL / QmBL**

ELmBL – metered electricity consumption in baseline, kWh/y
QmBL – metered water flow in baseline, m3/y

**UECbill = ELbillBL / QbillBL**

ELbillBL – electricity consumption based on electricity bills in baseline, kWh/y
QbillBL – water flow based on water bills in baseline, m3/y

Three years worth of data to be used to determine a baseline UEC (unless baseline is less than three years old), minimum one year.
Final UEC is an average of UEC values calculated for 3 years before the project.

**Monitoring of differential pressure**
In addition to parameters required for determination of UEC, head and reservoir level (if exists) should be monitored.

**Change of reservoir level**
If the average project differential pressure is lower than in baseline by more than 5% as the result of change of reservoir level, the applied UEC should be lowered accordingly.

**Change of head as the result of optimization**
If it can be demonstrated that the change of average head is the result of optimization system, the applied UEC shall remain as calculated above.

**Change of users head**
If it can not be demonstrated that the change of head is the result of optimization system, change of head should be considered as change of water consumers head (like change of irrigation equipment).
In such case, if the project average head is lower than in baseline by more than 5%, the applied UEC should be lowered accordingly.
If the average project head is higher than in baseline, this issue should be neglected for conservativeness.

**Combination with water saving**
As recommended in section "*Additional recommended changes of the Methodology sections / Applicability / Indirect energy saving*", this methodology is not applicable to projects saving energy indirectly (like water saving, compressed air saving, or steam saving).

## Optimization system for compressed air

"Optimization System for Compressed Air Station" is described in this report, section "*Additional recommended changes of the Methodology sections / Applicability*".

**Baseline energy consumption**

This project may combine Option 1 with Option 2 to determine baseline energy consumption, as follows:

$$E_{BL,y} = UEC * Q_y / (1 - l_y)$$

In this case, two specific parameters influencing the system energy consumption can be determined:

- volume of compressed air
- operating hours of the industrial facility using compressed air.

Baseline electricity consumption is the lower value between the baseline energy consumption calculated according to the volume of compressed air and the operating hours of the industrial facility using compressed air:

$$\mathbf{E_{BL,y} = MIN(ELairBL, ELhrBL)}$$

$$\mathbf{ELairBL = UECair * Qair,y}$$
$$\mathbf{ELhrBL = UEChr * Qhr,y}$$

$E_{BL,y}$ - baseline electricity consumption, kWh/y
ELairBL - baseline electricity consumption calculated according to the volume of compressed air, kWh/y
ELhrBL - baseline electricity consumption calculated according to the operating hours of the industrial facility using compressed air, kWh/y
UECair – unit energy consumption in baseline per compressed air volume, kWh/m3
UEChr – unit energy consumption in baseline per operating hours of the industrial facility using compressed air, kWh/hr
Qair,y - total quantity of compressed air supplied in project year 'y', m3/y
Qhr,y - operating hours of the industrial facility using compressed air in project year 'y', capped to baseline operating hours of the industrial facility using compressed air, hr/y

$$\mathbf{UECair = ELmBL / QmAirBL}$$
$$\mathbf{UEChr = ELmBL / QmHrBL}$$

ELmBL – metered electricity consumption in baseline, kWh/y
QmAirBL – metered volume of compressed air in baseline, m3/y
QmhrBL – metered operating hours of the industrial facility using compressed air in baseline, hr/y

Three years worth of data to be used to determine a baseline UEC (unless baseline is less than three years old), minimum one year.
Final UEC is an average of UEC values calculated for 3 years before the project.

**<u>Capped baseline operating hours</u>**

As recommended in section "*Baseline – Item 6 – Capped baseline operating hours / Capped baseline operating hours*", "capped baseline operating hours" are an average of 3 years before the project.

$$\mathbf{Qhr,y = MIN(QhrPJ,y, QhrCAP)}$$

Qhr,y - operating hours of the industrial facility using compressed air in project year 'y', capped to baseline operating hours of the industrial facility using compressed air, hr/y
QhrPJ,y - operating hours of the industrial facility using compressed air in project year 'y' as monitored

$$\mathbf{QhrCAP = AVERAGE(QhrBL_{-3y}, QhrBL_{-2y}, QhrBL_{-1y})}$$

$QhrBL_{-3y}$, $QhrBL_{-2y}$, $QhrBL_{-1y}$ - baseline operating hours of the industrial facility using compressed air 3 years, 2 years and 1 year before the project, hr/y

**Monitoring of pressure**
In addition to parameters required for determination of UEC, compressed air station weighted average pressure should be monitored together with storage tank volume.

**Change of pressure as the result of optimization**
If it can be demonstrated that the change of average pressure is the result of optimization system, the applied UEC shall remain as calculated above.

**Change of storage tank**
If the project average pressure is lower than in baseline as the result of increased volume of the storage tank, this may be regarded as energy efficiency measure and the applied UEC shall remain as calculated above.
DOE should use its sectoral expertise to calculate the relation between the change of storage tank volume and change of pressure.

**Change of consumers pressure**
If it can not be demonstrated that the change of pressure is the result of optimization system, it should be considered as change of consumer pressure.
In such case, if the project average pressure is lower than in baseline, the applied UEC should be lowered accordingly.
If the average project pressure is higher than in baseline, this issue should be neglected for conservativeness.

**Combination with compressed air saving**
As recommended in section "*Additional recommended changes of the Methodology sections / Applicability / Indirect energy saving*", this methodology is not applicable to projects saving energy indirectly (like water saving, compressed air saving, or steam saving).
If the project includes compressed air saving measures (like replacement of tools' nozzles, or replacement of compressed air tools by electric tools), the methodology is not applicable to these measures.

## Air conditioning control in office buildings

The recommended formula for emissions reduction is:

**ER = SAV * EL * (Adevice/Aac) * Occ * deviceX * hrX * EF**

ER – emissions reduction, $tCO_2/y$
SAV – default saving as in following tables, %
EL – project activity electricity consumption as metered using dedicated energy (kWh) meter for air conditioning system only, or using the building energy management systems, kWh/y
Adevice – floor area of rooms where the energy saving devices are installed, m2
Usually such devices are not installed in dining rooms, corridors and computer rooms.
Aac –building area which air conditioning electricity consumption is monitored using dedicated energy meter, m2
Occ – default occupancy, 75%
deviceX – % of correctly operating energy saving devices, as monitored and verified, %
hrX – correction factor for AC hours, as detailed below, %
EF – grid emission factor, $tCO_2/kWh$

**Correction factor for AC hours, hrX**
Application of energy saving devices should not increase AC hours. It is recommended to limit the AC operating hours to the business hours of the office building. ER will be reduced by the percent of excessive AC hours, by application of correction factor for AC hours, hrX.
hrX maximum value is 100%.

**Excessive operating hours of AC system = DeltaMorning + DeltaEvening**
**hrX = 1- (DeltaMorning + DeltaEvening) / AChr**

DeltaMorning – difference between the default time to switch AC on and the actual time when the AC system was switched on, hr/d
DeltaMorning cannot be negative.
The default time to switch AC on is 15 minutes before the official business opening hour.

DeltaEvening - difference between the actual time when the AC system was switched off and the default time to switch AC off, hr/d
DeltaEvening cannot be negative.
The default time to switch AC on, is 30 minutes before the official closing business hour.

AChr – daily operating hours of AC system, hr/d

**Occupancy sensors**
Occupancy sensor switches off the air conditioning when the room is not occupied.

Default saving, SAV

| Minutes | SAV |
|---|---|
| 15 | 30% |
| 30 | 28% |
| 60 | 25% |
| 120 | 20% |

Minutes - time to switch-off when room not occupied, in minutes.

**Air conditioning timer**
Air condition timer switches off the air conditioning in the room every few hours of operation (like every 2 hours). After switching off, the air conditioning remains shut down. To switch it on, it must be switched manually. In addition, the device does not allow to switch on the air conditioning for 15 minutes after was switched off.

Default saving, SAV

| hr | SAV |
|---|---|
| 1 | 35% |
| 2 | 25% |
| 3 | 15% |
| 4 | 10% |

hr - time when the AC unit is switched off

**Air conditioning central switch-off**
There are room air conditioning switchboxes which remains switched off after each interruption in electricity supply. This property is used by central control system in the office, which is programmed to cause such electricity supply interruption on the dedicated electric line to the air conditioning

switchboxes in rooms. The system is also set to perform such planned interruptions at the end of the workdays.
After switching off, the air conditioning remains shut down. To switch it on, it must be switched manually.

Default saving, SAV

| hr | SAV |
|---|---|
| 1 | 30% |
| 2 | 20% |
| 3 | 12% |
| 4 | 7% |

hr - time when the AC unit is switched off

## Lighting control in office buildings

### Occupancy sensors

Occupancy sensors lighting control systems reduces the use of artificial light when the room is not occupied. "Occupancy sensors" are also called "motion sensors", "presence sensors" or "vacancy sensors".
In many cases the occupancy sensors control not only room lighting but also air conditioning of the room. In such case, when the occupancy sensor detects that the room is not occupied, it switches off the lights and the air conditioning.

**ER = SAV * EL * (Adevice/Alight) * Occ * deviceX * EF**

ER – emissions reduction, $tCO_2/y$
SAV – default saving, as in following tables, as detailed below, %
EL – electricity consumption, as calculated below (minimum between the monitored energy consumption and calculated according to capped hours, considering daylight hours), kWh/y
Adevice – floor area of rooms where the energy saving devices are installed, m2
Usually such devices are not installed in dining rooms, corridors and computer rooms.
Alight –building area which lighting electricity consumption is monitored with the dedicated energy meter, m2
Occ – default occupancy, 75%
deviceX – % of correctly operating energy saving devices, as monitored and verified, %
EF – grid emission factor, $tCO_2/kWh$

**Default saving, SAV**

| Minutes | SAV |
|---|---|
| 15 | 30% |
| 30 | 28% |
| 60 | 25% |
| 120 | 20% |

Minutes - time to switch-off when room not occupied, in minutes

**Electricity consumption, EL**

Application of energy saving devices should not increase lighting hours and should not encourage using of lighting in daylight.

**EL = Min(ELmon, (CapLight [hr/d] * P [kW] * office operating days [d/y]))**

ELmon – project activity electricity consumption as metered using dedicated energy (kWh) meter for lighting system only, or using the building energy management systems, kWh/y

CapLight - maximum capped baseline hours, hr/d

**CapLight = od – ddl * Rdl**

od - daily office operating hours, year average, hr/d
ddl - default daylight hours in baseline = 6 hr/d
Rdl - default numbers of rooms which may use daylight = 50%
P - project lamps and ballast power, only of lamps which electricity consumption is monitored with the dedicated energy meter, kW

**CapLight = od – 6 * 50%**

**CapLight = od – 3 [hr/d]**

**Default daylight hours in baseline**

| | | Offices | Schools | Households |
|---|---|---|---|---|
| from | Yearly average | 09:00 | 09:00 | 08:00 |
| to | Yearly average | 15:00 | 15:00 | 16:00 |
| yearly average | hr/d | 6 | 6 | 8 |
| numbers of rooms which may use daylight | Average | 50% | 70% | 80% |

## Lamps replacement

Single lamp is considered for simplicity.

**Emissions reduction**

**ER = SAV * o * P * EF**

ER – emissions reduction, tCO2/y
SAV – energy saving, %
o – operating hours, hr/y
P – project lamp and ballast power, W
EF – grid emission factor, tCO2/Wh

**Energy saving**

**SAV = (1 – LpWBL/ LpWpj)**

LpWBL – baseline lamp + ballast efficacy (energy efficiency), default value from table "*Default values for baseline lamps and ballasts*" below, Lm/W (LpW, Lumen per Watt)

LpWpj – project lamp + ballast efficacy (energy efficiency), Lm/W

**Project lamp + ballast efficacy**

Minimum value between:

- calculated project lamp + ballast efficacy, LpWpjCalc
- default value from table "*Default values for project lamps and ballasts*" below

**LpWpjCalc = LpWpjLamp * (1 – Pballast%)**

LpWpjCalc - calculated project lamp + ballast efficacy, Lm/W
LpWpjLamp - project lamp efficacy, as labeled according to EU system, Lm/W (LpW, Lumen per Watt)
If the lamp has not label according to EU labeling system, the project lamp efficacy will be a minimum between:

- value from manufacturer's catalogue for the average efficacy during the lifetime (not the initial efficacy)
- default value from label below

Pballast% – project ballast power, % of the project lamp power, based on the ballast nameplate. If not available, as indicated on the product leaflet. If not available, default value from table "*Default values for project lamps and ballasts*" below.

**Operating hours**

Operating hours in households
Default value of 1 hr/d per average lamp, 365 hr/y per average lamp
o = 365 hr/y.

Operating hours in public buildings and office buildings

Default operating hours in public buildings and office buildings are based on the following calculation:

| operating hours | | office | Schools |
|---|---|---|---|
| working hours | hr/d | 9 | 8 |
| daylight hours | hr/d | 6 | 6 |
| rooms with windows | | 50% | 70% |
| lighting hours | hr/d | 6 | 4 |
| working days | d/w | 5 | 6 |
| working days | d/y | 261 | 313 |
| holidays | d/y | 10 | 77 |
| operating days | d/y | 251 | 236 |
| operating hours | hr/y | 2,256 | 1,886 |
| lighting hours | hr/y | 1,504 | 896 |
| occupancy | | 75% | 90% |
| lighting hours | hr/y | 1,128 | 806 |

Default operating hours for lighting for office building are 1,128 hr/y and for schools 806 hr/y.

**Power**

**P = Plamp + Pballast**

P – project lamp and ballast power, W
Plamp – project lamp nameplate power, W

Pballast - project ballast nameplate power, W, based on Pballast% and Plamp.

**Default values for baseline lamps and ballasts**

| Sector | Baseline | Lamp | Power | Lamp Efficacy | Lamp + Ballast Efficacy | Ballast, choke, starter, driver | |
|---|---|---|---|---|---|---|---|
| | | | | | | magnetic | Electronic |
| | | | W | Lm/W | Lm/W | % of lamp power | |
| Households | Incandescent | | 100 | 14 | 14 | N/A | N/A |
| | CLF | | 28 | 65 | 65 | N/A | included |
| Offices & schools | Fluorescent | T12 | 40 | 56 | 45 | 20% | N/A |
| | electronic | T12 | 40 | 56 | 51 | N/A | 10% |
| | Fluorescent | T8 | 36 | 97 | 78 | 20% | N/A |
| | electronic | T8 | 36 | 97 | 87 | N/A | 10% |
| | Fluorescent | T8 | 32 | 97 | 97 | N/A | 0% |
| | Fluorescent | T5 | 28 | 109 | 109 | N/A | 0% |
| Street lighting | Mercury | | 250 | 34 | 29 | 16% | N/A |
| | HPS | | 200 | 113 | 95 | 16% | 16% |
| Traffic attention | LPS | | 135 | 142 | 120 | 16% | 16% |
| Stadium | MH | | 150 | 103 | 96 | N/A | 8% |
| | CDM | | 250 | 88 | 81 | N/A | 8% |
| Other | LED | | 22 | 89 | 78 | N/A | 13% |

**Default values for project lamps and ballasts**

| Lamp | Lamp Efficacy | Lamp + Ballast Efficacy | Ballast, choke, starter, driver |
|---|---|---|---|
| | LpW | | % of Lamp Power |
| Fluorescent T8 | N/A | | 20% |
| Fluorescent T5 | 98 | 89 | 10% |
| HPS | 104 | 81 | 22% |
| LPS | 133 | 104 | 22% |
| CDM | 82 | 98 | 12% |
| LED | 79 | 64 | 20% |

**Compliance with Section 2 of the Methodology**

The following calculations should be done separately for each room.

Baseline illuminance in the room

$$LUXBL = \Sigma(nBL * PlampBL * LpWBL) / A$$

LUXBL - baseline illuminance in the room, expressed in Lux = Lm/m2 (Lm = Lumen)
nBL – number of baseline lamps in the room
PlampBL – baseline lamp nameplate power, W
LpWBL – baseline lamp efficacy, Lm/W
A – room floor area, m2

Project illuminance in the room

$$LUXpj = \Sigma(npj * Plamp * LpWpj) / A$$

LUXpj - project illuminance in the room, expressed in Lux = Lm/m2 (Lm = Lumen)
npj – number of project lamps in the room
Plamp – project lamp nameplate power, W
LpWpj – project lamp efficacy, Lm/W

Methodology Section 2 both requirements:

$$50\% \Rightarrow LUXpj / LUXBL - 1 \Rightarrow -10\%$$

## Efficient lamps in new facility

Single lamp is considered for simplicity.

**Baseline lamp type**

| Sector | Lamp | Share | Lamp Efficacy | Lamp + Ballast Efficacy |
|---|---|---|---|---|
| | | | LpW | LpW |
| | | | | |
| Households | Incandescent | 70% | 14 | 14 |
| Households | Fluorescent T8 | 10% | 97 | 78 |
| Households | CLF | 20% | 65 | 65 |
| | | | | |
| Office buildings | Fluorescent T5 | 100% | 109 | 109 |
| Street lights | HPS | 100% | 113 | 95 |
| Traffic lights | Incandescent | 100% | 14 | 14 |
| Traffic lights | LED | 0% | 89 | 78 |
| Tunnels | LPS | 100% | 142 | 120 |
| Bridges | LPS | 100% | 142 | 120 |
| Junctions | LPS | 100% | 142 | 120 |
| Stadium | MH | 90% | 103 | 96 |
| Stadium | CDM | 10% | 88 | 81 |

**Emissions reduction**

$$ER = SAV * o * P * EF$$

ER – emissions reduction, $tCO_2/y$
SAV – energy saving, %
o – operating hours, as determined in previous section, hr/y
P – project lamp and ballast power, as determined in previous section, W
EF – grid emission factor, $tCO_2/Wh$

**Energy saving**

$$SAV = (1 - LpWBL / LpWpj)$$

LpWBL – baseline lamp + ballast efficacy, default value from tables "*Baseline lamp type*" and "*Default values for baseline lamps and ballasts*" below, Lm/W (LpW)
LpWpj – project lamp + ballast efficacy, Lm/W (LpW), as determined in previous section.

## Influence of lighting efficiency on air conditioning and space heating energy consumption

It is recommended to neglect this issue.

## Intuitive energy saving devices in households

General recommendation is to avoid such projects from the following reasons:

- Baseline and project energy consumption is determined using sample. It is recommended to exclude the "sample" option from the methodology.
- Not reliable determination of self consumption of the "intuitive device" when operating and in standby.
- Stand-by electricity consumption of "intuitive device".
- Most appliances have already features for automatic switch off, within user defined time-frame.
- Stand-by losses of appliances are reduced continuously by the manufacturers (not so the stand-by losses of the "intuitive device").
- Negative influence on long-term habits and education.

## Use of term "DSM" in CDM context

DSM (Demand Side Management) is not necessary related to energy efficiency. The main purpose of DSM is to reduce electricity peak demand, mostly by moving (shifting) the consumption to off-peak hours. The example of such activity may be "cold storage" for air conditioning central system, when cold water or ice are stored in big storage tanks, cooled at off-peak hours (usually at night) using chillers, while during the peak hours, the cold water for air conditioning demand is circulated from the storage tanks, instead of running the chillers compressors which are big energy consumers.
DSM system utilizes the difference in peak/off-peak electricity tariffs. In case of cold storage, DSM increases energy consumption, reducing the electricity cost for the user, because of cheap off-peak electricity. Off-peak electricity is not necessary less GHG emissions intensive, as the base load (off-peak) may be from coal power plants, while the peak load is from natural gas power plants. Even in case when off-peak electricity is less GHG emissions intensive, application of average grid Emission Factor, will not bring to the user benefits from load shifting.
As the DSM is mainly load-shifting measure, which in most cases increases total energy consumption and as off-peak electricity is not reflected in grid Emission Factor, it is recommended not to use the "DSM" term in CDM context. "Energy efficiency" or "energy conservation" terms correctly reflect the activity of the related CDM projects.
Power plants should not be excluded from energy conservation, only because they are regarded as "supply side". Energy conservation projects (efficient lamps or optimization of compressed air system) are the same at power station (supply side) and in industrial plant (demand side).
It is recommended to remove the expression "demand side" from the methodology, replacing it by "energy conservation".

## Additional recommended changes of the methodology sections

### Technology/measure – Item 1

Recommended addition to the exiting text:

**Applicability**

General

- In case that the project does not apply EU energy labeling system, the project appliance /equipment must be more efficient than the baseline appliance /equipment, as determined by the same authorized laboratory, using the same testing procedure.
- This methodology is applicable for projects replacing baseline fuel (like paraffin) by electricity, only in case when the national refineries issued report describing changes of the refineries energy consumption as the result excessive fuel saved by the project, which is not needed any more and should not be produced by the refinery. If such report is not available, the methodology is not applicable to such project. Such additional fuel consumption of the refineries should be taken into account as leakage.

EU energy labeling system

- Appliances or equipment used in project are labeled according to EU energy labeling system, indicating unit energy consumption.
- The baseline model and the project model have energy label according to EU labeling system, which is less than 3 years old from the date of purchase of the project appliance.

Households

This methodology is applicable for new and existing households on the following conditions:

- Available national statistics regarding average electricity consumption per household of the appliance or energy consuming system related to the project.
- For projects replacing fuel used in baseline, available national statistics regarding average fuel consumption per household of the appliance/system related to the project.
- For EE in building envelope and solar houses, available well recognized computer simulation program (like DOE2) which will be used only for this purpose.

Public buildings and office buildings

This methodology is applicable to existing public buildings and existing office buildings applying:

- Occupancy sensors lighting and air conditioning control
- Daylight control systems

on the following condition:

- Dedicated, separate power supply electric line for lighting, equipped with separate meter, 3 years before the project and during the project activity.

Industry

This methodology is applicable to existing industrial plant on the following conditions:

- Project equipment like electric motors or compressors, must be more efficient than the baseline equipment, as determined by the same authorized laboratory, using the same testing procedure.
- PDD should detail nameplate details of each piece of equipment used in baseline and involved in the project.

- Project electricity consumption will be determined using on-site energy kWh meters, in addition to grid company meters. If such meters cannot be installed or will be not installed, the methodology is not applicable to such project.

**Spreadsheet file**

Spreadsheet file should be attached to PDD including transparent calculation of energy saving and emissions reduction.

**Protected documents**

PDD, MR, V/VR and all attached documents should be searchable and not copy protected, in order to increase the efficiency of CDM reviewing process.

**Energy management systems in buildings**

"*Energy management systems in buildings*" includes computer program for dynamic minimization of building energy consumption. The system includes at least few of the following functions:

- Set specific time to switch on and off, separate for every day of the week, separate for each piece of equipment
- Switch off energy systems (like ventilation of parking) in hours of inactivity
- Switch on/off energy systems based on sensor readings (like exhaust gas sensor in parking area)
- DSM – Demand Side Management, to avoid peak demand above the connected power capacity
- Air conditioning system energy optimization
    - Selection of optimum load of each compressor for maximum efficiency
    - Selection of compressor which shall supply the cooling demand in most efficient way
    - Control of "fresh air" ratio depending on outside temperature
    - Pumps operation optimization
    - Switch off unnecessary equipment
    - Prediction of load, setting operating parameters to meet this load
    - Setting different cooled water temperatures and flow for each part of the building, considering solar load
    - Monitoring of operation hours, energy consumption, energy efficiency, operating temperatures of the equipment and system
- Energy billing for air conditioning per room, which also encourages energy saving.

**Optimization System for Compressed Air Station**

"*Optimization System for Compressed Air Station*" includes computer program for dynamic minimization of unit energy consumption per volume of supplied compressed air. The system includes at least few of the following functions:

- Prediction of compressed air demand patterns (compressed air flows and pressures) – daily, weekly and yearly
- Optimization of compressed air storage tank pressure and volume
- Selection of compressor which shall supply the demand in most efficient way
- Selection of optimum load of each compressor for maximum efficiency
- Prediction of load, setting operating parameters to meet this load
- Rescheduling of compressors operations based on storage tank volume, required compressed air flows and required pressures
- Checking each compressor's efficiency at scheduled flow and pressure
- Selection of compressors, seeking maximum energy efficiency of compressors in parallel operation
- Monitoring and analyzing data of all compressors' performance

- Monitoring of operating hours, energy consumption, energy efficiency, operating pressures of the compressors and the station
- Monitoring of air demand hours
- Economic compressed air supply decision support, considering compressed air demand patterns
- Calculations of the best operating combination
- Combination driving performance curve and system characteristic curve
- Decision on the operation method for the minimum energy usage of compressed air station
- Application of compressors' schedule algorithm to each compressor
- Detection of leaks, based on pressure drop in periods of no demand (like during breaks)
- Energy billing for compressed air per each department and per facility of the industrial plant, which also encourages energy saving

**Optimization system for pumping station**

"*Optimization system for pumping station*" includes computer program for dynamic minimization of unit energy consumption per volume of supplied water. The system includes at least few of the following functions:

- Prediction of water demand patterns (water flows and heads) – daily, weekly and yearly.
- Rescheduling of pumping operations based on reservoir water levels, required flows and required heads.
- Checking each pump's efficiency, water flow, delivery head, pipeline resistance curve, electric power rate
- Selection of pumps, seeking maximum energy efficiency of pumps in parallel operation.
- Real-time pump station precision diagnostics, based on real-time pump-motor efficiency and power unit monitoring
- Checking and analyzing data of all existing pump's performance
- Economic water supply decision support with considering water demand patterns
- Calculations of the best operating combination
- Combination driving performance curve and system characteristic curve
- Decision on the operation method for the minimum energy usage on pumping station
- Application of pump schedule algorithm to each pump
- Detection of leaks
- Dynamic reconfiguration of water network:
    - to reduce unnecessary increases for pump heads
    - to reduce energy losses
    - to improve pumps efficiency
    - to select more efficient pumps

  while the reconfiguration is done in real-time by activating remote electric valves installed on the network branches by the optimization computer program, based on real-time monitored input.
- Billing which also encourages water saving and energy saving

**This methodology is not applicable to the following cases:**

Industry

This methodology is not applicable to new industrial plant, unless the relative energy saving (in percents) of the ECM applied in the project may be determined regardless the actual energy consumption.

Waste energy

This methodology is not applicable to projects using waste energy or heat or cold of other appliances or systems.

Indirect energy saving

This methodology is not applicable to projects saving energy indirectly (like water saving, compressed air saving, or steam saving).

Heat pump and absorption cooling using RE or waste energy
This methodology is not applicable to projects applying heat pump and absorption cooling using renewable energy or waste energy, as calculations are too complicated for this methodology. Such projects should apply other methodology, considering:

- available renewable energy or waste energy (daily and yearly pattern)
- demand curves for heating and for cooling, daily, weekly, monthly
- energy storage

Use of artificial lighting in daylight
This methodology is not applicable to lighting projects using artificial lighting in daylight.

## Technology/measure - Item 2

Recommended addition to the exiting text:

Reduction of compressed air demand as the result of energy efficiency measures applied to equipment consuming compressed air is not regarded as reduction of "Service Level" according to this section.
Reduction of compressed air leaks, is not regarded as reduction of "Service Level" according to this section.
Reduction of steam demand as result of energy efficiency measures applied to equipment consuming steam, or as result of reduction of steam leaks, is not regarded as reduction of "Service Level" according to this section.

## Technology/measure - Item 3

No recommendations for changes or addition.

## New section: Project alternatives

Recommended new section:

**Project alternatives**
For lamps replacement projects in public buildings and office buildings, the alternatives are:

- Use of daylight
- Occupancy sensors lighting control
- Daylight control systems

## Boundary - Item 4

No recommendations for changes or addition.

## New section: EU labeling system

This Section is before Section "Baseline"

EU energy labeling system
EU labeling system includes class (like "A"), and unit electricity consumption.
This allows determination of saving in %, as follows:

$$SAV = (1 - UELpj/UELbl)$$

SAV = energy saving, %
UELpj – project unit energy consumption, as indicated on label of the project model, according to EU labeling system, kWh/service
UELbl – baseline unit energy consumption as indicated on label of the baseline model class "A", according to EU labeling system, kWh/service

$$ER = SAV * EL * EF$$

ER – Emissions reduction, $tCO_2/y$
EF – grid Emission Factor, $tCO_2/kWh$

For households:
EL – electricity consumption of the appliance in average household in host country, according to host country national statistics, kWh/y per household.

For not households:
EL – project activity electricity consumption as monitored using dedicated on-site energy meter (kWh).

Saving period
The saving SAV is limited to the lifetime of the appliance or 7 years from the purchase date, whichever is shorter.

## New section: ECM in building envelope

This Section is before Section "Baseline"

ECM in building envelope

This includes the following ECMs:
- insulation
- location of insulation
- addition of thermal mass
- passive cooling
- passive solar
- solar houses
- shading
- windows' geometry
- selective/reflective coating/films for windows
- insulated shutters
- additional glazing
- windows sealing

Energy saving (SAV) in %, will be determined applying computer simulation program.

For households energy consumption used in the computer simulation program will be according to host country national statistics.
PDD shall detail all parameters of the ECM influencing the energy consumption of the relevant system.
PDD (or separate file attached to PDD) shall detail all input parameters used in computer simulation program.
Validation shall include alternative calculations of energy saving, like calculation of the maximum saving possible, using the DOE sectoral competence. DOE shall submit these alternative transparent calculations in spreadsheet.

**ER = SAV * EL * EF**

ER – Emissions reduction, $tCO_2/y$
SAV - energy saving, as determined using computer simulation program, %
EF – grid Emission Factor, $tCO_2/kWh$

<u>For households:</u>
EL – electricity consumption of the appliance in average household in host country, according to host country national statistics, kWh/y per household.

<u>For not households:</u>
EL – project activity electricity consumption as monitored using dedicated on-site energy meter (kWh).

## Baseline – Item 5 – additions

Addition before Item 5:

**<u>Home appliances</u>**
For home appliances the baseline energy consumption is average energy consumption of the appliance according to national energy statistics of host country, while the appliance is class "A" according to EU labeling system.

**<u>Baseline operating hours of equipment</u>**
Like, electric motors, compressors, pumps, fans and similar equipment.
Baseline energy consumption determination should not involve equipment operating hours.
Projects applying operating hours should apply the factory / industrial plant / facility operating hours and not equipment operating hours.

**<u>Computer simulation programs</u>**
Computer simulation programs should not be applied for determination of baseline, baseline energy consumption or baseline emissions.

## Baseline – Item 6

Change of the following section:

$$E_{BL,y} = \sum_i (n_i * \rho_i * o_i)/(1 - l_y)$$

$p_i$ Power of the devices of the group of *"i"* baseline devices (e.g., 40W incandescent bulb, 5hp motor). In the case of a retrofit activity, "power" is the weighted average of the devices replaced. In the case of new installations, "power" is the weighted average of devices on the market

$o_i$ Average annual operating hours of the devices of the group of *"i"* baseline devices

To:
In following cases baseline energy consumption may apply average hourly consumption and facility operating hours:

- Variable drives
- Replacement of equipment to more efficient in existing facilities
- Reduction of stand-by losses in existing public institutions and office buildings
- Street lighting
- Traffic lighting

$$E_{BL,y} = \sum_i (n_i * \rho_i * o_i)/(1 - l_y)$$

$p_i$ - waited average of hourly electricity consumption, kWh/hr
$o_i$ – project operating hours of the facility served by the device as monitored, capped to "capped baseline operating hours", hr/y

The current approach results in CERs without any efficiency improvement, as demonstrated in the following example:
10 kW air compressor working 1,000 hr/y was replaced with 5 kW compressor having the same efficiency. Industrial facility operating hours are 3,000 hr/y. Baseline energy consumption is 10 kW * 1,000 hr/y = 10,000 kWh/y. Unit energy consumption is 10,000 kWh/y / 1,000 hr/y = 10 kWh/hr. To meet the compressed air demand of the facility, project operating hours will be 2,000 hr/y. Project energy consumption is 5 kW * 2,000 hr/y = 10,000 kWh/y (as in baseline).
However, for determination of baseline electricity consumption, project operating hours will be used multiplied by baseline $p_i$ = 2,000 hr/y * 10 kWh/hr = 20,000 kWh/y.
This project may request amount of CERs corresponding to 100% of the energy consumption, without any real action to reduce emissions reduction.
Therefore, it is recommended not to apply the device operating hours, but the facility operating hours.

## Baseline – Item 6 – Capped baseline operating hours

Addition after Item 6

<u>**Capped baseline operating hours**</u>

"Capped baseline operating hours" are average of 3 years before the project.
Following are reasons for "Capped baseline operating hours":

<u>Over-estimated baseline "$p_i$"</u>
Current version of the methodology gives incentive to fewer baseline operating hours, which will result in higher baseline "$p_i$".
To reduce this risk, it is recommended to cap the project operating hours to "capped baseline operating hours". In such case, reduction of baseline operating hours will increase baseline "$p_i$", but will also reduce possible ER.

<u>Systems marginal energy consumption</u>
Following is example for air conditioning system.
According to the methodology, baseline energy consumption is linearly proportional to the project operating hours. Extension of operating hours during project activity comparing to baseline, happens usually in late afternoon or evening, when outside air temperature is lower than during the

day. Also solar energy contribution to the cooling load is much lower than during the day, resulting in much lower electricity consumption for air conditioning during the extended hour, than the daily average.

Marginal occupancy and activity of facility
It may be assumed that during the extended operating hours, the occupancy and the activity of the facility will be less than the daily average, resulting in lower marginal energy consumption of the facility in extended hours

**Baseline – Item 6 Option 2(ii) - EER**

Application of term "EER" in the context of the methodology is confusing.
EER is very well known as "Energy Efficiency Rate" or "Energy Efficiency Ratio", expressed in cooling BTU to kWh and used in USA as equivalent of European COP (Coefficient of Performance) for air conditioning units and systems.
Higher is EER, more efficient is the appliance or the system.
In the Methodology, "EER" is applied in opposite way, as specific energy consumption, calculated as electricity consumption divided by "output".
It is recommended to change this term to "Unit Energy Consumption - UEC".

**Project Activity Emissions – Item 8**

Change of the following section:

*Project energy consumption in case of project activities that displace grid electricity is determined as follows using the data of the project equipment or system:*

$$E_{PJ,y} = \sum_i (n_i * \rho_i * o_i) / (1 - l_y)$$

To:
In following cases project energy consumption shall apply average hourly consumption and facility operating hours:

- Variable drives
- Replacement of equipment to more efficient in existing facilities
- Reduction of stand-by losses in existing public institutions and office buildings
- Street lighting
- Traffic lighting

$$E_{PJ,y} = \sum_i (n_i * \rho_i * o_i) / (1 - l_y)$$

$p_i$ - waited average of hourly electricity consumption, kWh/hr

In all other cases, project electricity consumption will be monitored using dedicated energy (kWh) meters, other than grid company meters. If such meters are not installed, project electricity consumption equals to baseline electricity consumption.
Grid company meters should be used for double check by electricity bills.
This requirement does not apply to:

- projects applying EU labeling system
- ECM in building envelope of households, when the percent of energy saving was determined using computer simulation program.

Project electricity consumption should not be determined using coefficients or pre-calculated coefficients.

In projects involving electricity and steam, project electricity consumption and steam consumption should be based on actual monitored values using energy meters. If application of energy meters is not possible or not implemented, project energy and steam consumption equals to baseline.

Spreadsheet file should be attached to every monitoring report with actual meters' readings as indicated on meters, multiplication factor for each meter and transparent calculations of project energy consumption.

## Leakage – new Item: Refineries balance

Addition after Item 10:

Refineries balance
In case when the project reduces consumption of heavy fractions of the petroleum products, like paraffin or petcoke, leakage related to increased energy consumption of refineries to refine these products should be determined.

## Monitoring – new Item: Pumping stations

Addition after Item 11:

**Pumping stations**
Following additional parameters should be monitored for pumping stations:

- Baseline minimum reservoir level, m
- Baseline maximum reservoir level, m
- Baseline weighted average reservoir level, m
- Baseline maximum head, m
- Baseline minimum head, m
- Baseline weighted average head, m
- Project minimum reservoir level, m
- Project maximum reservoir level, m
- Project weighted average reservoir level, m
- Project maximum head, m
- Project minimum head, m
- Project weighted average head, m
- Baseline pumping station electricity consumption – 3 year before the project, kWh/y
- Baseline pumping station water flow – 3 year before the project, m3/y
- Project pumping station electricity consumption, kWh/y
- Project pumping station water flow, m3/y
- Baseline electricity bills based on other meter than the project meter – 3 year before the project, kWh/y
- Baseline water bills based on other meter than the project meter – 3 year before the project, m3/y
- Project electricity bills based on other meter than the project meter, kWh/y
- Project water bills based on other meter than the project meter, m3/y

## Monitoring – new Item: Compressed air systems

Addition after Item 11:

**Compressed air systems**

Following additional parameters should be monitored for compressed air systems:

- Baseline minimum storage tank pressure in operating hours, atm
- Baseline maximum storage tank pressure in operating hours, atm
- Baseline weighted average storage tank pressure in operating hours, atm
- Storage tank volume in baseline, m3
- Storage tank volume in project activity, m3
- Baseline compressed air system electricity consumption – 3 year before the project, kWh/y
- Baseline compressed air flow – 3 year before the project, m3/y
- Baseline operating hours of the industrial facility using compressed air operating – 3 year before the project, hr/y
- Project compressed air system electricity consumption, kWh/y
- Project compressed air flow, m3/y
- Project operating hours of the industrial facility using compressed air operating, hr/y

## Monitoring – new Item: Project electricity consumption

Addition after Item 11:

**Project electricity consumption**
Monitoring of project electricity consumption should apply only energy (kWh) meters, other than grid company meters. If such meters are not installed, project electricity consumption equals to baseline electricity consumption.
Grid company meters should be used for double check by electricity bills, if applicable.
This requirement does not apply to:

- projects applying EU labeling system
- ECM in building envelope of households, when the percent of energy saving was determined using computer simulation program.

## Monitoring – Item 12 – Sample

The current methodology description allows submission of CDM project for any product sold on the market, regardless its contribution to emissions reduction. All what the PP has to do, is to conduct sample test, or bench test, or survey, showing that his product consumes less energy than the "average" baseline sample. This may be easily done by selecting suitable cases from larger sample, to adjust the "average".
It is recommended to limit this approach to cases described in the following section "*Bench tests of a sample of the units*".

## Monitoring – Item 13 (a)

**Constant current and nominal power**
"*(a) Recording the "power" of the device installed (e.g., lamp or refrigerator) using nameplate data or bench tests of a sample*"
There is a difference between estimations usually used in engineering practice, and between exact determination of emissions reduction. Not many devices use constant current (like lamps), and application of such approach will result in overestimation of baseline emissions.
Application of nominal power is even worse, as it is usually higher than the actual average power (except lamps). Despite the methodology example, "refrigerator" is the case when the power is changing continuously and the only way to determine the refrigerator energy consumption is use of national statistics.
**It is recommended to remove Option (a) from the Methodology.**

**Bench tests of a sample of the units**

Bench tests include additional uncertainties in determination of ER:

- The tests may indicate lower than nominal power for the project appliances.
- PP may select nominal power for the baseline appliances and tested power for the project appliance.

To avoid these uncertainties, it is recommended to limit the bench test option to determination of the project device saving in percents, and only for cases when no standards for determination of appliance efficiency are available in host country or in participating country. If such standards are not available for the baseline appliance or for the project appliance, both, the baseline and the project device should be tested for energy efficiency using samples, by the same certified laboratory, using the same testing procedure and the same conditions for the baseline sample and the project sample. The result of these tests is not the average power of the device, but energy saving of the project device in percent, comparing to the baseline device.

The tests' documents should be attached to PDD describing:

- Test laboratory national certification as independent tests facility
- How the test laboratory selected the baseline and the project sample
- What exactly was tested
- In which conditions
- Tests results.

## Monitoring – Item 13 (b)

Use of "sample monitoring" may result in over-estimation of baseline energy consumption. It is recommended to use other method than sample (like national energy statistics).

It is recommended to delete this item.

## New Section: Nameplate details

It is recommended to add new section "Nameplate details" after "Monitoring".

**Nameplate details**

PDD should include nameplate details of all equipment involved in baseline.

This requirement does not apply to the following cases:

- Energy management and optimization systems
- ECM in building envelope

## New Section: Validation

It is recommended to add new section "Validation" after "Monitoring".

**Validation**

- Validation should include inspection of baseline equipment nameplate details during on-site visit.
- Validation report should include nameplate details of baseline equipment as validated.
- Validation should include solid evidence indicating percentage of efficiency increase of the equipment used in project activity comparing to equipment actually used in baseline.
- DOE should use its sectoral expertise to cap the maximum possible energy saving to the percentage of the efficiency difference and to other parameters, like baseline operating

hours of the industrial facility, baseline amount of the product / service and the expected project equipment efficiency decrease with time.

## New Section: Verification

It is recommended to add new section "Verification" after "Monitoring" and "Validation".

**Verification**

- Verifications should include inspection of project equipment nameplate details during on-site visits.
- Verification report should include nameplate details as verified.
- In households projects, the DOE on-site inspection will take place in 100 households.
- If the project included metered and non-meter sample for monitoring, the DOE on-site inspection at metered samples will be 50% of total number of samples included in on-site inspections.
- In optimization and energy control projects, on-site verification should confirm correct operation of each element of the "optimization" system.
- DOE should use its sectoral expertise to crosscheck if the percentage of saving is reasonable.

* * *