
# Energy Efficiency Technologies

# ANNEX II

## Technical Report

## Energy Efficient Solutions for Existing Communities

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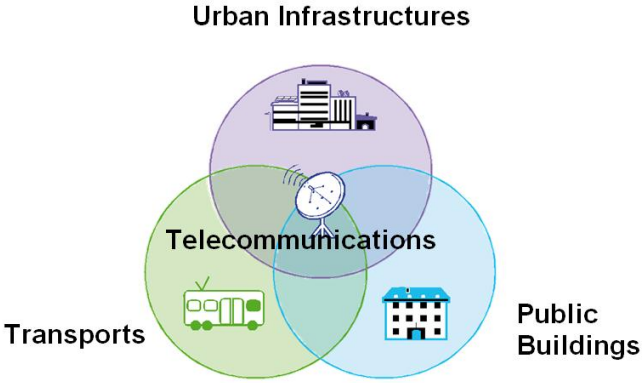
**July 2013**

# 1. Summary

Globally, local authorities of existing cities must face many challenges: develop the city, generate jobs, ensure their attractiveness over time, structure a responsible and sustainable growth. It is a matter of not only reducing the energy bill of the local and regional authorities, respecting regulations to come but as well provide the citizens with a clean and healthy environment.

The cities taking part of a virtuous effort on energy consumption reduction and climate change mitigation can only be done by integrating the impact of buildings or transports on the life quality in the communities. This report consider the technical aspect of their challenge through three components: the urban infrastructures (roads, celebrations lightings and so on), the public buildings (electricity, HVAC, cold, libraries, auditoriums, commercial hall, etc.) and the transports (access, parking lot and public transport projects, self-service bicycles, self-service electrical cars and so on).




Many technical solutions are proposed along three different axis : reduction of energy demand, increase of the installation performance and improvement of people's consumption behavior. Then all these solutions are chartered in terms of economical profitability (from quick wins to long term investments) versus energy savings (from 10% to 40 % or more). It is therefore possible to see where to study further through pre-diagnosis or more detailed studies in order to define the best options.

This report demonstrate that technical solutions are already available, even very profitable ones. Why does it not happen more often?

Cities need become more aware of all the potential of solutions they have at hand and information, advocating is certainly necessary. Since these solutions sometimes mix maintenance and investment, it is also not always easy for communities to address the subject. Furthermore, communities nowadays, may have some financing problems and are reluctant even to consider studying their potentials.

The industry is ready with technical solutions and certainly wishes to develop the skills, offers to respond to what we hope to be a growing demand for energy efficiency in communities.

Globally, local authorities of existing cities must face many challenges: develop the city, generate jobs, ensure their attractiveness over time, structure a responsible and sustainable growth. It is a matter of not only reducing the energy bill of the local and regional authorities, respecting regulations to come but as well provide the citizens with a clean and healthy environment.

The cities taking part of a virtuous effort on energy consumption reduction and climate change mitigation can only be done by integrating fully the other elements important for the citizens: quality of life and comfort of our citizens, working conditions for the companies, dynamism of the local economy, etc. Integrating these elements today will allow the anticipation of issues to come (climatic, economical, and statutory) and maintain thus the sustainability of the local and regional authorities.

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## 2. How will we live in 2025 and in 2050?

This question, at the centre of a great number of regular or thematic publications, directly meets the question of tomorrow's community. What will the city of the future look like? This question must be asked since more than 80% of the industrialized countries population live in an urban environment.

A sustainable evolution of our communities won't be able to pass on having a clear and anticipated development strategy. When one considers the impact of buildings or transports on the life quality in our communities, it appears clear that they will have a role to play in the fight against pollutions and the energy expenses. Therefore, it seems that the energy will have an important role in our communities' development strategies and will be more and more considered as a vector for environmental development but also economical development.

Because the issues for towns are both environmental and economical, it is necessary for them to create and divide wealth for everyone, master the budgets but also face the urban sprawl problems, pollution, life quality and mobility issues.

To obtain healthy and sustainable growth, managing energy demand and research for innovating and alternative solutions are proven to be central.

### Urban infrastructures

Urban infrastructures are part of the determining structuring bodies of the local and regional authorities. Road maintenance, sanitation, video surveillance, energy transportation, public lighting are essential components of the urban infrastructures that need to be well managed to guarantee the community operations and its attractiveness.

On the energy and climate aspects, all these components are nevertheless not placed at the same level. Thus, in France for example, the public lighting represents more than 40% of the towns' electric consumptions. Added thereto, close to 20% of the electrical cabinets have an overly powerful subscription. These data, associated with the growing cost of energy prices, show the importance of the economical issue linked to the town public lighting. In this matter, many improvement possibilities regarding Energy Efficiency can be found and they all agree with the existing European regulations on environment.

But the issues linked to the public lighting can't only be limited by the economical issue. As a visible element, public lighting participates actively to the attractiveness of a city. The issue for the tomorrow's communities is to know how to make use of their public lighting to ensure comfort and safety to their fellow citizen.

Thanks to technological advances, new forms of lighting will allow not only the reduction of electricity consumptions but also pollution levels, offering thus the users a superior quality of life.

Telecommunications will also allow widening the performance range of the public lighting while associating functions of video protection, telemonitoring and signalization. In France, the government wishes to triple the number of telemonitoring cameras by 2011, according to the last study from the administration's general inspection according to which the crimes and offences rate has progressed twice less quickly in French local and regional authorities equipped with videomonitoring.

## Property holdings

Property asset is strongly exposed to the evolutions of the regulations on energy and climate and to the evolution of increasing energy prices. The global cost of the local and regional authorities energy consumption rises up to 2 000 M€/year, out of which 75% for the buildings. Brought back to m², the annual costs in energy consumption of French towns property asset stagnate around 11 €. The issue for the municipalities is to reduce their dependence to fluctuations in energy prices and to reduce thus their global operating cost.

Renovations of the existing public buildings are essential to adapt them progressively to new technologies and to efficient solutions. They follow several objectives in the short, average and long terms:

- perpetuate the property asset,
- improve the cities' image,
- ensure the citizens' comfort,
- reduce the energy bill.

The issue today for communities is to build a new architectural heritage constituted of comfortable, sober and sustainable buildings in time. The choice for renewable energies, to technologies less energy consuming and more effective are part of the solutions. These will need to be associated to a true behavioral education so that everyone knows how to manage its energy and learns thus the good practices to consume less and better.

On new buildings, some solutions have widely showed their energy and economical efficiency.

On the other hand, on the existing property asset, the political objectives for energy efficiency improvements are extremely ambitious and, looking at the current rhythm of the renewal of the stock, the existing solutions will not be sufficient. To reach the objectives, we will need to innovate on technical, organization and society levels. On this basis, the principal issue is located in the renovation of the already built heritage.

## Mobility

Population in the cities increases more and more and so the dependence to infrastructures to travel. In a context of urban sprawl confronted to the double effect of fuel prices increase and new working hours, the treatment of mobility constitutes a fundamental component of our territories attractiveness.

The question of mobility is also asked in environmental terms; public transit networks are tremendous tools to reduce CO2 emissions and local pollutions. The fight against global warming will be determining for the evolution of transport.

The issue for tomorrow is therefore to develop public transportation on a national level with the financing of big infrastructures networks, and on a local level with local policies regarding mobility (like Urban Mobility Plan) that will apply general and specific measures to improve mobility in the cities.

Quality urban transports, connecting the different parts of the city and additional infrastructures like multi-modal platforms will have to be set up to facilitate mobility within the town (choice of trips, schedules regularity, interconnections reliability, development of multi-modal platforms, picture of the transport mode chosen, etc.) and to guarantee thus the comfort of the users.

## An investment for the attractiveness of a territory

Considering the context previously described, any land use project, rehabilitation of buildings, or investment project requires to examine its carbon and energy footprint.

Several reasons thereto:

- **Economy**: as it was already mentioned previously, if no one is able to foresee the evolution of the energy prices, one needs to warn against the risk volatility, or against any predictable increase evolution. Indeed, under the European pressure, France may not be able to keep its regulated prices in natural gas and electricity much longer. In such circumstances, the increase of prices is not certain; on the other hand, their volatility is assured. Therefore, it appears necessary to get prepared to avoid it by firstly informing ourselves on the purchase conditions and contracts conditions in the long term, and secondly by managing better the necessary quantities, or by reducing the consumptions.
- **Anticipation**: just like it is necessary to anticipate a volatility risk, our organizations must be able to reply to tighter regulatory constraints. This can be done by upgrading the existing installations, which asks to have foreseen the necessary resources for doing it.
- **Exemplarity**: qualify our territories to be references regarding the respect of sustainable development is an absolute precondition to diffuse its notion and requirements with our fellow citizens. Most local and regional authorities already talk about the subjects through the Agenda 21. Master the energy demand of our infrastructures and installations and pilot its consumption as closely as possible must become an essential component.
- **Citizenship**: our territories must not only set an example but also answer the population's expectations by showing how to fight concretely against climate change. Because, it is also our duty to inform to ensure that these issues are broadcasted and understood by all.

It is our responsibility not to burden our children with a bad understanding of these issues and a lack of anticipation!

# 3. Technical solutions for each city component

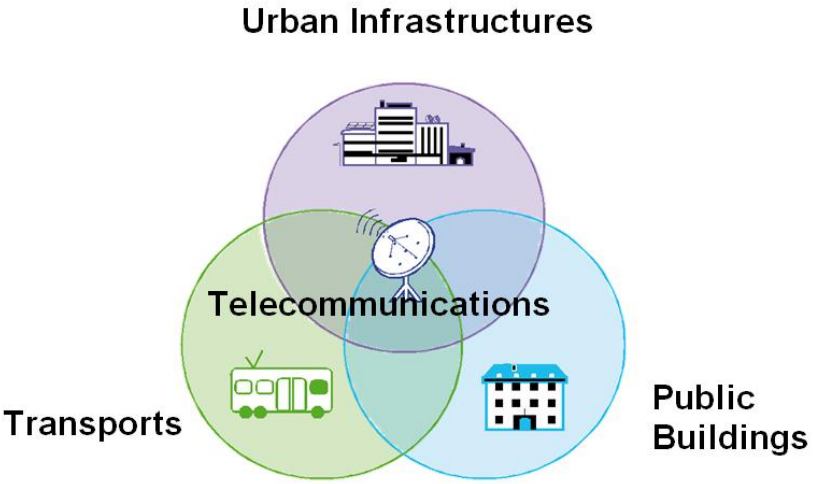
Today, the environmental, economical and regulatory issues are clearly identified. Practical, technical and organizational solutions are now necessary to face them without being surprised.

This chapter suggests solutions for the three big structuring town elements: the urban infrastructures, the public buildings and the transports.

The urban infrastructures: roads and urban roads, celebrations lightings and so on.

The public buildings: electricity, steam, cold, public amenities: libraries, auditoriums, commercial hall, etc.

The transports: road and parking lot and associated equipments; tramway, specific site public transport projects, self-service bicycles, self-service electrical cars and so on.




NOTE: The telecommunications are not considered as a town structuring element but as a set of solutions for the enhancement of the performance of each of the 3 above fields. Examples: the traffic management systems in the transports, the remote management system of the public buildings or the telemonitoring systems in the urban infrastructures.

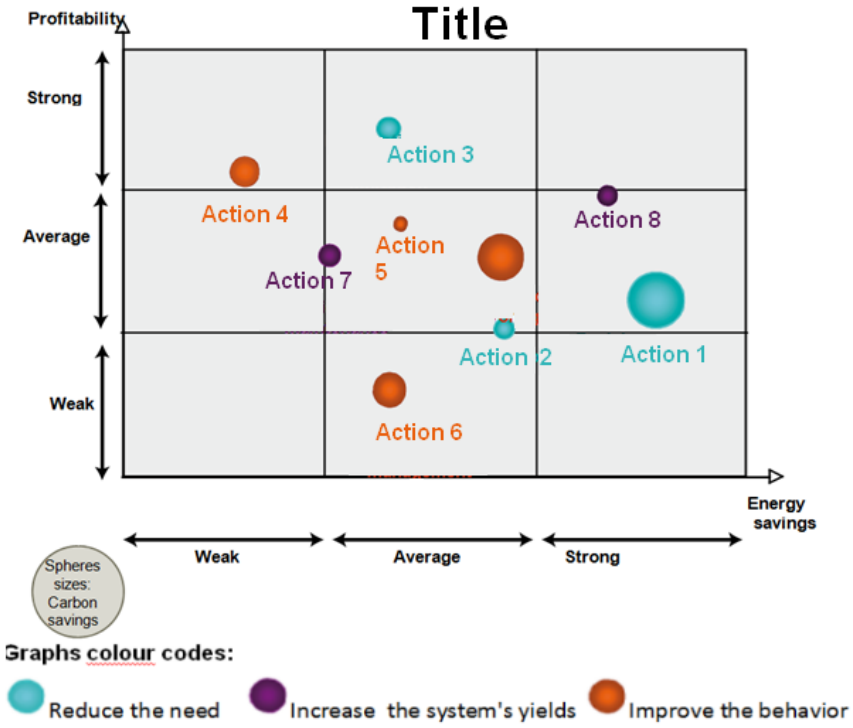
For each of these structuring elements, actions or solutions are possible, fitting the following ambitions:

- Reduce the need
- Increase the performance of the system
- Improve the behaviour
- Exploit renewable energies

Then, we will put these solutions into perspective in terms of return on investment (economical profitability, energy savings, GHG emissions…) in order to evaluate their relevance.

## 3.1 Methodology

The proposed technical solutions will be charted on a profitability versus energy savings matrix.




Reminder:

Evaluation criteria of **economical profitability**, placed on the ordinate axis:

- A solution with a strong economical profitability is often an inexpensive solution that enables to realize first energy savings (notion of "quickwins").
- A solution with an average economical profitability is a solution with an investment cost a little higher and more profitable in a few years.
- A solution with a weak economical profitability is a solution, to this day, whose investment is profitable with difficulty.

Evaluation criteria of the **energy savings**, placed on the abscissa axis:

- A solution with strong energy savings is a solution that allows generating an important percentage of energy gains (around 40% for the given scope).
- A solution with average energy savings is a solution that generates average energy gains (from 10 to 30% for the given scope).
- A solution with weak energy savings is a solution whose energy gains are generally inferior to 10% for a given scope.

Evaluation criteria of the **carbon savings**, placed in a spherical shape.

For each solution: the bigger the sphere, the higher carbon savings made.

Of course, the big families of the solutions presented above are not comprehensive and don't reflect systematically the specific results to every situation. Before taking a decision, a professional evaluation must be done. The charts are result of expert knowledge so that there can only be seen as indications that need to be confirmed.

## 3.2 Urban infrastructures

### Challenges of the urban infrastructures energy consumptions' control

Public lighting is a key element of town planning, in terms of safety, comfort but also attractiveness. By improving night visibility, we can reinforce the safety and comfort of road users. Until recently, the choice of a functional approach for public lighting predominated; it was necessary to assure sufficient lighting to allow the users driving at night at a given speed to perceive obstacles and pedestrians. Almost all of our public lighting system, still installed today, was conceived and realized in application of this principle.

In the middle of the 80's, an awareness took place on the potential of urban lighting illumination integrated to the architecture and to urban areas.

Unfortunately, this type of installation can sometimes lead to important energy consumptions and generate strong luminous nuisances.

Today, the awareness is made on the energy and climate impact of public lighting. Thus, we must now take into account the reduction of energy consumptions and GHG emissions with a view to achieving a "Factor 4".

An instructive example:

**Strong rise of consumptions for the Christmas illuminations.**

The multiplication of Christmas illuminations when getting into the festive season is causing a considerable energy waste from which the climatic and energetic consequences are beyond question.

The illumination installations are done in winter, during a season of high electric consumption. During these consuming peaks, France can only meet the demand by using the old thermal power stations.

According to an internal document of the ADEME (French energy agency) and RTE (the French TSO), every additional kilowatt-hour consumed for lighting in times of peak electrical demands, would have a carbon footprint close to 600 - 700 $gCO_2e$ per kWh.

Light pollution and the energy consumption linked to the Christmas illuminations represent a real problem on which it is necessary to work to reduce public expenditures and to encourage the limitation of climate change.

Solutions exist and allow reducing the energy consumption while preserving the attractiveness and the beauty of the city during festive periods.

The awareness on ecological issues in recent years raises the question of the rational use of energy and the reduction of luminous pollution more clearly. But the challenges are also financial.


*Weight of the Public Lighting in the town energy budget*

*Source: Study ADEME, EDF/GDF, AIVF, ATTF, DGCL, UFIP*

Using the $CO_2$ contained in the electricity consumed by the lighting established by the ADEME for 2002-2006 presents an average value of 119 $gCO_{2e}$ per kWh. The current emissions of the French public lighting system represent about 670,000 $tCO_{2e}$ /year.

Indeed, the global nature of public lighting represents therefore a huge potential for energy savings, which needs the implementation of a coherent methodological approach without harming these two fundamental objectives: users' comfort and safety. Today, we can obtain a better lighting while consuming less and lead thus to important energy and financial savings.

One of our main political issues is the control of the public lighting installations costs for our towns in order to increase their energy performance and reduce their GHG emissions.

## Essential actions to optimize the use and the costs

Regarding public lighting, the European norm EN 13201, not yet mandatory, sets up the illumination levels that need to be maintained in the different categories of public areas, essentially according to the level of safety.

While respecting this regulation, conceivable actions can be set up to optimize costs: change or modernize lampposts, regularly maintain the lighting lot, choose a rational use of public lighting, etc.

Essential actions, detailed below, can help transforming our existing public lighting systems into effective public lighting systems.

Reduce the need

• Resize and redeploy:

20% of the electrical installations have an over powerful subscription (source Gimelec[1]). True energy and financial savings can be made, if we reduce the power of the installed equipments as well as the number of lamps by lightings.

The savings made by the different schemes are the following:

| | P Normal power rating | P Reduced power | Hours rated power | Hours reduced power | Cons rated power | Cons reduced power | Cons (kWh/year) | Cost Cons | Cost cons + Subsc. | Saving/ Gross spending/year | Impact % Bill | Impact energy |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Permanent | 3.0 | 0 | 4100 | 0 | 12300 | 0 | 12300 | 462.48 € | 590.98 € | / | / | / |
| Alternated / reduced | 3.0 | 1.5 | 1910 | 2190 | 5730 | 3285 | 9015 | 338.96 € | 467.46 € | 123.52 € | -21% | -27% |

**The hypotheses are:**

Installation of an installed power of 3 kW. Cost of the subscription: 5.4 €/kW subscribed. Cost of the kWh: 0.0376 €/kWh. Annual length of normal functioning: 4,100 hours. Range of the reduced power rating: 11 pm to 5 am meaning 6 hours by night.

Variable: type of reduced power: > Permanent> Reduced> semi-permanent.

Tip: The solution of reduced power brings a better safety than the semi-permanent solution.

*Example of schemes allowing energy savings, "The best technologies in public lighting"*

*Source: ADEME EDF*

Similarly, in order to avoid the excessive number of lightings by acting on the spacing and the number of lighting points, these can be redeployed according to our buildings' architecture and to our street maintenance services.

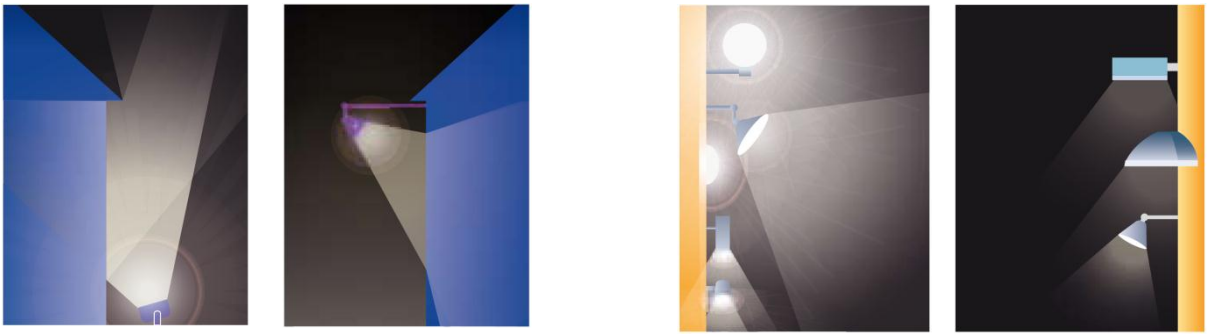
The height of the lampposts can also be optimized to ensure an optimum response to the need for functionality, safety and attractiveness of our territories.

• Adapt the level of illumination and avoid the over-lighting:

[1] Gimelec: a federation of 230 businesses in electricity.

The International Commission on Illumination has set up some recommendations in terms of illumination levels. The French association of the Lighting sets up, yet without any mandatory application, the following illumination level: from 10 to 20 lux for lanes open to traffic, 10 lux for pedestrian lanes and parking areas. The installations must respect, in the best possible way, these indicators.

Other techniques help avoiding energy waste and limiting luminous nuisances. We can thus avoid lighting from bottom to top, avoid round bowls because they reduce the luminous flow and provoke dazzling sight.



Avoid to light from the bottom up.

At the opposite, lighting from the top is effective and conservative.

A good orientation of spot lights avoids glare and losses of light.

*Examples of bad lightings locations that provoke an over lighting*

*Source: ASCEN (Association for the Safeguard of the Sky and Night Environment).*

Install passive signal light system

These reflecting signals are effective and don't consume any energy. Applicable on roads and in rural zones, they reduce the number of lights and reduce thus the need for electricity.

Increase the performance of the system

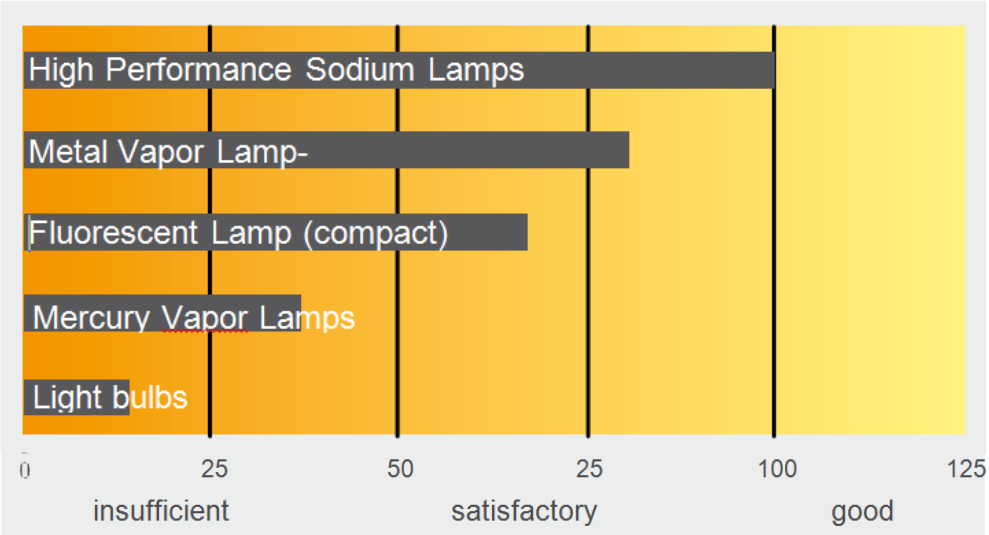
- Optimize luminous sources:

**The High Performance lamps**

In the market of lamps, the offer is tremendous. The ones presenting the best results in terms of Energy Efficiency are the following:

- High Pressure Sodium (HPS)
- Metal halide lamps

Incandescent bulbs and low pressure mercury bulbs should better be avoided because they need very high powers and heat more than they light up.




*Lighting performance in lumens/watt of typical lights with ignition ballasts*

*Source: ASCEN (Association for the Safeguard of the Sky and Night Environment)*

Install efficient lights:

**LEDs**

LEDs represent one of the key technologies today. oLEDS currently under development and improvement will be key in the future. Thanks to them, we are able to save more than 80% of our energy.

An instructive example:

**Illuminations of the Champs Elysées.**

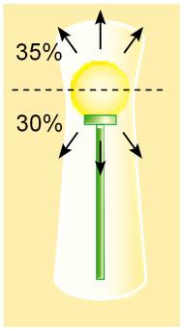
Over the years the electricity consumption of the Champs-Elysées Christmas illuminations has greatly evolved. Last winter 2012-13, the illumination consisted of 12,5 km of LED to cover 2.5 km of the famous avenue. The overall electricity consumption has been of 31 MWh. It was 40 % less than two years before, when the first LEDs where introduced. Before 2006, the ancient incandescent lamps led to consume 460 MWh, 16 times more.

**Lights with optimized reflectors**

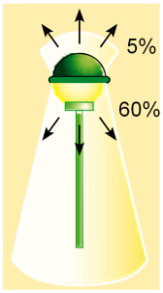
Certain lamps emit important quantities of light upward, generating thus losses of energies and a rise of luminous pollution.

The directional lights with "Full-cut Off" reflectors don't emit any light under the horizontal avoiding thus light losses and rising the energy savings.

**Light circulator with opal ball:**
- **35%** of lost light upward (more luminous nuisances).
- **30%** of useful light pointing downwards




**Ball light with reflecting optic:**
- **5%** of lost light.
- **60%** of useful light pointed downwards.




*Note that 35% of the light emitted by the lamp is absorbed by the opal envelope.*

*Example of the influence of reflectors for illumination.*

*Source: Union of the Lighting/ADEME*

Renew the ballasts:

The most classically used ferromagnetic ballasts are nevertheless not the most effective because they can induce important over consumptions at their end of life. When replacing lightings or installing new lightings, it is therefore recommended to use electronic ballasts. These generate energy savings while limiting the losses caused by conventional systems. Over voltage control also allows to extend the life length of the lamps.

These ballasts also offer the advantage of ensuring the power supply automatic cut when a lamp is defective. Besides, they guarantee the voltage stabilisation and regulation and contribute thus to a better maintenance of the colour temperatures in time.

In comparison with the ferromagnetic system, we can therefore name in favour of electronic ballasts, the following advantages:

- integration of the priming, stabilization and correction functions of the power factor;
- control of the networks' over voltage;
- energy savings from 10% to 20%;
- luminous gradation for certain ballasts;
- optimum functioning of the lamp.

• Adopt a good maintenance policy:

The public lighting equipments, by their exterior location, are always exposed to the meteorological conditions and natural aggressions. A preventive maintenance plan is therefore essential to preserve them in a good condition, maintain their energy performances and control the operating costs. A good maintenance leads to a longer life expectancy of the equipments.

Changing the old bulbs at the right moment, not too early, not too late, in order to avoid the rise of electrical consumption due to the decrease of their luminous flow (an over voltage of 10% causes a temperature elevation higher than 20% and reduces the life cycle of the components by 50%) is recommended. While changing, we can ask to clean the optics of the lightings, to check the lamps fixings, the connection and the state of the equipment.

Improve the behaviour

• Manage the life time:

Energy management systems allow a better management of the ignition of public lighting. These systems can be coupled with variation, regulation or remote management systems.

For example, we can name astronomical clocks that bring the necessary flexibility to the management of numerous control points or particular applications (festive lighting, events, etc.) or twilight switches (cells) which measure the quantity of the surrounding natural light and release the necessary lighting from an assigned threshold adapted to the visual task.

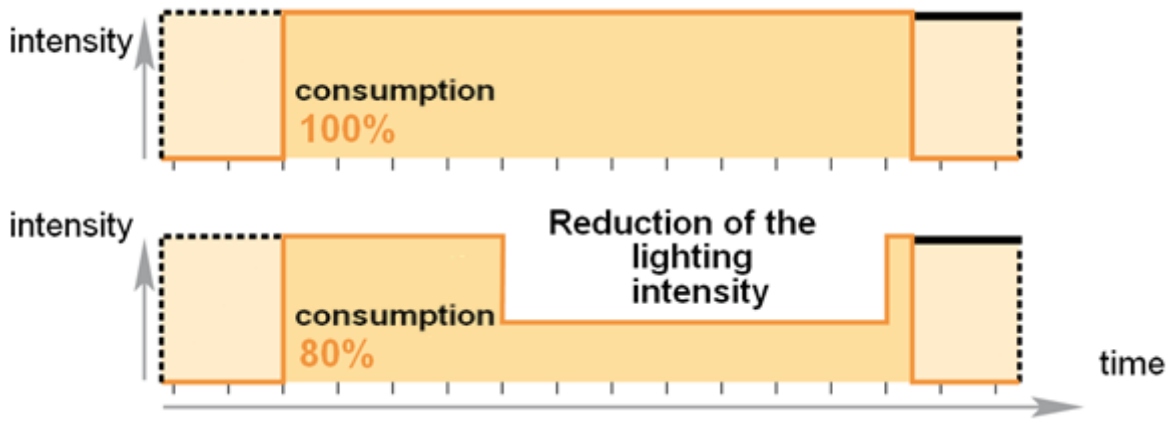
• Install regulation and voltage reduction systems:

The voltage regulators – reducers avoid excess voltages, over consumption sources and the defusing of lamps due to voltage drops. They aim at reducing the power during the hours of low use. They also guarantee that the voltage arriving to the lamps is always in the rated range, thus ensuring optimum lighting levels and an extension of the equipments' lifetime.

Two types of regulation can be chosen:

- The voltage variation in the electrical installation, which allows renewing the local and regional authority's entire public lighting. It only works if the existing installation is made with ferromagnetic ballasts.
- The bi-power ballasts which allow managing the lights point by point. The need for a previous setting can nevertheless be proven to be not very flexible.

The reduction of the lighting intensity and the disconnection at night are solutions that generate energy savings up to 1/3 of the electric consumption. An example:




*Example of consumption reduction thanks to the reduction of lighting intensity during a few hours*
*Source: ASCEN (Association for the Safeguard of the Sky and Night Environment)*

Install remote control and telemonitoring systems:

Telemonitoring and remote control systems are wonderful tools to manage the equipments in real time. They allow to control and to monitor every luminous point independently, while transferring the information of every luminous point to a control center that analyses the malfunctions.

• Raise awareness and inform:

The raising of awareness and the information can concern two types of targets: the municipal agents and the citizens.

In order to be in a position to face the issue, municipal agents must be informed on the main areas of action, and on the energy and climate challenges as well as about the new regulations.

For the inhabitants of the local and regional authorities, communication campaigns (expositions, debates, lectures, and so on) may raise awareness and mobilize them around innovating solutions in public lighting.

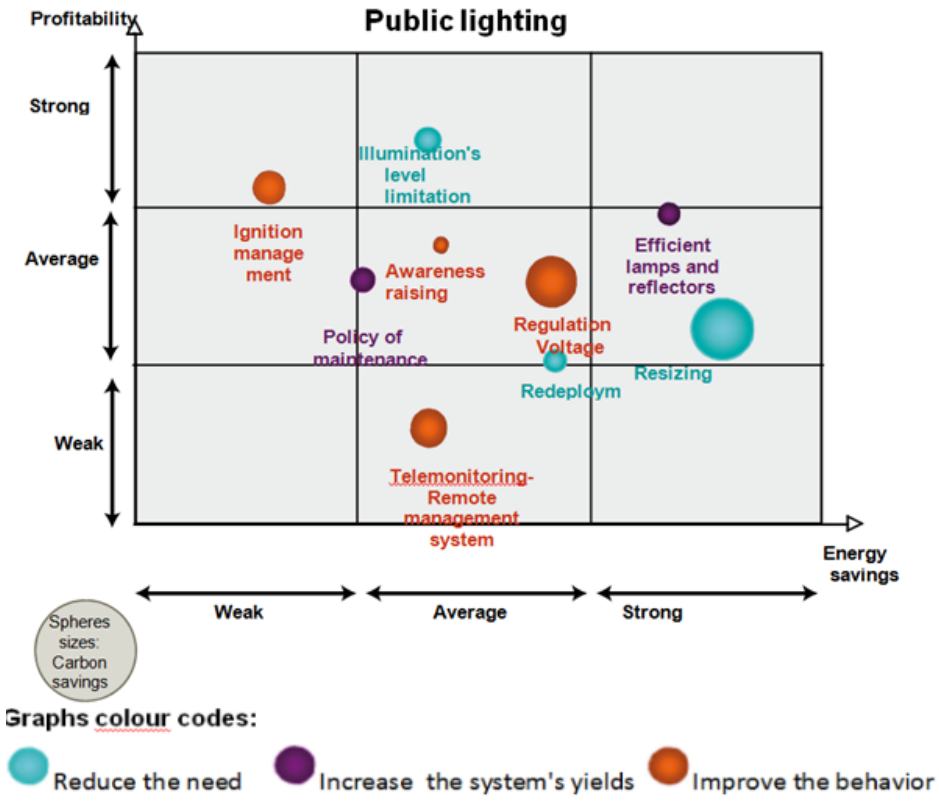
Information and awareness sessions in schools can also be useful. Children are sensitive and receptive towards the respect of the environment, they therefore represent essential targets. When taught at a young age, good practices, and the understanding of the issues become more easily reflexes.

Exploit renewable energies

In order to reduce carbon emissions due to public lighting and thus diminish pollution, choosing technologies that use more virtuous energies like solar lamps or wind power lamps may be a solution.

Currently under improvement and development, these technologies still face many limits: sound nuisances in the case of wind power lamps, short length of life of the batteries and inverters (around 5 years) for solar lamps.

## Comparisons by solutions' criteria



The delay for return on investment regarding public lighting varies according to the solutions. Quickly profitable investments from an economical point of view allow to realize quick savings that may finance longer term investments.

## Identification of the most effective solutions to apply

Generally, the most effective solutions are the ones who need a quite low initial investment, presenting thus a reasonable cost/profitability ratio.

*Reduce the need*
*Increase the system's yield*
*Improve the behaviour*

| Type | Means | Gains | Profitability Term |
|---|---|---|---|
| **Reduce the need** | • Limit the illumination level, while respecting the regulations.<br>• Install ignition time and length management systems. | • Reduction in electricity consumptions.<br>• Realization of the first energy savings regarding electricity.<br>• Reduction in luminous pollution and in carbon emissions.<br>• Reliability and improvement of the ignition and extinction precision on the whole lighting network. | Short |
| **Renew the former equipments by high-performance equipments** | • Replace the former lamps by better performance lamps (with a superior level of illumination for least powers). Ex: replace the mercury vapour lamps by high pressure sodium lamps, except in the gardens because the colour rendition is less good.<br>• Replace the former lightings by less consuming lightings.<br>• Replace the ferromagnetic ballasts by electronic ballasts. | • Reduction in the electricity costs dedicated to the PL system.<br>• Reduction in the carbon emissions, therefore, decrease of the negative environmental impact of the whole PL system.<br>• Improvement of the PL network effectiveness.<br>• Increase of the equipments service life.<br>• Improvement of the local and regional authority's image: an image of innovating cities in favour of Sustainable Development.<br>• Increase in the citizen's comfort.<br>• City security by the harmonization, reliability, regularity and the coherence of the lighting | Average |
| **Resize** | • Reduce the power of the equipments.<br>• Reduce the number of lamps by lighting points. | • Reduce the electricity consumption.<br>• Reduction in energy costs.<br>• Reduction in carbon emissions.<br>• Less waste of electric energy. | Average |
| **Install power and voltage regulation systems** | • Install power regulating systems in the electrical installation (possible only if ferromagnetic ballasts).<br>• Install voltage regulating systems directly on the lightings. | • Supply of a fixed value continuous voltage to a receiving circuit from a variable value voltage.<br>• Reduction of losses.<br>• Achievement of optimum lighting levels.<br>• Possible to obtain a financial assistance from the ADEME, at the maximum rate of 30%. | Average |
| **Redeploy** | • Change the location of the lighting points for a new optimum location, adapted to the buildings and streets architecture.<br>• Adapt the choice of the lamps and lighting points to the location. | • Removal of the excessive number of equipments in the PL network.<br>• Reduction in the costs of electric equipment.<br>• Optimization of the lighting level in the streets according to their specificity (pedestrian zone, urban boulevard, ring road, …)<br>• Increase in the comfort and the safety of the citizens. | Average |

| Type | Means | Gains | Profitability Term |
|---|---|---|---|
| | | • Improvement of the local and regional authority's image. | |

If we want to transform the image of the local and regional authorities, we can implement a Light Management Master Plan. This is matter of public lighting planning in the community scale, that has an overall reflection over time, from 10 to 15 years.

## 3.3 Public buildings

### Challenges in the control of public buildings' energy consumption

The construction's sector represents a third of the energy consumption of the European Union. The new Energy Efficiency Directive has set a goal of yearly renovation of 3 % of total floor area of heated and/or cooled buildings owned and occupied by central governments. The Energy Performance Directive ask all Member States to set strong energy performance requirement, to strengthen them every 5 years, and to act so that by 31 December 2020, all new buildings are nearly zero-energy buildings, and that new buildings occupied and owned by public authorities are nearly zero-energy buildings after 31 December 2018. As for existing buildings, Member States will also draw up national plans to increase the number of nearly zero energy buildings.

We will need to renovate quickly the existing built housing stock in order to reach these goals. So, we understand well that the key consideration of the challenge is situated on the existing building stock.

Example of definition for a low consumption building.

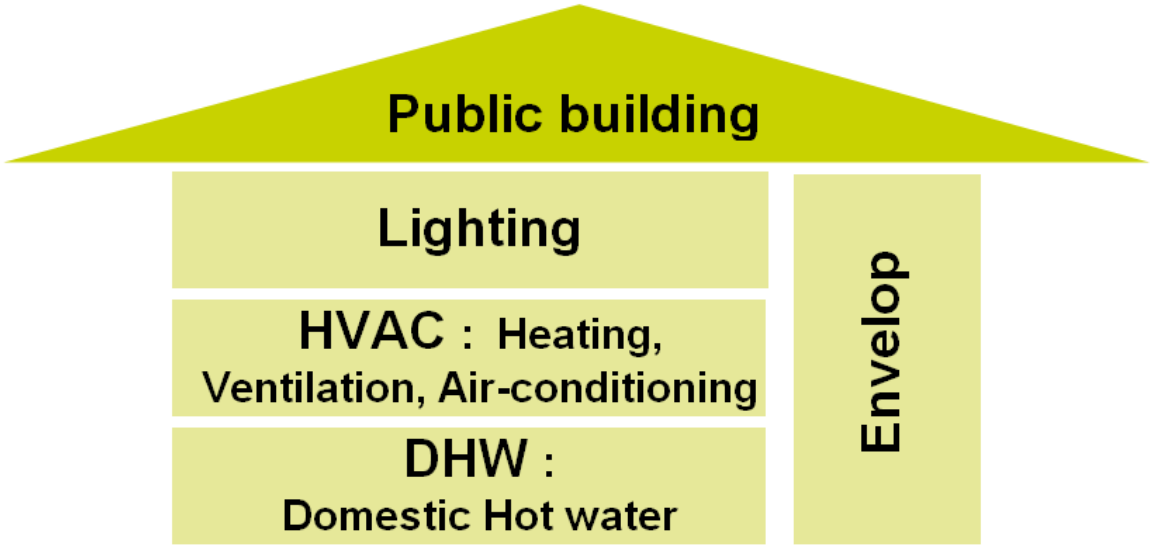
- A very efficient envelope thanks to a reinforced thermal insulation of the roofs and partitions and, more and more, an insulation by the outside (55% of the projects) as well as the use of triple glazing (18% of the projects),
- The use of renewable materials such as the cellulose wadding and wood fibers for insulation (20% of current projects),
- An improved ventilation and more particularly a heat recovery ventilation (60% of current projects, 90% of current projects in the tertiary),
- A high efficiency heating system: heat pump (45% of current projects of individual houses and 40% of current tertiary projects), condensing gas boiler (55% of current residential projects) wood stove or burner (40% of current individual houses projects),
- A very high use of renewable energies (present in 90% of current projects): 90% of current residential projects use solar thermal energies for domestic hot water, 55% of current tertiary projects use photovoltaic energies.

The combination of these technologies might reach a very high global performance of the buildings.

*Low consumption buildings*
*Source: Press release June 19th 2009, ADEME - MEDDE*

Regarding renovation, several types of solutions exist - more or less expensive and more or less effective. According to the current state of our buildings and our means, we will be able to undertake immediate improvement projects.

In order to obtain quick energy and carbon savings, we must first of all act in the most consuming sectors, such as the lighting, the heating and the air-conditioning.




*Target sectors to apply measures on Energy Effectiveness in a building.*

We must note that in the future, public buildings will need to set the example regarding energy efficiency and will have to respect more important requirements, and quicker than for the other buildings.

To finish, we need to remind that in buildings belonging to a public authority, open to the public, it is mandatory in some countries, to inform the public about the energy consumptions and the clean carbon emissions of the building, on a poster in welcoming places.

### 3.3.1 Lighting

The inside lighting is one of the main energy consuming component in the buildings. Very visible and strongly linked to the well-being of the users, it is also often a consuming component on which there are large potential sources of energy savings.

#### Key actions to optimize the use and the costs

Reduce the need

- Reduce the level of lighting and redeploy:

Reduce the lighting level in our public buildings, while respecting the regulations and the comfort of the occupants, can generate first quick energy savings.

According to the architecture of our buildings, it can also be useful to redeploy the lightings by replacing them optimally.

- Resize:

To avoid wastes, it can sometimes be necessary to resize the interior lighting stock. The objective here is to make sure that all the sources are adapted to the right need, not more, not less. Consequently, the power of certain equipments can be reduced as well as the number of lamps per lightings.

- Optimize the architectural environment of the equipments:

Unlike dark partitions that can weaken the illumination by 20%, clear partitions give a feeling of openness and luminosity. Repaint or replace the surface of the walls and ceilings, so that they are clearer, can therefore prove to be useful.

Increase the system's yield

- Engage a policy of regular maintenance:

Ensure a good maintenance of the installations leads to a longer service life of the equipments. On the contrary, used lamps, with a low light flow, over consume uselessly. Changing the lamps at the right moment, cleaning the lightings reflectors at least once per year avoid light and energy losses.

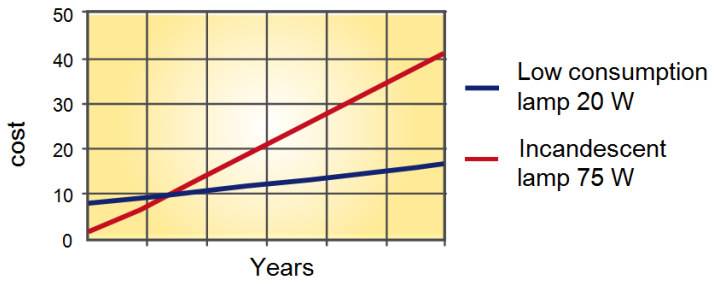
- Renew the old equipments by new ones with high yield:

Renovating the lighting equipments most energy consuming by more efficient equipments is essential in order to optimize our installations and our energy costs.

Some examples:

Replacing the incandescent lamps by low consumption lamps helps achieving savings of about 40 to 70% with a payback time between 1 to 3 years.

Evolution of the lighting cost on 6 years with a 3 h/day functioning period

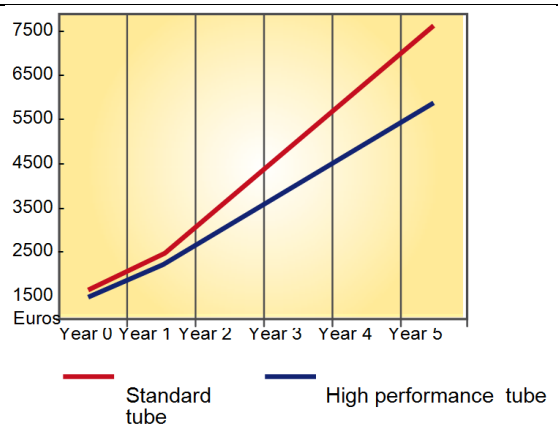



*Comparison of the lighting cost between a low consumption lamp and a classical incandescent lamp*
*Source: OX sheet "Efficient lighting of the tertiary buildings " ADEME.*

- Replace the existing optics by efficient optics and remove some of the lamps.
- Replacing the standard tubes by High Performance tubes helps achieving energy savings of about 8% with a payback time of around 2 years.

| Year | Standard tube | High yield tube |
|---|---|---|
| 0 | 1 646.00€ | 1 517.04€ |
| 1 | 2 434.40€ | 2 179.30€ |
| 2 | 3 765.76€ | 3 129.05€ |
| 3 | 5 097.12€ | 4 078.80€ |
| 4 | 6 428.48€ | 5 028.55€ |
| 5 | 7 759.84€ | 5 978.30€ |
| **Savings made in 5 years: 1 781.54€** | | |

Replacement of the 2 tubes on the 2nde year




*Comparison of the operating global cost between a standard tube and a high performance tube*
*Source: OX sheet "Efficient lighting of the tertiary buildings " ADEME.*

- Replacing the ferromagnetic ballasts of the lightings by electronic ballasts allows to make energy savings from 20% (without management system) to 45% (with a management system).

| Before | After |
|---|---|
| 72 lightings of 2 x 40 W<br>Installed power = 7.7 kW<br>No reflector<br>Ferromagnetic ballast<br>Control system Illumination level 90 lux<br>Consumption: 15,500 kWh/year | 60 lightings of 1 x 58 W<br>3.3 kW<br>Reflector<br>Electronic ballast Manual control<br>280 lux<br>5,800 kWh/year |

Investment: 6,507 Euros - Gains: 2,170 Euros/years - Return on investment: 3 years
Improvement of the illumination level: 190 lux

*Exemplary operation realized within the European project GREENLIGHT (hospital corridors in Germany)*
*Source: ADEME.*

Improve the behaviour

• Install regulation and effective systems:

Several solutions can help avoid useless energy consumptions in daily life. They can reduce the consumptions from 2 to 45% depending on the chosen solutions.

- Install spread out or centralized timers (through a Energy Management System for example) in the places used intermittently: toilets, meeting rooms, parking lots, etc.
- Install presence and movement detectors in the circulation areas: corridors, stairways, etc. (strong profitability)
- Install potentiometers, dimmers and push-buttons, to turn off, light up and change the lighting.

Install fluorescent tubes in the premises. In the rooms where the daily occupancy is high, install a regulation connected to a photoelectric cell (needs the replacement of the former ballasts). This automatic light intensity regulator modulates the luminous flow of the fluorescent tubes.

The expected energy savings are of 20% with the change of ferromagnetic ballasts to electronic ballasts. These savings can reach 40% with the light intensity regulation.

- Decompose the network by rooms with an independent management: for the corridors, the toilets, etc.
- Install a centralized management system by PC of the atmosphere and consumptions. This system works from a central unit ensuring different functions: allocation of lighting areas to an order, hours of use by office and by floor. Substations placed in the whole building decipher the orders originating from the central computer and drive the lightings connected to them.

- Raise awareness and inform:

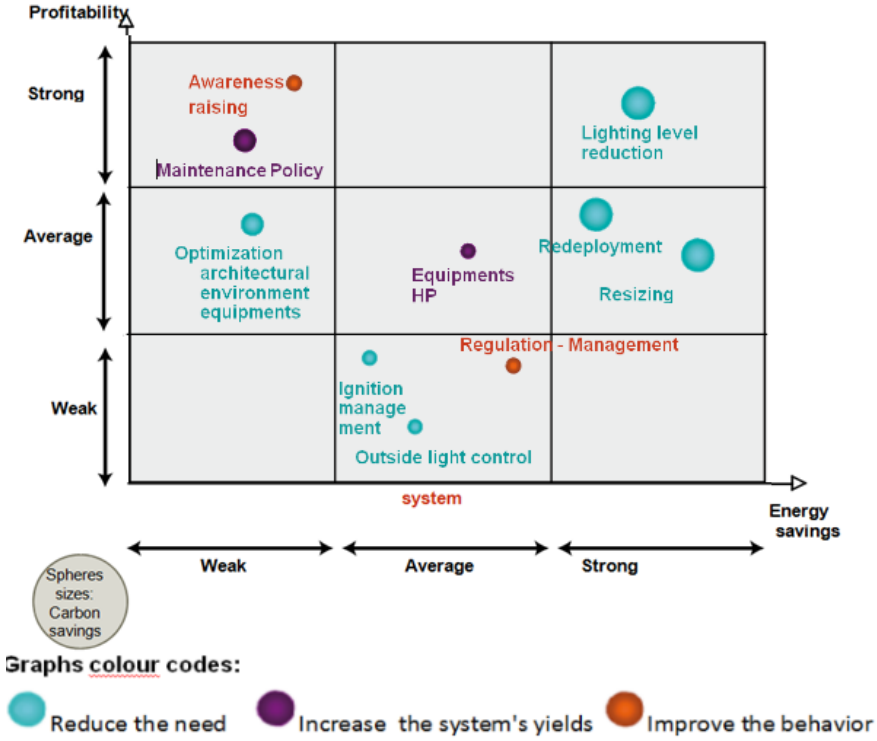
As for the public lighting, the awareness raising must be done among the municipal agents and the local and regional authority's inhabitants.

Different media settings and communication actions can be useful to inform on the challenges of the sustainable development and the regulations, and to transmit the good practices: regular internal publications and informative sessions for the municipal agents, expositions, debates, lectures, billposting, and so on for the users.

The conducted actions among children and youngsters, in schools, remain an effective vector of awareness rising.

## Comparisons by solutions' criteria

PUBLIC BUILDING: Inside lighting




NB: the big families of the solutions presented above are not comprehensive and don't reflect systematically the specific results to every situation. Before taking a decision, a professional evaluation must be done.

The return on investment regarding inside lighting varies according to the solutions. Quickly profitable investments from an economical point of view allow to realize quick savings that may finance longer term investments.

## Identification of the most effective solutions to apply

Generally, the most effective solutions are the ones who need a quite low initial investment, presenting thus a reasonable cost/profitability ratio.

*Reduce the need*
*Increase the system's yield*
*Improve the behaviour*

| Type | Means | Gains | Profitability Term |
|---|---|---|---|
| **Reduce the need** | • Reduce the lighting level, while respecting the regulations.<br>• Optimize the architectural environment of the equipments.<br>• Stop the control of the exterior light.<br>• Install ignition time and length management systems. | • Reduction in electricity consumptions.<br>• Realization of the first energy savings regarding electricity.<br>• Decrease of the light pollution and carbon emissions.<br>• Reliability and improvement of the ignition and extinction precision on the whole lighting network. | Short |
| **Redeploy** | • Change the location of the lighting points for a new optimum location, adapted to the building's architecture.<br>• Adapt the choice of the lamps and lighting points to the location. | • Limitation of the excessive number of equipments.<br>• Reduction in the costs of electric equipment.<br>• Optimization of the lighting level.<br>• Increase of the comfort of the users.<br>• Improvement of the picture of the building and thus local authorities. | Average |
| **Resize** | • Reduce the power of the equipments.<br>• Reduce the number of lamps by lighting points. | • Reduce the electricity consumption.<br>• Reduction in energy costs.<br>• Reduction in carbon emissions.<br>• Less waste of electric energy. | Average |
| **Install power and voltage regulation systems** | • Install presence and movement detectors (toilets, corridors, etc.).<br>• Install push-buttons (stairs, etc.).<br>• Install time-switches. | • Decrease of electricity costs.<br>• Reduction in carbon emissions.<br>• Adaptation of the equipments use to every situation, according to the needs.<br>• Use simplicity, in the case of presence and movement detectors, (lighting the lamp with a gesture is not necessary, the light turns itself automatically). | Average |
| | • Replace the former lamps for low consumption lamps with superior performance.<br>• Replace the former optics by efficient optics.<br>• Replace the fluo tubes by high performance tubes.<br>• Replace the ferromagnetic ballasts by of electronic ballasts | • Reduction in the electricity costs.<br>• Reduction in carbon emissions.<br>• Increase of the equipments service life.<br>• Improvement of the image of the public building and thus of the local authority.<br>• Increase in the users' comfort. | Average |

### 3.3.2 HVAC (Heating, Ventilation, Air-conditioning) and DHW (Domestic Hot Water)

In tertiary buildings, Heating, Ventilation and Air-conditioning (HVAC) represent between 50% and 80% of the electricity invoice and more than 50% in general of the energy invoice.

The use of air-conditioning systems during summer is more and more frequent. If it enhances the thermal comfort and the productivity by reducing the thermal stress, the air-conditioning also causes a strong increase of energy consumptions (around 1 kW for the smallest air-conditioner) and contributes to the global warming (the cooling fluids released – CFC, HFC and so on – have a much higher warming power then the $CO_2$).

The ventilation is also an important comfort tool, knowing that we spend 95 % of our time inside. Against all odds, our indoors are considerably polluted. The combined action of designs allowing good ventilation and actions on the behaviors enables a real enhancement of the indoor air quality.

The European directive on Energy Efficiency, the Kyoto Agreement and the Thermal Regulation require today to raise the Energy Efficiency of the HVAC systems. The stated goal is to produce a maximum of secondary energy (heat first and eventually electricity with cogeneration) from a minimum of primary energy (fossil sources and preferably renewable energies) with the less harmful waste possible.

In order to move in this direction, two action plans are possible:

- Encourage the development of efficient heating generators: yield of generation or production (primary energy consumed/secondary energy produced), with : High efficiency boilers, condensation boilers and cogeneration.
- Encourage the use of cleaner energies, local or renewable energies in the production system, with: fuelwood, thermal solar, geothermal heat pump, heating networks.

Regarding domestic hot water (DHW), the energy consumptions of the production systems represent around 3.2% of the national consumption and 15 % of the consumed energy in the residential and tertiary sector.

In certain tertiary buildings, the HVAC consumption exceeds 20 % of the global energy consumption. The heated cold water, taken from the regular taps, represents the major part of this consumed energy. In hospitals or in cloakrooms, it corresponds to important energy losses. In these contexts, the user, who is not paying what he is really consuming isn't encouraged to change his behavior to achieve savings.

A good design and a good choice of equipments in terms of HVAC and DHW, as soon as the building is designed are necessary. Even if the initial investments are high, they must be evaluated according to the savings made on the whole functioning costs, which make the efforts profitable at the scale the building's life cycle.

## Key actions to optimize the use and the costs

Reduce the need

- Reinforce the general insulation:

When a building benefits from an efficient envelope, its energy needs are considerably reduced. Several elements must be examined and respected:

  - A good insulation: it avoids the cooling of the walls and reduces therefore the internal condensation.
  - The external insulation of the walls: It eliminates thermal bridges.
  - The installation of double or triple glazing to limit heat losses.
  - The good insulation of the roof.

A good insulation is also useful in terms of DHW, by avoiding losses in the production as well as in the distribution. The thermal insulation of parts of network crossing non heated rooms limits the heat losses and contributes to improve the comfort.

The insulation reduces the investments on technical equipments by diminishing their size.

- Manage the unoccupied rooms:

Lowering the temperature of the boiler in periods of inactivity and reducing it to the minimum during longer inactivity periods enables to achieve real energy savings. At night, during the weekend and the holidays, schools often use this principle of programming timer.

- Stop the equipments:

In summer, heating is not necessary. This is why stopping the boiler (dedicated to the heating) is a way of being sure that there is no consumption. This practice is also valid for the air-conditioning; leaving the air-conditioning on while nobody's inside the room represents an avoidable energy waste.

- Limit the DHW flows:

An ordinary water tap debits 15 l/minute that represents 225 l in 15 minutes and 6.5 m3 at the end of a month.

The water flow limitation systems enable to reduce uselessly extracted water volumes. Different devices can reduce by about 50% the flows of the taps: aerators and hand showers, low flow turbulence hand showers, and so on.

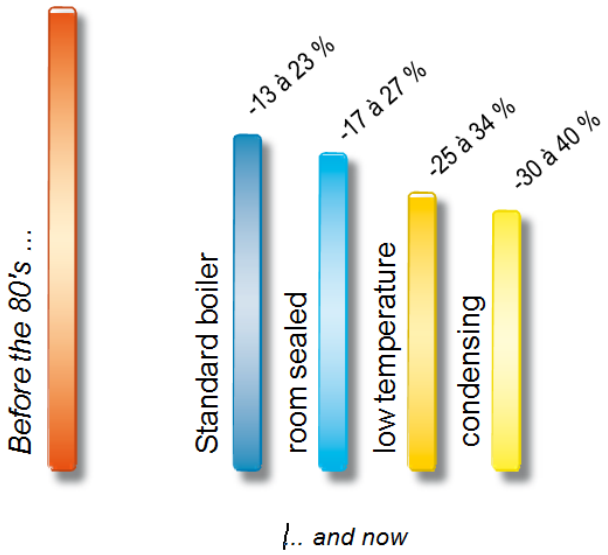
Increase the system's yield

- Renew the former equipments by high performance equipments:

Changing the former boilers (20 years or more) for new boilers, can generate energy savings of at least 15% of the consumptions.

Even more important savings, up to 30 or 40%, are possible thanks to very efficient systems, like for example condensation boilers or low temperature boilers. With these types of boilers, gains are not only energy. These less polluting systems emit less GHG.

According to the ADEME, the replacement of all the boilers of more than 20 years old would save the rejection of more than 7 million tons of $CO_2$ in France.




*Energy savings depending on different types of boilers.*
*Source : ADEME*

In application of the Montreal Protocol, the refrigerant fluids R22 (HCFC: Hydrochlorofluo-Rocarbur) are banned from sales since the 1st of January 2010. The installation's maintenance up to 2015, will be covered only with recycled products. The quantities of R22 that will be recycled will not be enough to maintain the current stock functioning. It will probably be necessary to replace the installations of the chiller or to modify them to work with a HFC fluid (R404a, R407c, R507 or R134a). The new fluids used will participate in the decrease of GHG emissions.

- Improve generation and distribution technology

Already today, the district heating and cooling sector is a green industry. On average, 86 % of heat for district heating in Europe derives from a combination of recycled and renewable heat.

The current district heat supplies and distribution networks are appropriate for the current level of heat demands, but with transition to more renewable sources and considerably lower final heat demands, the basic district heating technology must be enhanced in order to maximize the benefits of these developments.

A key change that will be brought in the future by an improved generation of distribution technology is lower and/or more flexible temperatures in the distribution networks. This key change will deliver both lower distribution heat losses and higher utilization of available renewable resources such as biomass, geothermal and solar energy. Together with further ICT developments and further integration with other networks and urban functions (waste management, transport, industry etc.) they will be even more flexible and allow smart communities to become exchange systems in which the primary energy content of any fuel will be exploited to the maximum, the potentials of natural thermal sources and renewable energy fully reaped and no energy wasted - while ensuring a high quality of life to all citizens.

- Maintain and regularly control:

Maintenance is necessary to ensure the occupants health and safety as well as the service life length of the equipments. A good policy of preventive maintenance helps reducing the breakdown risks, increasing the service life length of the equipments and reducing expenses: a regularly serviced boiler reduces from 8 to 12% the consumed energy. Operations, such as chimney sweeping, improve the boiler's yield by 1%.

The domestic hot water network also needs a regular maintenance: cleaning of the production devices, distribution circuits and its peripheral elements (joints, faucet filters, etc.), verification of the state of the room's ventilation where the DHW production devices are installed.

- Resize the boiler installation:

To ensure an optimum performance, it is important to be sure that the boiler correctly adapts to the needs. It is even truer when the needs have evolved since its installation. New boilers are very flexible and remain highly efficient, but old ones might need to be changed. For example, an oversizing might generates an electric overconsumption of the pumps, and cancels thus the realized savings by the use of a clean energy such as solar in solar heating pumps.

Improve the behaviour

- Raise awareness and inform:

The first source of energy savings lies in the eco-citizen behaviour of all. The community agents and the citizens must become aware of the incidence of their behaviour on the energy consumption and the consumption control regarding HVAC and of DHW. Good practices must be observed quickly, in order to become of consuming reflexes: reduce the polluting products or equipments regarding air-conditioning, by preferring a natural ventilation, use less hot water, do not leave the water flow uselessly, etc. All these daily practices have an important weigh in the final report when one knows that 1 °C of added set-point temperature implies an increase of 7 % in the energy consumption.

- Optimize the air flows:

For heating and air-conditioning, we are dealing with air flows, these must be well respected.

Some bad habits:

  - Put files on the fan coil units;
  - Place furnishings in front of the emitters;
  - Obstruct the air outlets;

- Install regulation and management systems:

Wanting to optimize its consumptions and achieve savings isn't incompatible with comfort imperatives. To combine both savings and comfort, it is necessary to learn to consume only what we need, not more, not less. For example, we can remain vigilant in maintaining the right temperature in our premises. According to the construction code: 19°C when one is present in the room, 16°C when one is absent less than 48H and 8 °C when one leaves on vacation.

The "automated" solutions (whatever the heating method and the installed air-conditioning) such as ambient programmable thermostats, the ambient timers, programming clocks, energy management systems, etc. allow us to adapt, adjust and program the temperatures according to our needs and to achieve thus energy savings. For example, it is the case for thermostatic faucets on radiators. These allow to maintain the room at the chosen temperature, according to the type of occupation of the rooms and natural heat provisions (depending on the orientation of the building and the hours).

When it's possible, it is recommended setting up intelligent set-point systems (programmable timer) like energy management systems. These systems allow to achieve important energy savings. The heating and air-conditioning regulation systems (acting according to a chosen temperature) can for example help us to lower the consumption from 10% to 30% if it interacts on the lots on the whole.

A previous training of the users can be proven necessary if one wishes to optimize the possibilities offered by these systems.

For domestic hot water, technologies also allow to consume reasonably, according to the real needs: timers (push-buttons …), waterfall management of the boilers, manual shut-down of the boilers (except one) in summer, faucets with automatic opening and closing (detection) in the toilets...

| | Traditional fitting | Fitting with set automatic closing |
|---|---|---|
| Washbasin | Use: 1 minute<br><br>**Consumption: 12 liters** | 2 impulses on the faucet<br>1 to wet<br>1 to rinse<br>Total: 20 seconds<br>**Consumption: 8 liters** |
| Shower | Average length of use:<br>3 minutes<br><br>**Consumption: 36 liters** | 3 impulses<br>1 to get wet<br>2 to rinse<br>Total: 1.5 minutes<br>**Consumption: 18 liters** |

*Example of the realized water savings with the installation of a faucet with automatic set closing in sports facilities or in support services of other sectors.*

*Source: ADEME*

Exploit renewable energies

Wood energy, thermal solar, geothermic heat pumps, heat networks with renewable energy (biogas, cogeneration heat) and so on, use less polluting energies.

Currently, financial assistance is offered to set up installations using renewable energies. The region assistance, tax credits, ADEME, etc. reduce the initial investments costs.

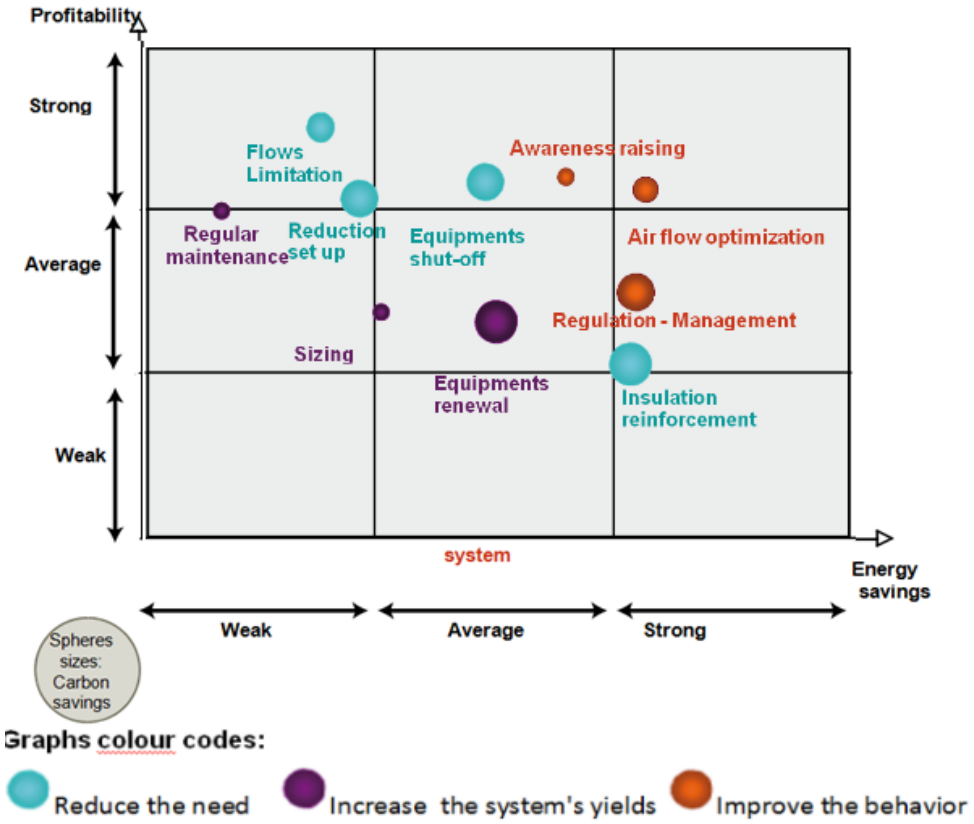
Despite all, setting up Renewable Energy installations varies a lot from an energy type to the other. Not all of the Renewable Energy are available homogeneously on the French territory. For example, low geothermal energy (<1000m) is mostly present in the Île de France and Alsace regions. Considering the important initial investments made, certain of these energies are still conceivable only on strong powers networks.

Nevertheless, the very low geothermal energy (0 to 1000m), is present in many regions. And even if its implementation must be done so as to use rationally the natural resource present (heat coming from a water table, or a humid ground), it is a real opportunity to divide by 4 the heating and cooling consumptions.

Some examples:

- The reversible heating systems such as the aerothermal boiler.
  It captures the energy of the air.
  The outside air transmits (heating mode) or recovers (cooling mode) calories through a heating pump.
  These are healthy and economical heating methods, which soon show profitable returns thanks to the Coefficient of Performance (COP). They enable to control the energy consumptions and guarantee a real sound comfort.
  With these installations, in winter, up to 75% of energy savings can be achieved.
- Geothermal energy: the energies originate from the ground.
  The principle of the geothermal energy is to recover the stocked energy in the ground, by buried sensors. It is a reliable and durable energy that has as the major advantage of not depending on weather conditions (sun, rain, wind).
- The installation of solar panels to heat the water. They will presumably not be able to meet the total hot water needs but they will constitute its low temperature preheating, in addition to another source of energy (electric, natural gas).
- Coupling photovoltaic installations with water storages might also be a solution to preheat the water.

PUBLIC BUILDING: HVAC and DHW




The return time on investment regarding HVAC and DHW varies depending on the solutions. Quickly profitable investments from an economical point of view enable to achieve quick savings that can finance investments in a longer term.

## Identification of the most effective solutions to apply

Generally, the most effective solutions are the ones who need a quite low initial investment, presenting thus a reasonable cost/profitability ratio.

*Reduce the need*
*Increase the system's yield*
*Improve the behavior*

| Type | Means | Gains | Profitability Term |
|---|---|---|---|
| **Set up reduce levels of energy in case of absence – Stop the equipments and optimize air flows** | • Reduce the boiler's temperature during absence periods.<br>• Install hour timing systems in the premises during hours of small activity (night, weekend and vacation).<br>• Stop the boiler dedicated to the heating during summer.<br>• Respect the air flows: do not to obstruct the air outputs, do not place furnishings in front of the heat emitters, etc. | • Reduction in electricity consumptions.<br>• Optimization of the systems' yield.<br>• Less than energy waste.<br>• Optimization of the equipments' yield.<br>• Realization of the first energy savings regarding electricity. | Short |
| **Limit water flows** | • On the water taps, install systems that reduce the water volumes, enough to satisfy the needs of the users (especially in the toilets). | • Reduction of the water volumes uselessly extracted.<br>• Decrease of the water consumption.<br>• Reduction in energy costs. | Short |
| **Install regulation and management systems** | • Install automated systems for the heating and air-conditioning regulation.<br>• Install timer systems and automated opening and closing systems (Especially in the toilets). | • Reduction of the consumption of our equipments.<br>• Reduction of the water consumption.<br>• Energy savings.<br>• Global management of the heating and air-conditioning system.<br>• Increase of the comfort of the building's users.<br>• Optimization of the equipments' use.<br>• Reduction of the maintenance's interventions, therefore decrease of the costs.<br>• Regulation according to the users' needs. | Average |
| **Resize the installation** | • Size correctly the boiler installation. | • Adaptation of the system to the building's needs.<br>• Less unnecessary energy consumptions.<br>• Optimization of the equipments' yield.<br>• Less investment. | Average |
| **Renew the former equipments by high-performance equipments** | • Renew the former boilers for high performance boilers. | • Achievement of significant energy savings.<br>• Reduction in the heating costs.<br>• Reduction of maintenance interventions, therefore decrease of the maintenance costs.<br>• Increase of the users' comfort.<br>• Reduction in the emissions of $CO_2$. | Average |

## 3.4 Transports

### Challenges of the energy consumptions of transports control

Currently, 80% of the European population is concentrated in urban areas. This fact reinforced the increase of the transport pollution up to 40% of GHG in the cities. Despite the public transport offer, the use of individual vehicles such as cars remains frequent. By habit, comfort, independence, freedom, users abandon their personal vehicle with difficulty. In the city, we frequently observe thus problems of roadway saturation and increase of pollution of the air, etc.

To reduce the pollution linked to the transports, an evolution towards less polluting new transportation methods is therefore necessary. We observe more and more the promotion and the development of soft transportation methods: bicycle renting, electric cars, carpooling, tramway, etc. Urban Movements plans, propose for example effective measures to increase the performance of the transports in the local and regional authorities but also to improve the living environment and the comfort of the users.

Simultaneously, a virtual mobility, true alternative to physical mobility is developing. Thanks to the investments in the sector of the telecommunications development, new working methods are being developed and reduce physical movements: teleworking, video conferences, internet, high speed voice-data-images networks...

### Actions for the control of energy consumptions and carbon emissions

Reduce the need

- Promote the remote work:

Today, the evolution of technologies enables us to work remotely easily and efficiently. Thus, remote work has evolved significantly. By limiting the number of movements, it reduces the level of pollution and the GHG emissions.

- Centralize the activities:

To limit the citizens' motorized movements in the city, we can give priority to the construction of activity centres centralizing a big number of commercial and cultural offers: supermarket, cinema, various stores, post-office, sports fields, medical centre, pharmacy, etc.

But the ideal situation towards we must tend is the development of eco-neighbourhoods. Completely designed to achieve energy and carbon savings, these new neighbourhoods, more ecological and environment-friendly bloom little by little, often during neighbourhoods' renewals. The perimeter of such bodies must evidently fully take into account the transport dimension to limit them.

- Promote trade through the Internet:

Buying on the Internet also enables to reduce the number of movements. Pooled delivery systems don't stop evolving with for example organized systems of delivery by neighbourhood, in order to optimize the rounds. To promote purchases on the Internet, we could imagine a premium system in favour of people using this type of method.

Increase the system's yield

- Improve the service vehicles and choose less polluting fuel:

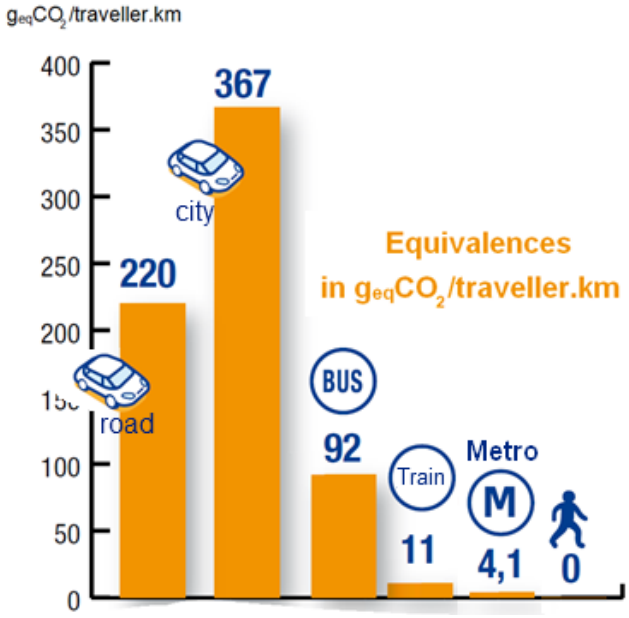
The offer regarding low emissions vehicles has developed considerably. Local authorities must play an exemplary and leading role in this matter. Renewing service cars by less polluting cars would be a strong action not only in terms of environmental responsibility but also in terms of exemplarity.

Developing the choice for low polluting emission fuel such as biofuels (rapeseed, ethanol, etc.) or electricity goes down the same road.

- Develop public transit:

Benefiting from a payload higher than personal vehicles, public transit have lower energy needs and a smaller ecological impact. On different levels, they allow to achieve savings: energy savings per driven kilometre, occupied space savings, time savings, stress savings, safety improvements, etc.

Rightly so, the development of public transit such as the subway, the bus, the tram,… is essential for the future of our cities, in a logic of reduction of GHG emissions and pollutions but also in a logic of improvement of life's environment and comfort (sound, visual comfort, ...) The tram is equally a transportation tool and a tremendous vector of urban design and of territorial marketing.




*$CO_2$ emission per transported traveler per km according to the transportation mode*
*Source: PREDIT and JM. JANCOVICI*

- Schedule regular road maintenance:

The deterioration of the road infrastructures is increasing the vehicle's fuel consumption.

- Improve the behavior - Promote new movement concepts.

  - Carpooling: gather to share vehicles and the costs for identical journeys.

  Even if carpooling has limits, it is developing increasingly, for work journeys, for extra-curricular activities, ...Also seen as a vector of social link but also as a tool for the reduction of spendings, it enables to reduce concretely the number of vehicles on the road and the pollution linked to that. Carpooling websites are set up by local and regional authorities in order to make it easier for people to organize themselves. Chicago even requires companies to organize systematic carpoolings.

  - Install bicycles renting systems

  Already existing in several cities around the World, this scheme has found its audience. When we know that 50% of car journeys made in cities are less than 5 km long! Bicycles help to get quicker from a place to another and match with the development of a healthier new way of life.

  Nevertheless, improvements are still necessary: more secured bicycles traffic, dedicated lanes on the road, bicycles sharing systems, etc.

  - Install electric cars rental sharing systems (viable in big cities).

  For example, Paris set up the Autolib' service in the city centre and its suburbs, in September 2010. A total of 4000 electric vehicles in 1400 stations are planned. This service will enable the users to borrow a vehicle whenever they want to (around the clock) without previous reservation and to leave it in a different place than the departure place, unlike carsharing.

  - Promote carsharing with non locally polluting vehicles (for example electric vehicles).

- Build new parking lots outside city centres:

The intra-urban parking lots are not a solution to the problem of traffic cutting. In the light of this, we can focus more on the construction of parking lots outside the urban perimeter, situated nearby public transit lines (car/tram relay parking lots for example). These multimodal infrastructures, by giving users facilities for any easier access to the city centre, allow to reduce traffic, air pollution, sound nuisances and so on.

- Label private and public transportations according to their emissions:

This labelling system, already existing for buildings, enables to classify the vehicles according to their polluting emissions (A, B, C categories). These labels, valid for personal vehicles and for public transportations, would show which ones are most environment-friendly and raise the awareness of the rest of the population about more virtuous energies.

- Install urban traffic management systems:

The traffic congestion in the big-sized cities is a problem and a considerable factor of energy consumption, waste of time and increased levels of pollution.

For better traffic control, priority to public transportations vehicles should be given, by reserving them special lines for example.

To facilitate the public transit and the urban traffic in general, the Intelligent Transport Systems and the Information Assistance Systems can be proven useful. With the ITS (Intelligent Transport Systems), we can for example give priority to the public transportations at intersections. They also allow to monitor the network by a central station; With the IAS (Information Assistance Systems ), we can inform travellers in real time about schedules, waiting times and possible disturbances in order to improve the attractiveness of public transportation and to optimize the users' trips.

These two systems, even if they are expensive in their implementation, have direct effects on operations. Finally, in order to control well the cities' traffic, speed limits for vehicles must be imposed.

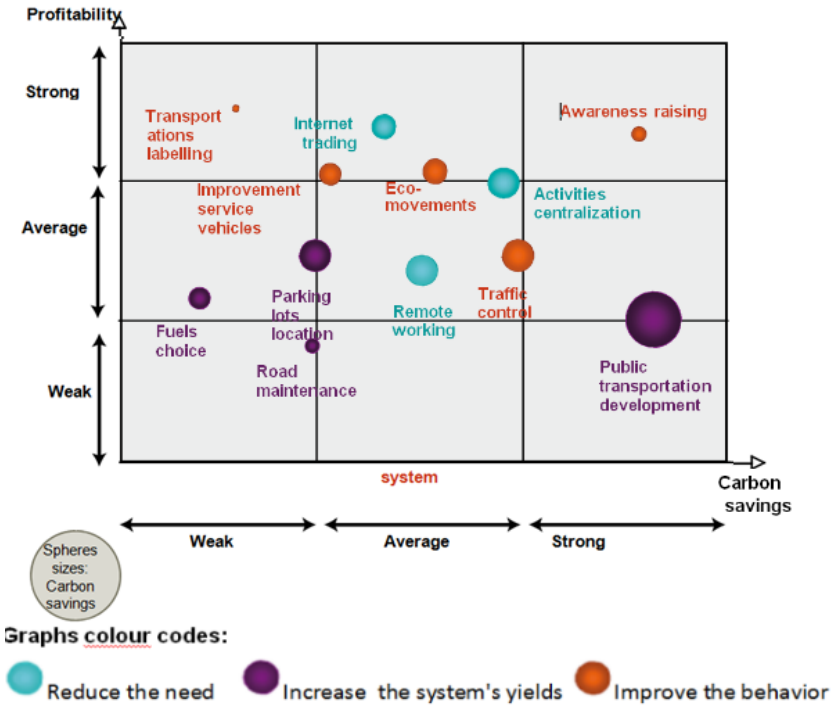
- Raise awareness to improve the users' behaviour:

Preoccupied above all by comfort, autonomy, time saving issues… the users need to be positively warned on the consequences of their daily trips, and about the repercussions on climate of their transportations choice. Without making them feel guilty, it is important to sensitize them profitably and deploy reliable and practical solutions for them.

- Promote public transportation.
- Promote green transportation methods: walking, riding a bicycle, scootering etc.
- Promote the urban traffic plans: reserved roadways (bus, bicycles, …), one-way streets, adapted pedestrian installations, etc.
- Launch awareness campaigns on eco-driving and carpooling. The car drivers' behaviour is very important for the air quality. Aggressive driving with acceleration and sudden braking leads to a consumption's growth of 20% or more.
- Create training programs about energy savings for driving personnel programs. Up to 10% of the energy consumptions could thus be saved.

## Comparisons by solutions' criteria

Public Transportations



In the case of transports, the ENERGY AND CARBON SAVINGS are reversed.

The return on investment regarding transport varies according to the solutions. Quickly profitable investments from an economical point of view allow to realize quick savings that may finance longer term investments.

## Identification of the most effective solutions to apply

Generally, the most effective solutions are the ones who need a quite low initial investment, presenting thus a reasonable cost/profitability ratio.

*Reduce the need*
*Increase the system's yield*
*Improve the behaviour*

| Type | Means | Gains | Profitability Term |
|---|---|---|---|
| **Promote Internet trading** | • Help the businesses introducing this new sale concept : shopping centers, big stores, etc.<br>• Propose assistance for the creation of websites specialized on Internet sale and delivery.<br>• Encourage the installation of online purchase platforms.<br>• Create a low emissions transportation network , dedicated in the distribution of the products.<br>• Create promotion campaigns for these new trading methods. | • Fluidity improvement.<br>• Reduction in the level of the city's air pollution, therefore, reduction of CO2 emissions, in accordance with the European regulations and objectives to reduce by 20 % the GHG emission by 2020. | Short |
| **Renew the municipal service vehicles' stock** | • Replace the current vehicles for green vehicles (lower level of CO2 emissions) and electric cars.<br>• The classical performance of a car is under 20% because most of the produced energy is dissipated in heat. This is not the case of electric cars, whose performance rises to near 60%.<br>• Install a computerized consumptions control system.<br>• Realize specific trainings to energy-efficient driving.<br>• Launch awareness operations for drivers about car pollution. | • Reduction in the CO emissions and contribution to the European regulations objectives of reduction of the GHG emissions by 20% by 2020.<br>• Raise citizens awareness about the influence of vehicles in climate change.<br>• Exemplarity regarding the inhabitants. | Short |

| Type | Means | Gains | Profitability Term |
|---|---|---|---|
| **Promote the new movement concepts** | • Create websites to promote carpooling: a free connection and the possibility of organizing trips between people in real time.<br>• Implement the system of self-service bicycle renting.<br>• Promote carpooling with electric cars. | • Reduction in the CO emissions and contribution to the European regulations objectives of reduction of the GHG emissions by 20% by 2020.<br>• Raise citizens awareness about the influence of vehicles on climate change.<br>• Favourable opinion of the authorities' image. | Short |
| **Vehicles and green public transportations labelling** | • Label all vehicles (private cars, public transportations, etc.)<br>• Follow-up of the pollution and emissions level. | • Raise citizen awareness on non polluting cars, thanks to the publication of emissions.<br>• Promotion of green transportations in the local and regional authorities.<br>• Improvement of the local authority's image. | Short |
| **Optimize the traffic's control** | • Create reserved corridors networks for the public transportations vehicles.<br>• Create specific roadways for the non motorized transportations (bicycles).<br>• Treatment of the saturation by the implementation of special settings on one or more intersections.<br>• Take into account public transportations in the framework of the urban mobility plan.<br>• Automatic reconstruction of the trips lengths for the users' information.<br>• Create traffic statistics in the framework of an observatory of movements.<br>• Install road traffic video-monitoring equipments.<br>• Install dynamic information systems on the network in order to inform the users.<br>• Install a centralized technical control system that allows to know the functioning state of all the equipments and intervene quickly when an intersection is in default for example.<br>• Install GHG follow-up systems on public transportations in order to control the emissions in real time. | • Improvement of the city"s traffic.<br>• Reduction in the pollution and therefore increase of the air quality.<br>• Reduction in the fuels consumptions and also in the $CO_2$ emissions.<br>• Traffic fluidity.<br>• Broadcasting the information to the travelers | Average |
| **Improvement policy of road infrastructures** | • Maintain regularly the roads. | • Reduction in the fuel's consumption of the citizens' vehicles and thus the CO emissions. | Average |

| Type | Means | Gains | Profitability Term |
|---|---|---|---|
| **(State measure)** | 2 | • Improvement of the roads' state: traffic increase of non motorized transport modes as bicycles, carts and scooters.<br>• Good image of the city. | |
| **Set up an improvement and public transportations development policy** | • Create city centre bypass roadways.<br>• Install added parking lots alongside tram lines.<br>• Develop a pedestrian and bicycle networks. | • Reduction in the CO2 emissions and contribution to the European regulations objectives of reduction of the GHG emissions by 20% by 2020.<br>• Improvement of the air quality of our towns and thus the life level of the citizens.<br>• Raising awareness of the citizens about the current climate-energy problem.<br>• Enhance the image of the local and regional authority.<br>• Optimization of the city's traffic | Average |

# 4. What study for which needs?

## Descriptions of possible studies

| Study/Tool | Typology | Description |
|---|---|---|
| Carbon Footprint | Prior study | ➢ Accounting tool of the GHG emissions that enables, from easily available data, to evaluate direct induced emissions of the town. It represents the impact of the activities on climate change.<br>➢ Allows to have a "carbon accountability" according to the public regulations and draw a distinction between solutions and actions towards the less polluting choices. |
| Greenhouse gas balance sheet | Regulatory study : (article 75 of the Act n° 2010-788 of the 12th of July 2010 and enforcement decree n° 2011-829 of the 11th of July 2011) | ➢ Is intended to create a greenhouse gas balance sheet for the scopes 1 and 2 to elaborate the territorial climate-energy plans. |
| Energy Efficiency Diagnosis (DPE) | Regulatory study<br>(Climate plan 2004-2012) | ➢ It is a photograph of the building which is translated by a dual label and that enables to rank on a value scale the energy consumption ( with a quantified estimate for heating, domestic hot water production and cooling).<br>➢ The calculating method allows to set an order of magnitude with a ranking from A (very good) to G (very bad). A second label allows to determine the impact of the consumption of the greenhouse effect going from pink for a low emission to parma for strong emissions and to a purple shade.<br>➢ The diagnosis can be coupled with "recommendations" and general enhancements (not described, not detailed, not quantified extensively) to achieve energy savings projects.<br>➢ It can be used as a support to a global building enhancement strategy and plan of the town and it has a 10-year validity period. |

| Study/Tool | Typology | Description |
|---|---|---|
| Energy Pre Diagnosis | Prior study | ➢ Quick evaluation tool of a site's energy savings potential which aims at defining the opportunity to launch small works and/or prepare one or two careful studies by quantifying the economical conditions of realization.<br>➢ It is an analysis with prior information gathering on site, a visit and investigations. Then, a study report that presents the recommendations for action classified into 3 categories: immediate action (energy saving without significant investment), priority action (in the short term since there is a high level of profitability) and useful action (to implement but with a lower profitability). |
| Global Energy Diagnosis | Prior study | ➢ Represents a complete approach of enhancement of the energy efficiency of a given site with a multi-energy, multi-use and multi-techniques detailed study.<br>➢ It is an analysis with prior information gathering on site after various visits. The result is a report with recommendations assessed according to their profitability.<br>➢ Key element for the sound management of the town's buildings energy optimization or of the complex elements. |
| Feasibility studies of the energy supplies with the use of renewable energies | Prior study | ➢ It gives you all the technical, operational and economical elements to assess the utility or the constraint of installing energy production equipments from renewable energies. |
| Asset management strategy plan with an energy section | Strategy/ Planning | ➢ Allows to qualify the whole estate's stock: technical state, use and functioning, market potential, and determine its evolution over 5 to 10 years (extension, regeneration, demolition and so on) by identifying the economical issues of each action.<br>➢ • It gives a strategic and prospective vision in the medium and long term of the estate's stock management. |
| Specific Energy Diagnosis | Specific study | ➢ Energy diagnosis specific to a given use such as lighting, driving force, electricity supply system, ventilation, heating, and so on.<br>➢ Allows to assess the energy savings sources relating to an action on a use; assess specifically and precisely the profitability and the energy costs.<br>➢ This study enables to quantify the expected gains through a quantified simulation, just before the reduction actions of energy consumptions or GHG emissions. |
| Energy losses Study | Prior study | ➢ The thermography technique allows to visualize the energy losses of a building. Thus, it enables to identify the specific areas causing an energy waste and that need a priority focus.<br>➢ Thanks to this study, you can act to adopt measures and improve the building's insulation, and therefore, reduce the energy bill as well as limiting the GHG emissions. |

## Scenarii “If I want...”

| Study/tool | Reduce my operating costs | Reduce my GHG emissions | Reduce my energy consumptions | Communicate | Respect/ anticipate the regulation |
|---|---|---|---|---|---|
| Carbon Footprint® (BC) | * * | * * * | * * | * * | * * * |
| GHG emissions balance sheet (BEGES) | / | * | * * | / | * * * |
| Energy Efficiency Diagnosis (DPE) | / | / | / | * * | * * * |
| Energy pre-diagnosis | * * | * * | * * * | * | * * * |
| Global Energy Diagnosis (DEG) | * * | * * | * * * | * * | * * |
| Feasibility studies of the energy supplies with the use of renewable energies | * * | * * | / | * * * | * * * |
| Asset management strategy plan with an energy section | * * | * | * | * * * | * * |
| Specific Energy Diagnosis (DES) | * * * | * * * | * * * | * * * | * |
| Energy Losses Study | * * | * * * | * * | * * * | * |

## Studies to reach energy and environmental efficiency in towns

In the project launching methodology for energy efficiency, one of the first steps is the realization of technical studies, firstly to identify quickly the potential of optimization, and after, more into detail, in order to continue the energy savings approach. As we can see there are many types of studies from pre-diagnosis to detailed studies.

All these studies allow us to renovate the equipments and installations which are consuming more energy by more efficient equipments and thus achieve energy and carbon savings.

The resulting improvements, will favour the image of the cities, more modern and environmentally responsible.