Quick Wins

Reducing energy consumption in public transport

October 2013

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The partners of this project are:

- STIB (Brussels, Belgium) as lead partner
- TfGM (Manchester, UK)
- moBiel (Bielefeld, Germany)
- RATP (Paris, France)
- RET (Rotterdam, The Netherlands).

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INTRODUCTION

1 Ticket to Kyoto project

The Ticket to Kyoto Project aims to reduce CO_2 emissions in public transport through more environmentally friendly behaviour and changes in infrastructure. The five partners of the project are:

- moBiel, Bielefeld, Germany;
- RATP, Paris, France;
- RET, Rotterdam, Netherlands;
- STIB (Project Lead), Brussels, Belgium;
- TfGM, Manchester, United Kingdom.

The project runs over four years (2010 to 2014) and is co-financed by the INTERREG IVB North West-Europe Programme.

1.1 Work packages

To reach its goal, the project has identified five key actions plans that will be delivered within the following work packages (WP).

- **WP1 - Achieving Quick Wins**: The five partners have implemented “Quick Win” energy saving measures (easy to achieve in the short term without large investments) and are sharing their results and know-how.
- **WP2 - Investing in infrastructures to reduce CO2 emissions**: Around 60% of the T2K budget (around €7,2 million) is dedicated to investments focusing on braking energy recovery, energy savings in stations and infrastructure, heat recovery and producing power locally.
- **WP3 - Developing strategic CO2 plans for 2020**: In 2012 and 2013, each partner has built a common CO_2 footprinting method, defined common indicators, improved energy metering within partner organisations and developed a standard CO_2 calculator to inform users on CO_2 emissions produced when they use public transport in the five partner cities. This workpackage will be concluded by the final CO2 strategy for 2020, adapted to each partners context.
- **WP4 - Optimizing policies and regulations for CO2 reduction measures**: Considering the interactions between public transport companies and their stakeholders including local governments, suppliers, maintenance operators, as well as the policy and legal context within which they operate.
- **WP5 - Mobilising people and industry through public campaigns**: Involving T2K partners’ internal and external stakeholders to reduce energy use and CO_2 emissions through awareness raising campaigns and events and sharing best practice on communication strategies on these subjects across the five partners.

1.2 Partners

1.2.1 moBiel – Bielefeld (D)

Carrying 43,3 million passengers over a total of 10.95 million vehicle kilometres in 2009, moBiel is the leading mobility service provider for Bielefeld, Germany. The company of about 700 employees has ambitious plans: increase ridership rapidly to 80-100 million passengers by 2030, while keeping cost effectiveness to at least the current level.

For the next years a huge network development is foreseen: The existing high floor light rail system will be completed by a new low floor tramway line. Together with some smaller extensions the network length will increase from 37 km to over 55 km.

1.2.2 RATP – Paris (F)

The RATP-operated multimodal network in the Paris Region is one of the world's largest and densest mass transit systems: 14 metro lines, 2 RER (regional express train) lines, 3 tram lines, over 350 bus lines, and shuttles to 2 major airports transport 3 billion passengers each year.

1.2.3 RET – Rotterdam (NL)

RET is the public transport company that provides public transport services in the city of Rotterdam and its periphery. It operates five metro lines, eight tram lines, 60 bus routes and a fast-ferry service. Public transport services commute some 600.000 people daily. Rotterdam is the second largest city in the Netherlands and largest maritime port in Europe. The population of the city was around 600.000 inhabitants in 2012 whereas the greater Rotterdam (Rotterdam-Rijnmond) area hosts more than 1.3 million people.

1.2.4 STIB – Brussels (B)

STIB is the largest Belgian urban public transport company and serves the 19 municipalities of the Brussels-Capital Region as well as 11 other outlying communes. It provides transport for a population of over 1,100,000 inhabitants and thousands of commuters. STIB network has 4 metro lines, 18 tram lines, 50 bus lines and 11 night bus lines. In 2012, over 349 million people chose public transport to get around the capital.

1.2.5 TfGM – Manchester (UK)

Transport for Greater Manchester is the organisation responsible for implementing local transport policy, set by the Greater Manchester Combined Authority and its Transport for Greater Manchester Committee. TfGM is the delivery arm for the elected body, responsible for investment in improving transport services and facilities, supporting the largest regional economy in the UK outside London. Transport for Greater Manchester is responsible for providing the facilities and infrastructure to support efficient transport systems and to enable people to make sensible choices regarding their transport options. TfGM manages 22 bus stations around Greater Manchester, 12,500 bus stops and over 4000 bus shelters, 38 tram stops and 37 km of tram tracks.

Partners	moBiel	RATP	RET	STIB	TfGM
Population	325,000	12 million (Greater Paris)	1.3 million (Greater Rotterdam)	1.1 million (Brussels Capital Region)	2.6 million (Greater Manchester)
Scale	55 million pax p.a. (set to double by 2030) in Bielefeld urban area 700 staff	3.5 billion pax p.a. in Greater Paris Region 56,000 staff (companywide)	185 million pax p.a. in Rotterdam metropolitan area 3,000 staff	311 million pax p.a. in the Brussels metropolitan area 6,500 staff	280 million pax p.a. in Greater Manchester Approx. 550 staff
Transport modes operated	Tram services (with some parts underground) Bus services	Regional rail services (in part) Metro lines Tram lines (3 out 4 lines) Bus services (in part)	Metro lines Tram lines Bus services Ferry service	Metro lines Tram lines Bus services	TfGM does not operate services directly Tram lines Supported bus services Some influence over regional rail
Public transport operations	moBiel is responsible for planning, operation and maintenance of tram & bus infrastructure and services	RATP operates the services (RATP Operations) and owns and maintains the infrastructure (RATP Infrastructure)	RET operates the services and maintains the infrastructure	STIB operates the services and maintains the infrastructure	TfGM owns the tram network & bus infrastructure and enters into agreements with private sector operators who run tram and bus services
Governance and operator status	The local authority is Stadt Bielefeld (the City of Bielefeld) moBiel, a publicly owned company, is the "preferred operator" for bus and tram services in the city	STIF is the Region's transport authority RATP is a publicly owned company and the internal operator for the Region but the provision of services will be put out to tender in the coming years (third party operator)	The responsible authority is Stadsregio Rotterdam (City Region) RET, a publicly owned company, was the internal operator for SRR but the provision of services will be put out to tender in the coming years (third party operator)	Brussels Capital Region (Transport Minister) is the transport authority (with Bruxelles Mobilité as its executive arm) STIB is the internal operator for the Brussels Capital Region	TfGM is a public body, governed by elected representatives from the ten Greater Manchester local authorities Tram and bus operations are a mix of concessions (franchises) and open market (majority of bus services)
Financial information (approx, budget definition can vary)*	moBiel budget €66.6 million (72% covered by PT operations revenue)	RATP annual income: €4.2 billion RATP financial: €183 million	RET budget: €488 million & financial results: €10 million	STIB annual budget: €600 million p.a. (55% covered by operations revenue)	TfGM annual budget: £274 million (ITA budget)
Energy costs (approx. per year)*	Electricity: €2.4 million Fuel: €2.9 million	Electricity: €90 million Fuel (incl. support fleet): €88 million HVAC: €10 million	Electricity: €10 million Fuel (incl. support fleet): €7.7 million	Electricity: €20 million Fuel (incl. support fleet): €13 million	Electricity: £ 3 million p.a. (£1 million for tram traction & £1 million for traffic signals)

* Based on the most recent data available

2 Goal of this publication

The aim of this report is to describe how T2K partners have been able to reduce their energy demand and to improve their energy efficiency in a relatively simple way by implementing Quick Wins actions. By sharing this knowledge, other public transport companies will be empowered to implement similar schemes within their own organisations, thus delivering further energy reductions and helping to tackle climate change.

2.1 The Quick Win concept

To improve energy consumption and reduce the related CO_2 emissions, three sequential strategies must be followed:

1. Reducing the energy needs (less)
2. Improving the efficiency of existing systems (better)
3. Investing in new technologies and renewable energies (cleaner)

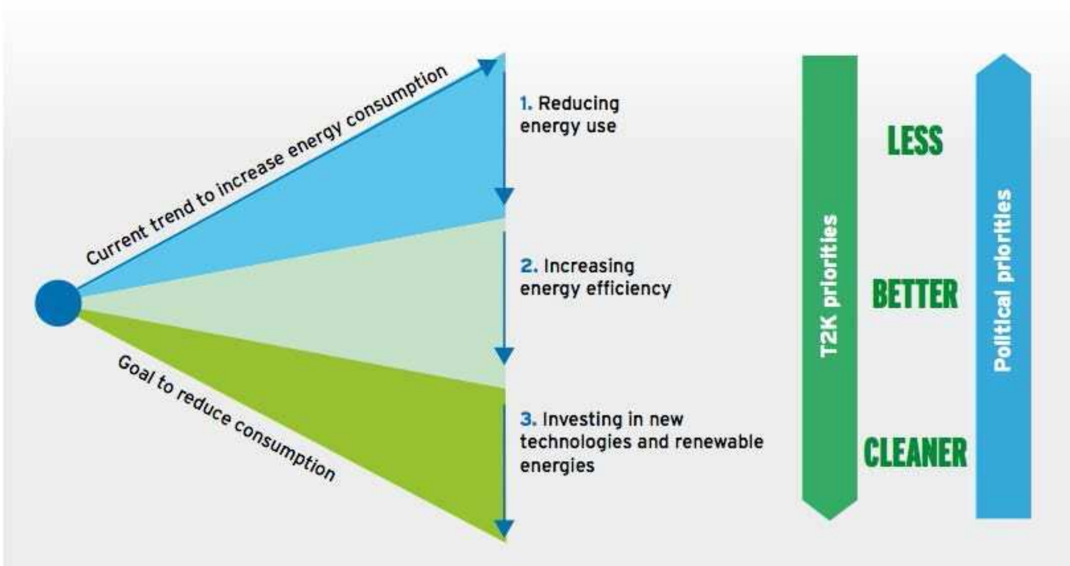


Figure 1: Strategy for reducing the energy consumption, Source: Association Negawatt,Drawing by F.-O. Devaux, STIB, 2011

The first two strategies can be achieved by implementing energy saving and efficiency measures without the need for large investments. They refer to the **Negawatt** concept: a negawatt is a theoretical unit of power representing an amount of energy (measured in watts) saved. The energy saved is a direct result of energy conservation or increased efficiency. The third strategy is longer-term and requires significant investments[1].

A good energy management strategy should first consider reducing energy needs and improving energy efficiency before considering investments in renewable energy technologies. It is better to consume less energy than producing renewable energy to compensate higher energy needs. Unfortunately, political priorities often focus more on sustainable energy sources instead of reducing energy needs (top down approach) as this requires actions at every single level. Public transport companies will gain more and more quickly by elaborating energy saving strategies (bottom up approach) that will directly impact their energy bill with less capital costs.

The **Quick Win** concept consists in implementing short-term actions that can bring significant financial and environmental benefits by simply optimizing existing assets and by encouraging more responsible behaviours among staff and subcontractors.

Definition of a Quick Win within the T2K project

- leads to energy reduction ;
- has long-lasting effects ;
- has a return on investment of less than 5 years;
- has a short implementation period (less than one year);

Not every Quick Win project will be suitable for every company involved in the public transport sector. It is important that the most suitable solution is identified for each company, but whilst the exact detail for each project contained in this report may not fit, the ideas themselves and the approach taken may provide stimulus for others to take a similar course of action. Many of the ideas considered and implemented have come about through employee engagement and the development of their ideas, rather than from a top-down approach.

It is important also, to recognize that projects of this nature need the support and buy-in from senior management to allow the initial investment and to enable the projects to progress. Many of the projects will also require significant buy-in from employees. Changed working practices, additional or new training may be required and methods of operation updated. It is important to ensure effective and timely information to maintain support and ensure continued motivation. It is also the case that for many projects of this nature, it is possible to integrate the changes into the normal working practices of the company thus ensuring continued rather than one-off, successes in reducing emissions and securing savings. The projects detailed in this report can be achieved at comparatively low cost, with short implementation

[1] In the framework of the Ticket to Kyoto project, energy saving investments have been implemented in the Work Package 2 and are detailed in other reports available on www.tickettokyoto.eu

timeframes and a return on investment of between one and five years. These projects deliver energy reductions and cost savings, which have a long-term impact.

2.3 Structure of the document

The first part describes why it has become vital for public transport operators to manage energy in a more conscious way.

The second part shortly describes each Quick Win in such a way as to allow other stakeholders to gain the fullest knowledge and understanding of each project. The Quick Wins are structured in different main topics. For each topic, the main elements to be taken into account are clearly identified and case studies taken from the T2K partners' experience are presented. This will give the readers a unique document to be used as a toolbox for identifying, quantifying and implementing projects in their own company.

This picture shows a fictional public transport network. Results are based on the T2K partners experience.

Assumptions on an annual basis:

- **Depot consumption**: 2.5 GWh (heating) – 2 GWh (electricity)
- **Main office consumption**: 1,5 GWh (heating) – 3 GWh (electricity)
- **Metro stations lighting**: 15 GWh (250 MWh/station – 60 stations)
- **Metro consumption**: 100 GWh
- **Bus fleet**: 600 vehicles
- **Interchange consumption**: 300 MWh (electricity)
- **Escalators consumption**: 5.5 GWh
- **Station service area**: 25 MWh (electricity)

PART I: Why and how to save energy?

3 Energy challenges

The planet is progressively heading towards a serious energy crisis, owing to escalating demands for energy overtaking the available supply. Tickets to Kyoto partners had to face significant energy price increases over the last years. This situation has had direct impacts on their activities due to the financial pressures it generates. Moreover, the climate change issue requires a dramatic drop in the energy consumption to limit increases in global temperature.. Those economic and environmental challenges led to a critical situation and actions must be taken now to mitigate the effects.

In this chapter, the current trends on energy price increase and their impacts for public transport operators will be depicted.

3.1 Public transport context

Public transport companies are faced with important challenges when considering initiatives to reduce energy use and CO_2 emissions (Hatkins, 2012):

- trade-off between high short term costs and potential long term benefits;
- balancing public transport emission reduction with wider transport sector policy objectives
- split responsibilities and incentives
- informational failures and uncertainty
- carbon price externality
- policy and regulatory frameworks
- technology risk
- high search and transaction costs
- path dependency (lock-in)
- inertia and behavioural barriers.

Five options are available for transport companies:

1. Reduce transport services
2. Raise passenger fees
3. Obtain a larger budget from the public authorities

4. Increase revenues / passenger numbers

5. Decrease the energy needs and increase the energy efficiency

It is obvious that the two first options will not act in favour of a modal shift from private car to public transport and are unlikely to be accepted. They should thus be avoided. In the current economic situation, public transport companies can hardly expect to receive additional funds from their public authorities to compensate for higher energy costs. Increase ridership requires significant investments and adapted public policies. As a result, transport companies must prioritise energy efficiency measures in order to reduce their energy bill and the related carbon emissions and ensure they can continue to expand their services.

3.2 Energy prices evolution

3.2.1 Electricity prices

The electricity prices for industrial consumers have known a strong increase during the last years as depicted on the graph below. The European average price for one kWh increased by 45% between 2005 and 2012, rising from 6,72 c€/kWh to 9,76 c€/kWh. The situation is slightly different among the countries but a common trend is clearly noticeable. This situation is particularly critical for large public transport companies operating several metro and tram lines as it has a straight impact on their operational costs.

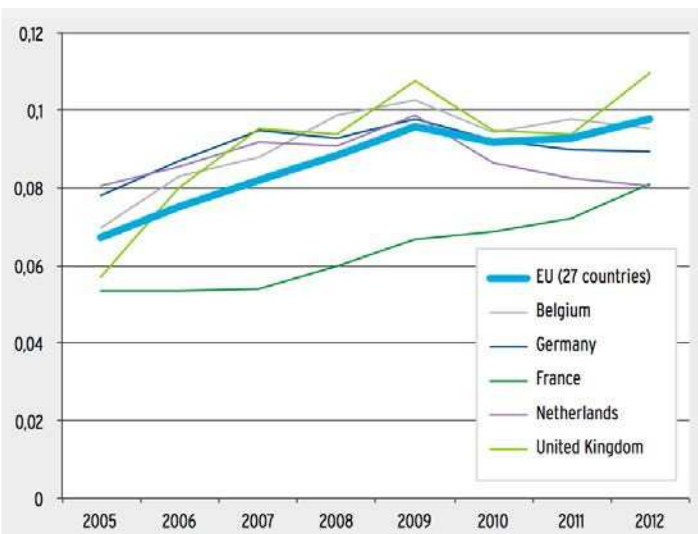


Figure 2 : Evolution of the electricity prices for industrial consumers between 2005 and 2012 (EUROSTAT)

3.2.2 Gas prices

Gas prices have been following an increasing curve over the last years although the prices increased relatively less than for electricity. A significant drop can be observed in all European countries in 2010. However, the trend is clearly upwards and impacts the heating costs of large buildings such as offices, depots, workshops and stations.

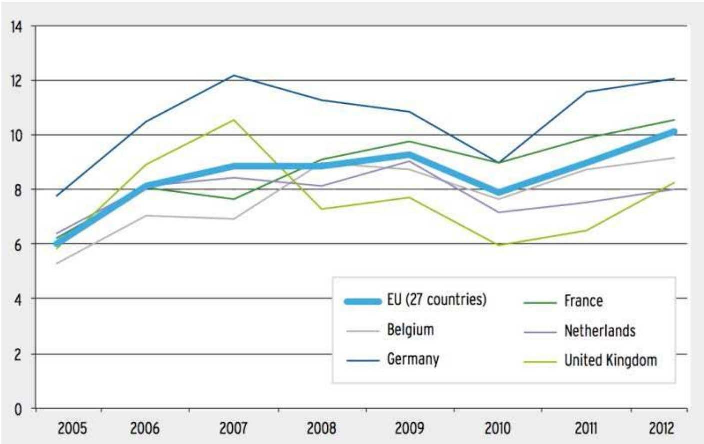


Figure 3 : Evolution of the gas prices for industrial consumers between 2005 and 2012 (EUROSTAT)

3.2.3 Transport fuel prices

As far as automotive diesel prices are concerned, all European countries have been facing the same upwards trend with prices increasing from around 1€/litre in 2005 to more than 1,4€ in 2012. The costs of operating large bus networks are directly linked to the fuel price and this rapid increase was difficult to compensate for public transport operators. Energy prices have shown a high degree of volatility, which means that public transport operators and transport authorities are exposed to large financial and operational risks.

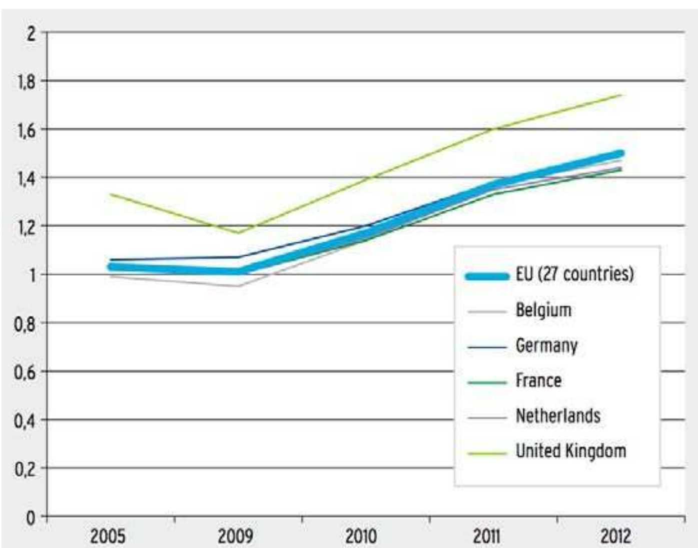


Figure 4 : Evolution of the automotive diesel prices between 2005 and 2012 (EUROSTAT)

STIB (Brussels)

STIB spends approximately €20 million per annum on electricity and €13 million per annum on fuel (including support fleet). The energy costs raised by more than 50% between 2007 and 2012. This increase results from an 8% increase of the energy consumption due to services expansion and from a 41% increase in the energy price. It must also be pointed out that the energy efficiency was considerably improved over the period as transport services (expressed in places-kilometres) increased by 25% whereas the energy consumption increased by only 8%.

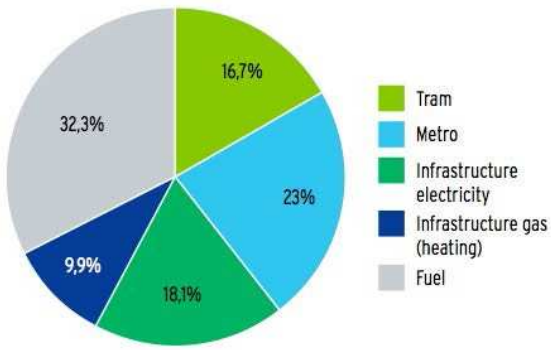


Figure 5 : STIB energy use in 2012

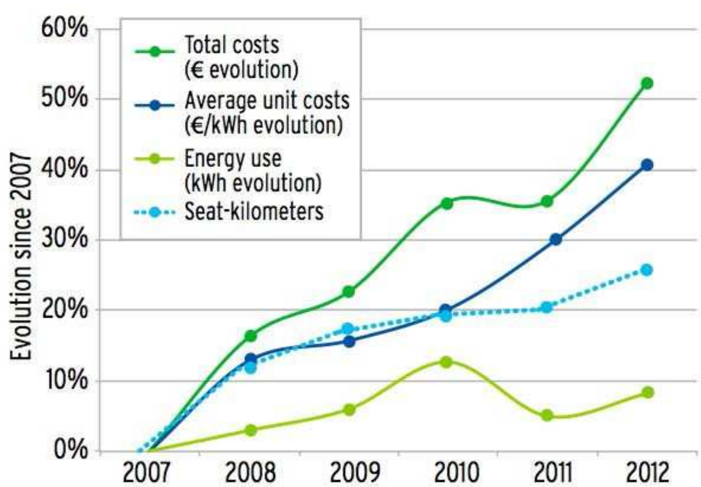


Figure 6: STIB energy use in 2010 – STIB energy costs in 2010

RET (Rotterdam)

RET spends approximately €10 million on electricity, €7.8 million on fuel (buses and fleets) and €2.1 million on gas and district heating per annum. The table below summarizes the energy used by RET in 2010. Electricity use includes traction, stations, office buildings and depots. RET has been procuring 100% green electricity since 2008. Buses are generally diesel (Euro V and EEV) although the fleet includes a couple of hybrid buses and electric buses (with range extenders). Petrol and gasoil are purchased through a standard procurement process.

Energy source	Volume used
Electricity	125 GWh
District heating (offices)	1.8 GWh
Natural gas (depots heating)	19 GWh
Gasoline (company fleet)	240,000 litres
Diesel (buses and ferry)	5.6 million litres

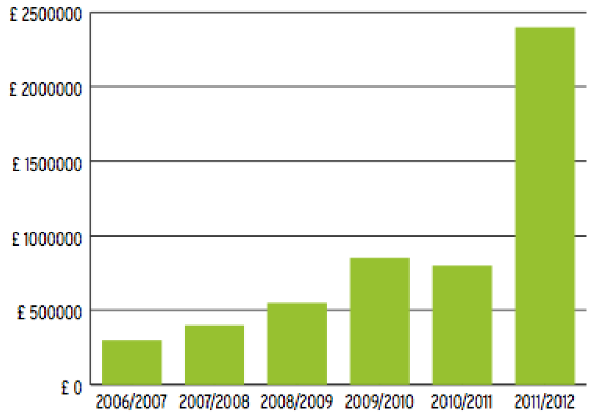
Table 1 : RET annual energy use

3.3 Energy consumption

Public transport operators are facing an increase in their energy consumption most of the time due to services expansion or improved service level. The objective to reduce energy use and carbon emissions needs to be balanced with the wider objective to reduce overall transport sector emissions by encouraging more users to switch from the private car to public transport and low carbon modes. Initiatives to encourage this change in behaviour can result in increases in energy use and emissions for the public transport sector through the provision of additional services and equipment.

TfGM (Manchester)

TfGM's energy costs were €2,5 million higher in 2011/2012 than they were in 2006/2007. This is because the company is building many new infrastructure and buildings to expand the public transport network and improve the service quality for the passengers in order to reduce carbon emissions from travel in the Greater Manchester.



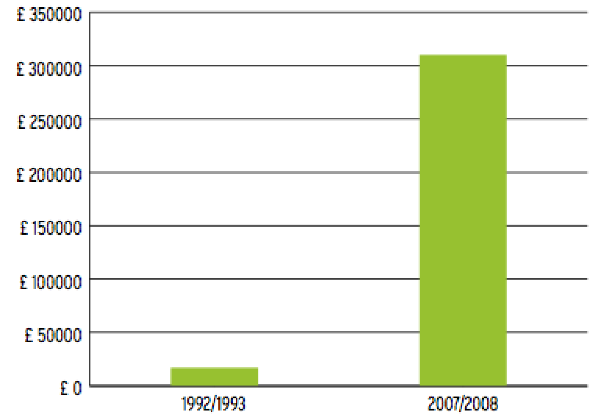


Figure 7 & Figure 8: TfGM energy costs evolution between 2006 and 2012 - Comparison of the electricity usage of the old and new Middleton bus station in Manchester

The reasons for the new bus stations using so much more energy than its predecessors is the improvement in passenger waiting facilities. Old bus stations largely consisted of bus shelters and a small accommodation unit, but TfGM replace them with large state of the art facilities to encourage the use of public transport. Unfortunately, this pattern also inhibits TfGM from meeting its energy and carbon targets. Either TfGM needs to design bus stations with less facilities to reduce consumption or needs to massively increase the amount of on-site renewable energy generation, which is usually difficult given the constraints of the sites.

3.4 Energy mix and CO_2 emissions

We observe differences in electricity mixes and resulting carbon intensity in Europe. For example, in France, the high proportion of nuclear and hydropower results in relatively low carbon electricity. This means that initiatives, which aim to further reduce energy consumption and energy carbon intensity, do not deliver as many benefits as in Holland, Germany or the UK.

Energy source	Belgium	France	Germany	Netherlands	UK
Electricity	6%	13%	16%	10%	7%
Nuclear	52%	76%	23%	4%	18%
Gases	33%	4%	14%	63%	45%
Petroleum products	0%	1%	2%	1%	1%
Solid fuels (coal mainly)	6%	5%	42%	21%	28%
Other	3%	1%	3%	1%	1%
Electricity carbon intensity (gCO_2/kWh)	224.8	70.9	672.2	413.3	508.5

Table 2 : Energy mix for the T2K partners countries in 2009 (EEA)

moBiel (Germany)

The average figures at national level can of course be relatively different than the figures at the corporate level. The example of Bielefeld shows that the energy mix for electricity comprises a larger part of nuclear power than the national average in Germany. The national and local goal to replace the fossil part (especially coal) is now tightened by federal energy policy change to quit nuclear production by 2018.

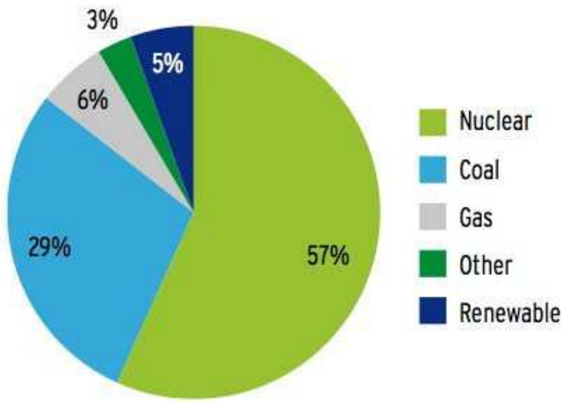


Figure 9 : moBiel energy mix in 2011

RATP (Paris)

RATP has developed its own Energy and Climate Change Strategy ("Politique Energie-Climat"), adopted by the organization's board in 2005. It has led to a carbon footprinting ("Bilan Carbone©") including all RATP activities on the Greater Paris network: public transport operations, buildings and offices (including staff restaurant), infrastructure and vehicle maintenance, staff travel, freight movements between suppliers and RATP, emissions from waste and sub-contractor emissions. Main sources of carbon emissions for RATP in 2008 were as shown in the figure below. Energy use is the most important source of emissions (66%), followed by infrastructure and vehicle embedded emissions due to the scale of RATP infrastructure and rolling stock. 2008 results showed a 8% decrease in RATP emissions (on 2005 levels), with energy efficiency and emission reduction initiatives more than offsetting the increase in RATP's offer of services. (Source: RATP Bilan Carbone©).

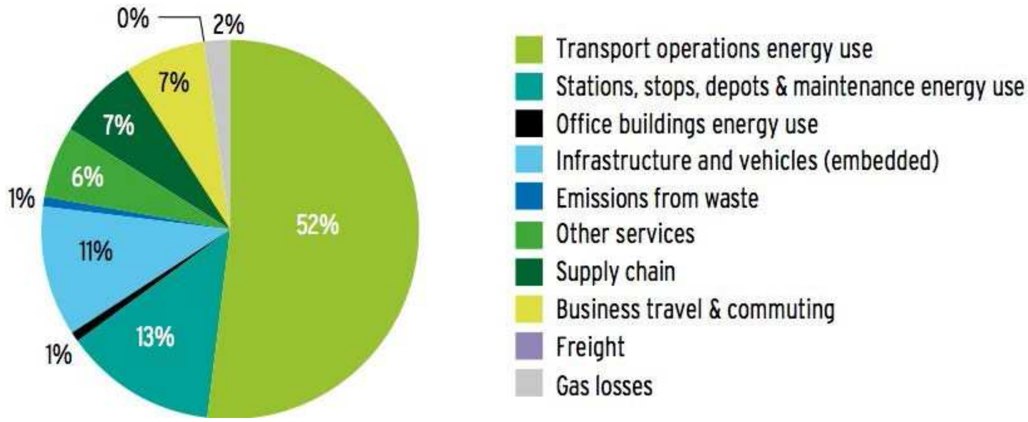


Figure 10 : RATP Carbon footprint in 2008

4 Energy metering

"You can't manage what you can't measure" is a self-evident truth. In fact, having a good understanding of how equipment works and how much energy it consumes is a very important task in order to manage energy in a consistent way. As a result, before considering implementing energy efficiency projects, it is vital to develop a strategy regarding energy metering and monitoring.

4.1 Energy metering

4.1.1 Concept

Smart meters (also referred as automated meter reader – AMR) are high-tech electricity and gas meters that measure your energy use. The key difference from standard meters is that they can send this information back to your energy supplier and receive communications themselves. This is usually through mobile phone communication networks, although other technological options are possible. Smart meters do not necessarily have an energy use display, but they can provide detailed real time energy use information, which can be used to display the amount of energy used. Smart meters are similar in size to regular meters and are relatively easy to install on equipments. Various types and models of smart meters are available, but all of them have the same basic functionality.

Figure 11 : Example of a smart meter (Liberty)

4.1.2 Objectives

- Increase the knowledge on energy consumption
- Detect energy waste and enable actions
- Monitor the effects of implemented measures
- Communicate on project results

4.1.3 Implementation

Energy managers should be aware that they will never have the opportunity to measure everything and that this would be useless and costly. There is little benefit in analysing detailed energy use data from sites or equipments with very limited consumption. It is recommended to determine a threshold level of usage above which a smart meter would be installed. Moreover, portable devices can also be used for specific metering purposes during a specific period. Smart meters bring several benefits if the data are monitored and targets are set: lower energy costs (often by a significant amount), no staff costs to read meters, less staff time required to liaise with suppliers over disputes, easy billing of tenants, etc.

The followings steps should be followed for the installation of smart meters:

- List all existing meters
- List total annual energy costs/meter
- Define a threshold above which it is worth replacing an existing meter by a smart meter
- Assess whether the installation of smart meters can be included in the tender for energy supply
- Identify suitable times and dates outside of operational hours for installation in order to minimise service disruption
- Install smart meters and check that they are properly connected to the energy management system
- Download data and configure the energy management system

The installation of smart meters is not very time-consuming but requires an energy manager or building services engineer planning and managing all replacements, mostly outside of operational hours. Energy consumption data must be analysed using heating-degree-day and cooling-degree-day data obtained from recent, local weather data. Otherwise, comparisons between two periods will be misleading. Free sources are available for each country.

4.1.4 Case studies

4.1.4.1 Smart metering in Manchester (TfGM)

This project involved the replacement of existing main electricity meters with smart meters (AMR), which provide half-hourly energy usage data. The data can then be downloaded and analysed to identify areas of energy waste. This enables better understanding of energy consumption and enables the introduction of monitoring and targeting of sites energy usage. The majority of sites only had energy data from sporadic meter readings taken directly by staff, often just every few months. This level of data did not enable the energy team to identify areas of energy waste, or too understand and manage the usage at the sites. Upon the introduction of the role of Energy Officer, it was determined that improving the data available was a key priority for energy management. This project, to replace existing electricity meters with “smart” meters, was the first step in that process.

TfGM then listed all its meters and established the estimated annual usage and cost associated with each meter. Then they established that any site with annual electricity costs over 2,292 Euro was worth being fitted with a smart meter.

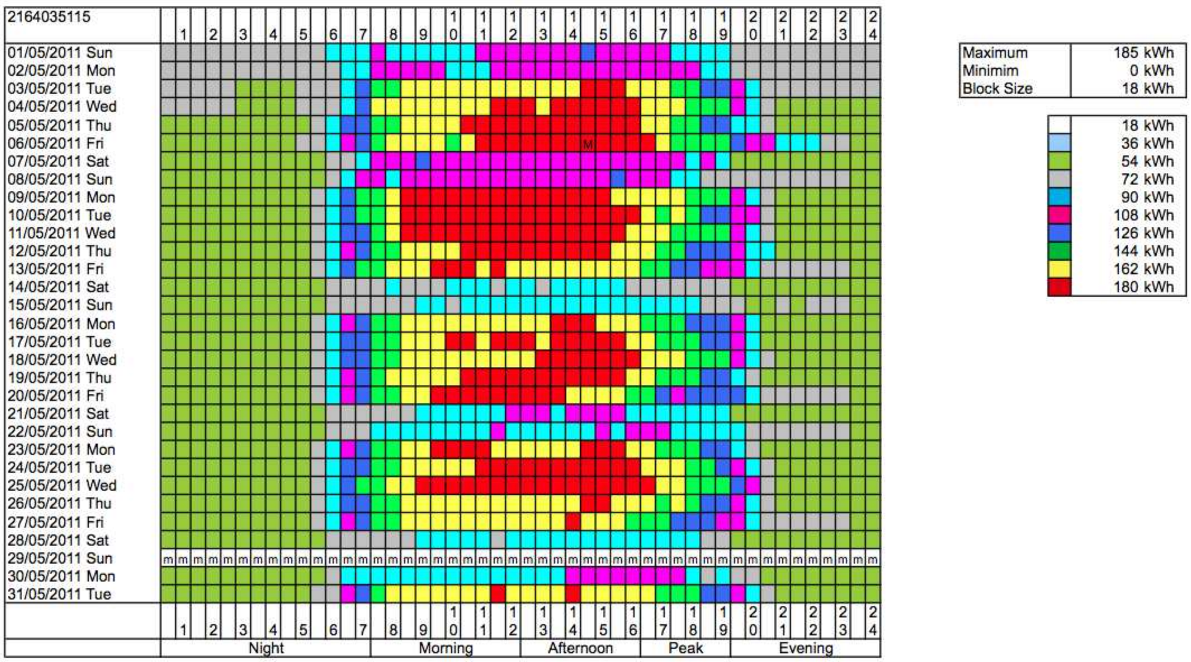


Figure 12 : Electricity use at the Piccadilly Head office (TfGM)

The level of investment required was minimal, due to the fact that TfGM leased the meters from the energy supplier. Capital costs would be higher if the meters would have been purchased directly. Staff resources involved up to 45 minutes for each meter replacement appointment, not including any time spent travelling or arranging the meter replacements. Wherever possible, staff based at the relevant site were utilised, in order to minimise the staff resources required. The Energy Officer led the programme arrangements and consulted with stakeholders in advance. This was time consuming, but worthwhile as all potential issues were resolved in advance of installation and no problems occurred once the contractors were on site.

This was a single event, and once the meters were installed, no further action was required relating to the smart meters. TfGM has evaluated the resources required for energy management, and data analysis now takes one member of staff several hours a week as a minimum. An energy management information system “Systems Link” was procured and used to monitor all energy data and to set individual site-based targets. Most data can be set to automatically import into Systems Link, further reducing staff resources required. This enables automatic exception reporting and reduced the staff resources required for data analysis. The system automatically validates invoices when they are entered into the system, and flags up anything unusual.

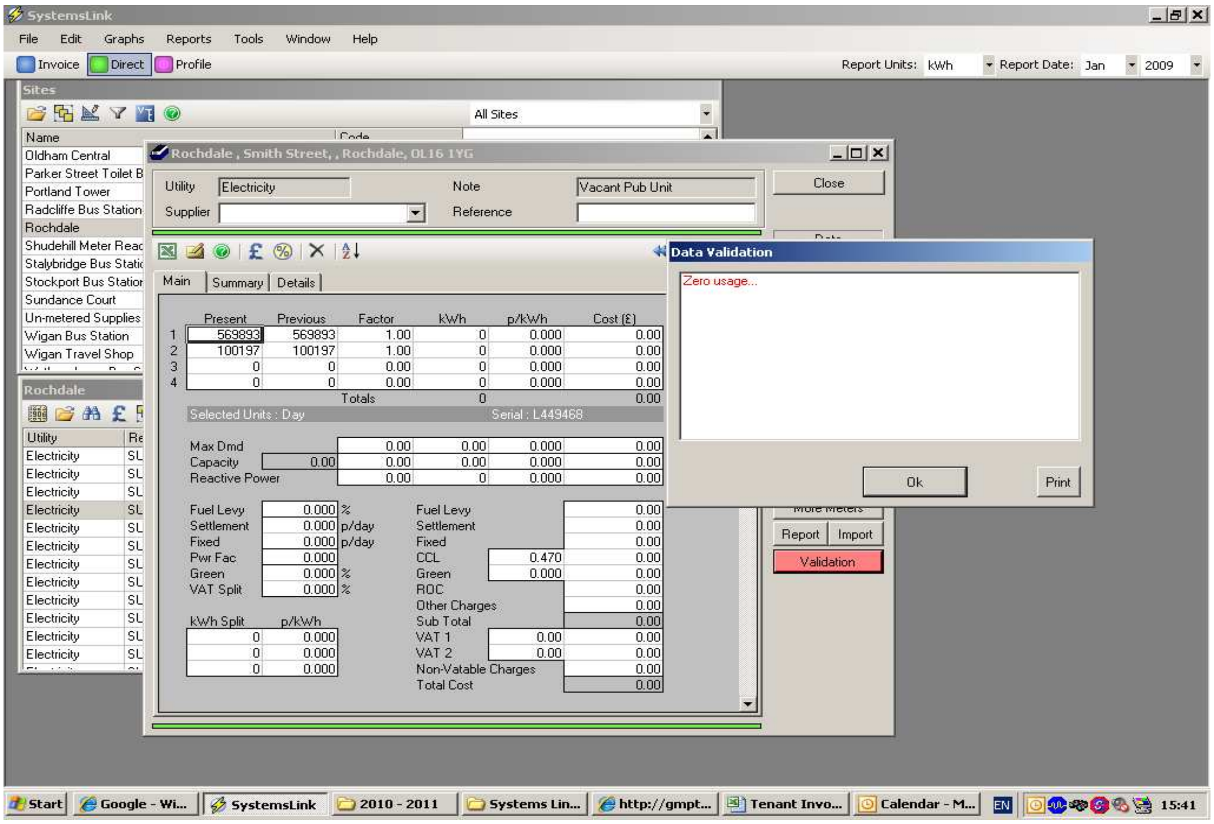


Figure 13 : Automatic invoice validation system – Systems Link

This pilot project has led to energy waste being identified and in the first year following installation, TfGM has seen a 6% reduction in metered electricity usage thanks to the corrective actions taken to minimize consumption. TfGM has now installed gas and water loggers at all sites. These measure the gas and water use every half an hour and provide detailed data which is read remotely, but they are not “smart” as they are not capable of 2 way communications, they can only send data. TfGM’s gas and water use and costs are too low to justify the expense of true smart meters.

4.1.4.2 Temperature metering project in the Philidor Building in Paris (RATP)

The Philidor building is a tertiary estate of 6.300 m^2 for 280 employees. It comprises an IT room, a cafeteria and company restaurant. The consumption of the site is 1,600 MWh of electricity with annual energy costs of around 130k€. No energy management system was currently used in this building. Thus, RATP decided to invest in a smart metering system that allows measuring the temperatures in all the offices and to monitor heating and ventilation remotely.

Figure 14 : View of the Philidor building in Paris – RATP

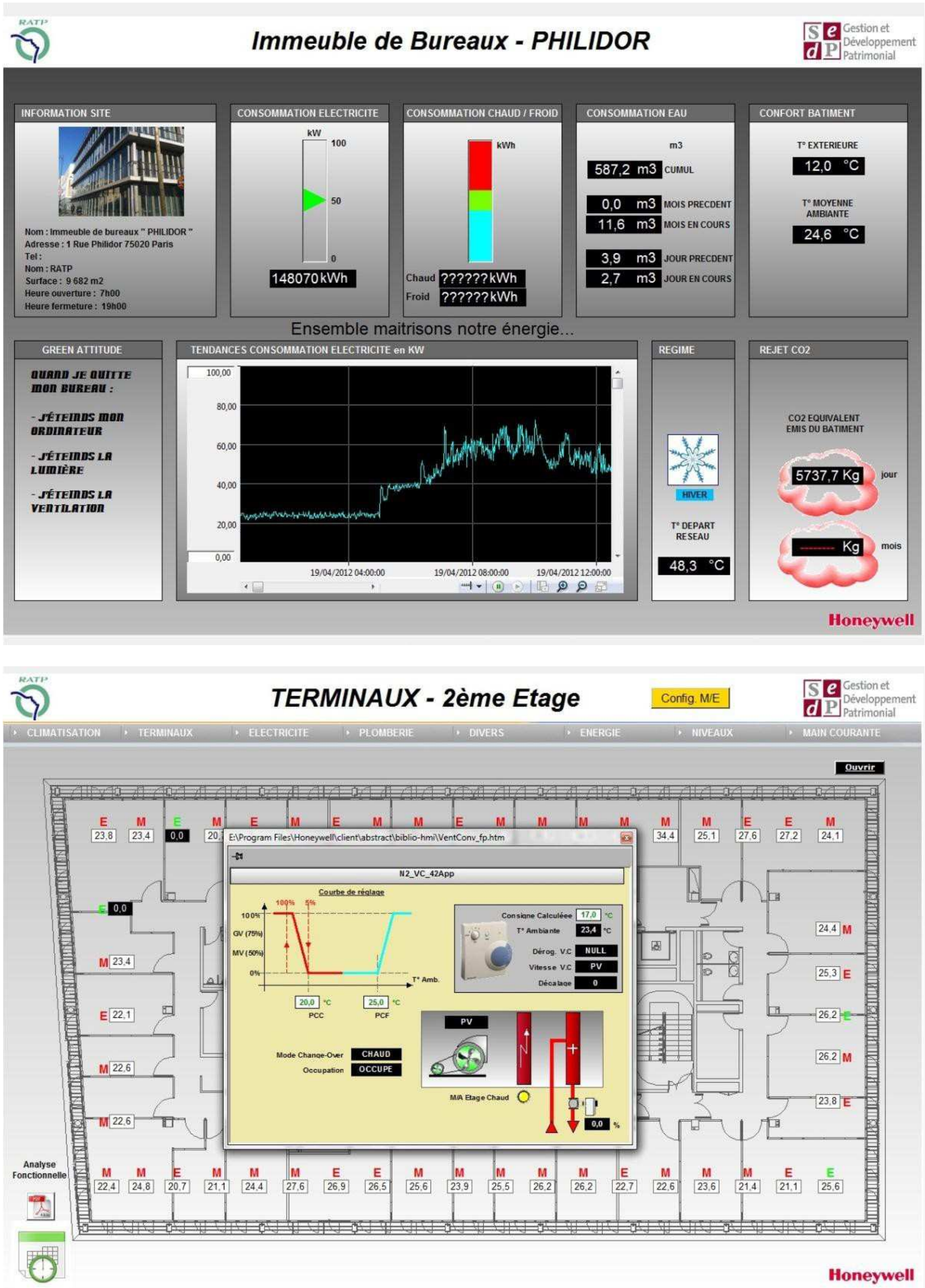


Figure 15 : Screenshots of the smart metering software of the Philidor building in Paris – RATP

This investment allowed RATP to better monitor the energy consumption of the building. RATP expects a decrease of 280 MWh per year (around 4,5%).

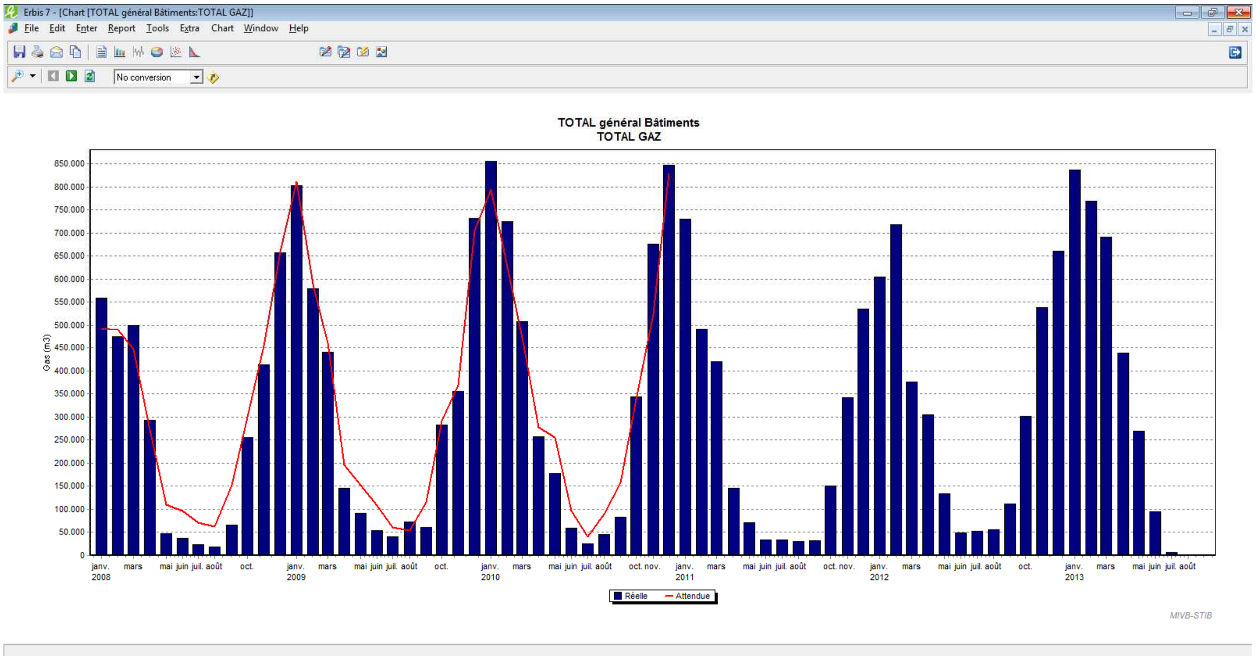
SUMMARY		
Investment	105.000€	
Staff resources	3 man-months	Follow up of the tender
Energy savings (%)	4,5%	
Energy savings (kWh)	280,000 kWh	
CO_2 emissions avoided (tons)	14 TCO_2	
Cost savings (€)	25,000€	
Payback time (years)	4 years	

4.1.4.3 Optimizing energy metering in Brussels (STIB)

STIB has smart meters for its high-voltage electricity network (11kV) located at the substation level. They allow a daily monitoring of the global energy consumption both for traction and buildings. This information is sent to the technical and finance departments for evaluation purpose. However, these meters do not give sufficient information for a precise analysis of the consumption per building or equipment.

Figure 16 : Actaris smart meter use on the high-voltage STIB network

STIB has also a software called ERBIS where data (gas, electricity and water) are encoded manually on a monthly basis. This tool is useful for visualization purpose and makes it possible to compare the effective energy consumption with the energy bills received by the supplier. However, the lack of automation is critical due to the risk of errors and the unavailability of data when staff is off during vacation.



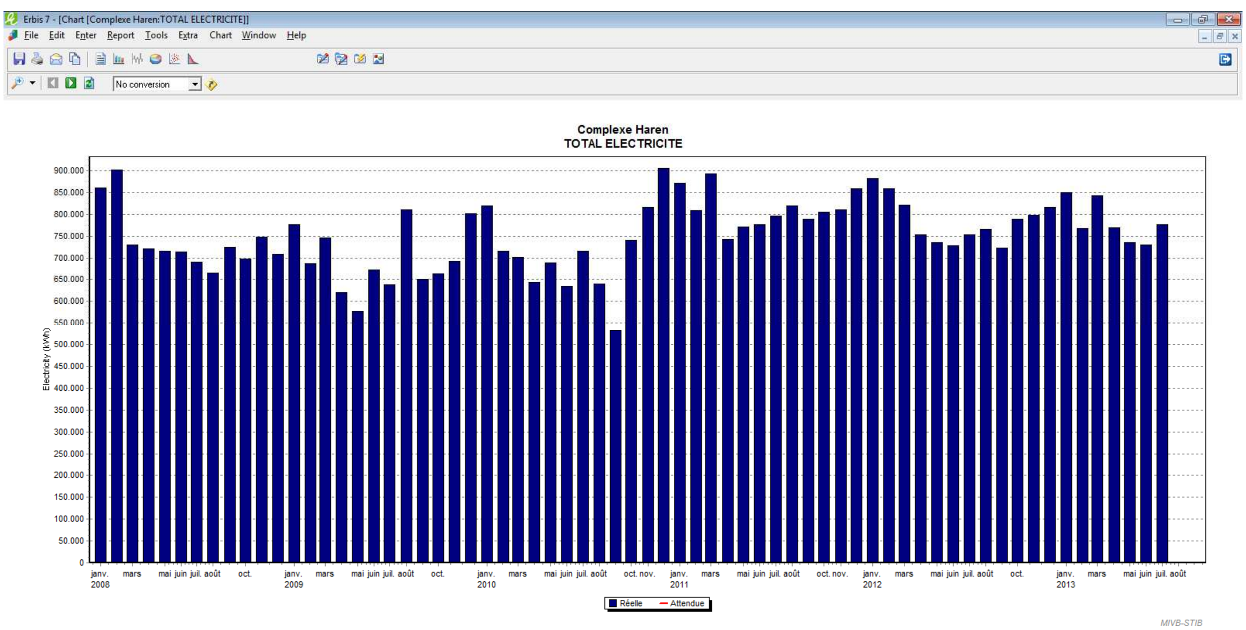


Figure 17 : Screenshots of the ERBIS energy management software

Hence, in the scope of the T2K project, STIB is investing in a new tele-metering system to have a much more granular follow-up of the electricity, gas and water consumption.

4.2 Energy audits

4.2.1 Concept

Most public transport estates such as workshops or depots were inherited from the past and are not efficiently insulated from heat and cold. As a result, it is useful to achieve energy audits to identify the energy losses and what actions are the most effective to undertake in order to reduce the energy consumption.

An **energy audit** is the verification, monitoring and analysis of the use of in an existing building aimed at quantifying its overall energy performance. Energy audits assist industrial companies or facilities in understanding how they use energy and help to identify the areas where waste occurs and where opportunities for improvement exist. Beyond simply identifying the sources of energy use, an energy audit seeks to prioritize actions to improve energy efficiency according to the greatest to least cost-effective opportunities for energy savings. It is therefore a very useful tool for energy managers in order to plan future investments. In many countries, energy audits have become compulsory.

The audit is achieved by recording the characteristics of the building structure including the walls, ceilings, floors, windows, etc. For each component, the resistance to heat flow is measured and the leakage rate or infiltration of air is analysed. This can be strongly affected by the window construction and the quality of door seals. The audit will also assess the efficiency, correct installation and programming of mechanical systems such as the lighting, heating, ventilation, air conditioning equipment and energy management systems (thermostats, sensors, …). Professional and independent auditors will be helpful for delivering energy audits as they require the use of specific equipment: blower door, infrared cameras, … They may also include interviews of the staff to understand its patterns of use over time. It is concluded by the submission of a technical report containing recommendations for improving energy efficiency with cost-benefit analysis and an action plan to reduce energy consumption.

4.2.2 Objectives

- Increase the knowledge on energy consumption
- Estimate potential energy savings actions
- Benchmark similar sites
- Plan and prioritize energy-efficient investments in a consistent way

4.2.3 Implementation

The followings steps should be followed when realizing energy audits:

- Collect all existing consumption data

- Simulate the current energy consumptions
- Highlight the strengths and weaknesses of the building and benchmark performance
- Identify and estimate the potential energy savings for each component
- Evaluate the interest of investing in renewable technologies
- Prioritize potential actions and investments and propose different scenarios

Among the proposed actions, some will be categorized as Quick Wins to be implemented rapidly and offering rapid gains whether others will require larger investments.

Achieving an energy audit of a building requires having an energy manager collecting all relevant data and organising on-site visits for the auditors. The cost for an energy audit of an industrial estate such as a workshop is between 5,000 and 10,000€.

4.2.4 Case studies

4.2.4.1 Energy audits in depots and workshops in Paris (RATP)

In the framework of the « *Grenelle de l'environnement* », French public policy defining key actions for tackling sustainable development issues, it was decided that all public-owned buildings would be subject to an energy audit by 2010. The aim is to reduce energy consumption by 40% and GHG emissions by 50% by 2020. As a public company, RATP had to meet this new regulation and underwent energy audits for all its tertiary and industrial buildings: 32 sites have been assessed in 2012 and the remaining 14 will be assessed in 2013 and 2014.

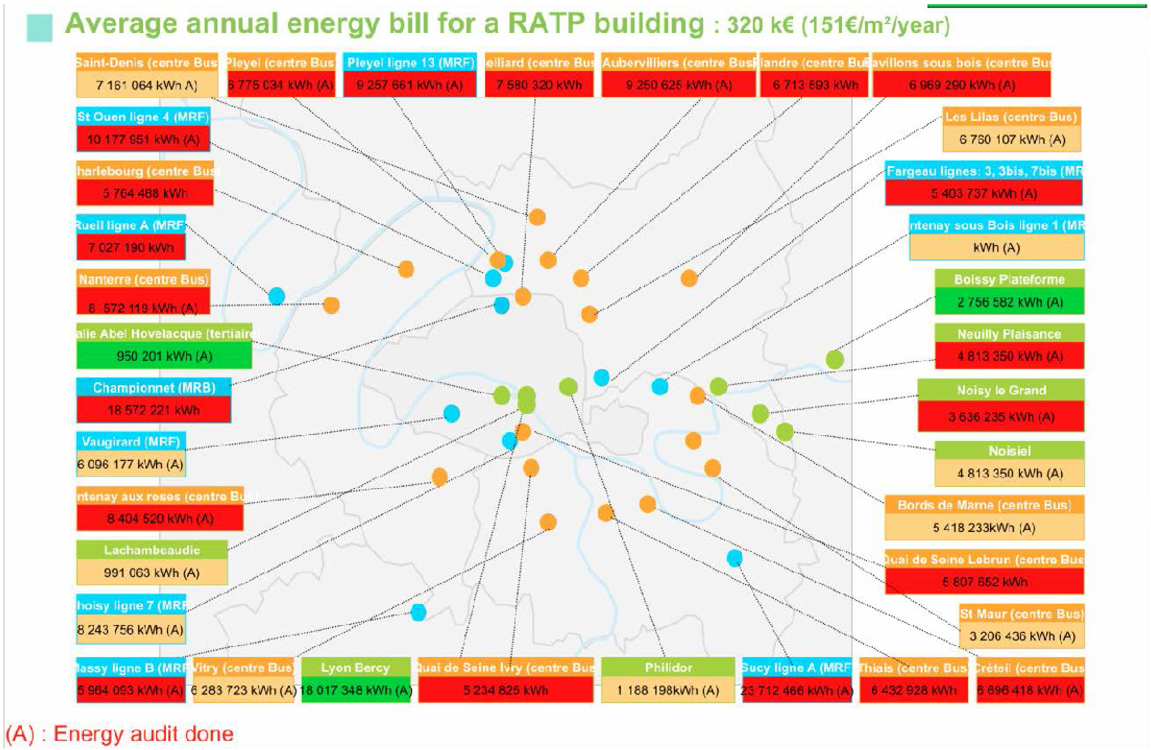


Figure 18 : Benchmarking of the energy performance of the RATP buildings (RATP)

This large investigation made it possible for RATP to have a clear view on the energy performance of its estates and to make useful comparisons between similar sites. The average energy bill for a RATP building amounted to 320.000€ per year with an average cost of 151€/m^2/year. It is also a great tool for monitoring the achievements made in the different buildings. In a previous phase, energy audits have focused mostly on expensive actions that were not relevant for the short-term as they would require additional studies and budgets. As a result, a new analysis framework has been established in order to highlight what measures could be taken in a shorter term. This led to Quick Wins actions regarding heating, cooling and ventilation systems.

The Bords de Marne bus workshop is an interesting case study. This 8.400 m^2 is composed of different buildings (depot, workshop, offices, welfare facilities), each with specific requirements.

Figure 19 : Aerial view of the Bords de Marne bus workshop (RATP)

The energy audit highlighted the following issues:

- The building envelope (walls, ceilings, windows) is not well insulated and measured temperatures
- differ strongly from the programming
- The single-flow ventilation or double-flow ventilation without energy recovery are not efficient
- The openings in the ceiling have a very weak thermal performance and cause important heat
- losses

The analysis of the energy demand all over the day showed that none of the equipments were switched off during the night and the use of infrared cameras pointed out that significant heat losses were occurring. These investigations allowed the auditors to define different scenarios and to decide which targets could be attained. Then an action plan was developed to prioritise the measures. For each action, the annual energy savings, the costs and the payback time were given.

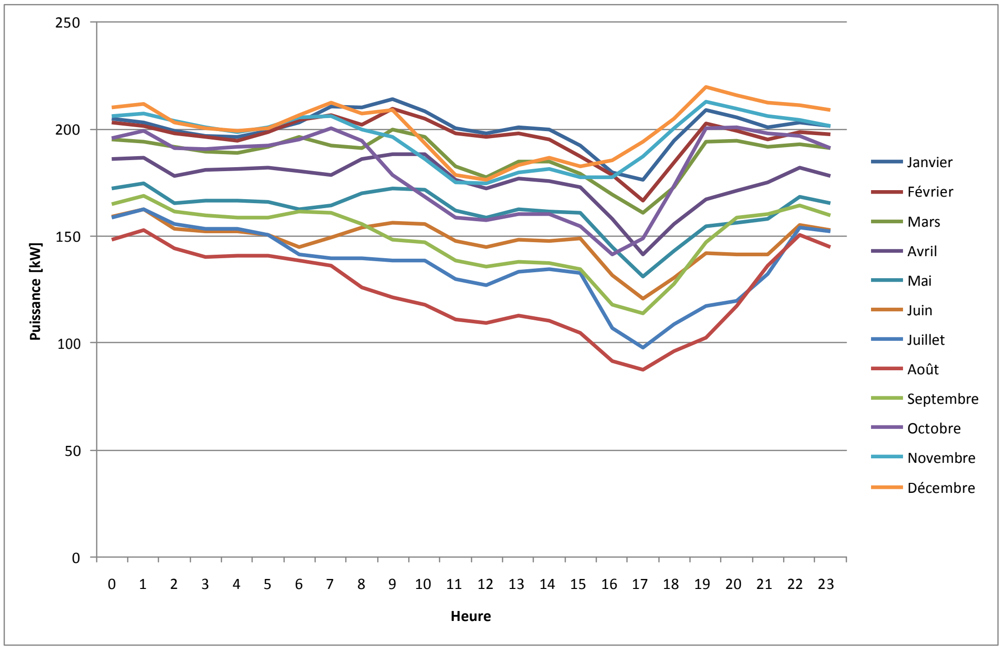


Figure 20 Energy demand analysis of the Bords de Marne bus workshop in Paris (RATP)

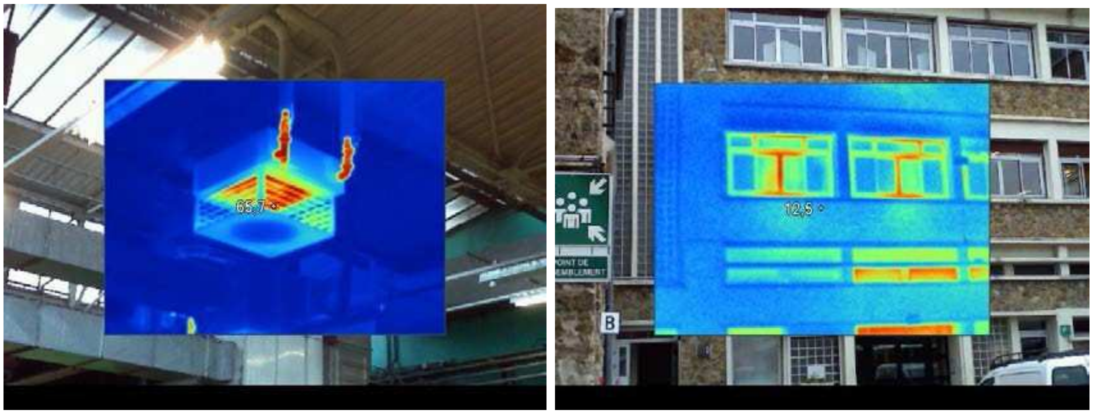


Figure 21 : Infrared camera analysis of the Bords de Marne bus workshop (RATP)

4.3 Energy efficiency evaluation protocol

4.3.1 Concept

Because energy consumption and costs are often “invisible” to all but a very few project managers, a very important question arises when considering energy efficiency projects: *“how can we know that we are really saving energy?”* In many cases, companies have little expertise for correctly evaluating the benefits regarding energy-efficient systems or actions.

It defines standard terms and suggests best practices for quantifying the results of energy efficiency investments and projects. The IPMVP provides a very credible guide to help any project manager verify that savings have occurred and to quantify the impact. The IPMVP Protocol has become the national measurement and verification standard in the United States and many other countries, and has been translated into 10 languages. The **International Performance Measurement and Verification Protocol** (IPMVP) has been published by the Efficiency Valuation Organization (EVO).

The purpose of the IPMVP is to increase certainty, reliability, and level of savings by providing an international, industry-wide approach and a consensus on methodologies. It also provides a basis for negotiating the contractual terms with subcontractors to ensure that an energy efficiency project achieves or exceeds its goals of saving money and improving energy efficiency.

4.3.2 Objectives

- Estimate potential energy savings for energy-efficient systems
- Serve as a decision-aid tool
- Benchmark similar or competing investments

4.3.3 Implementation

Basically the IPMVP provides four options to evaluate energy savings[2]:

1. **Retrofit Isolation - Key Parameter Measurement**: in this option, only the key parameters of the energy efficiency project are measured while the others are assumed.
2. **Retrofit Isolation - All Parameter Measurement**: in this option, all the parameters of the energy efficiency are measured.
3. **Whole Facility**: This option is generally used when energy savings are substantial and the retrofit adjustments are difficult to measure. This requires the use of utility meters.
4. **Calibrated Simulation** – A simulation model estimates the amount of energy used by a facility when there is no data available for the baseline.

[2] www.energyadvantage.com

To make sure that the energy savings evaluation is accurate, changes occurring during the implementation of energy-efficient actions need to be considered in the savings calculation. The IPMVP divides these into Routine Adjustments and Non-Routine Adjustments:

a) Routine Adjustments are the factors expected to change routinely during the reporting period, such as weather, production volume, occupancy etc.

b) **Non-Routine Adjustments** are those factors, which are not usually expected to change, such as facility size, the design and operation of installed equipment, the number of weekly production shifts, or the type of occupants.

The graph below shows the energy savings achieved considering the adjustments to the baseline period.

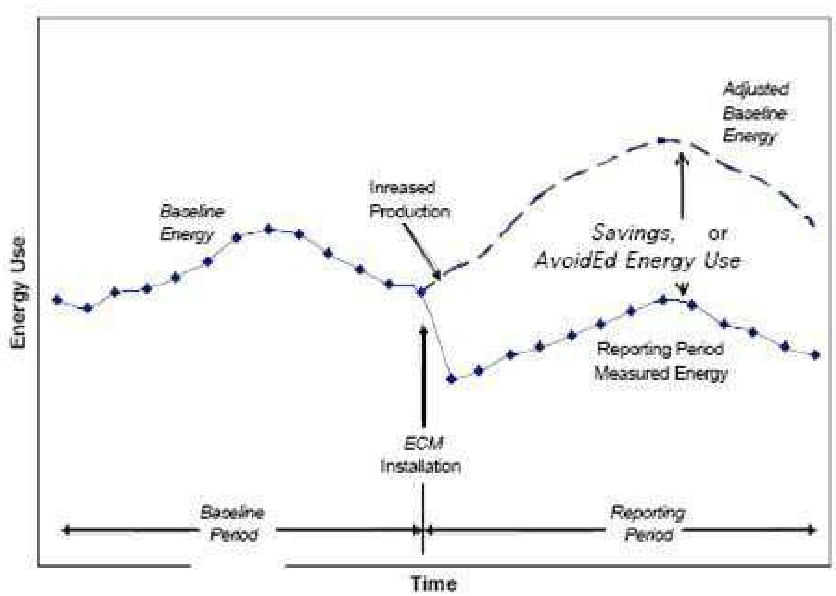


Figure 22 : Evaluation of energy savings based on the IPMVP protocol (Energy Advantage)

Public transport companies can either train some staff to become IPMVP auditor (2-3 days training) or hire an external company. In both cases, the company must have a clear understanding of the consumption data and ways to monitor the consumption on a certain period of time (see section 2.1 about smart metering). Suppliers start integrating this protocol in their commercial bids to make sure a common methodology is used for evaluating the energy efficiency improvements of new systems.

PART II: Implementing Quick Wins

5 Heating, ventilation and cooling (HVAC)

5.1 Adjusting heating systems

5.1.1 Concept

Depots and workshops are large halls required for parking and maintaining public transport vehicles. In order to guarantee a certain level of comfort for the employees, they must be heated during winter. Generally, heating is achieved by the use of radiant gas heaters. However, heating installations are rarely optimized to work only during working hours resulting in a high energy consumption. Properly adjusting the heating systems can strongly impact the energy use of such industrial estate.

Administrative buildings are usually better insulated. Nevertheless, a proper heating adjustment can drastically reduce the energy needs.

5.1.2 Objectives

- Decrease the energy consumption of heating systems
- Reduce air pollution and greenhouse gas emissions
- Reduce maintenance costs by lowering the use of the heaters

5.1.3 Implementation

The first step regarding the optimization of the heating system is to have a good understanding of how the depots and workshops are operated to identify precisely when and under which conditions gas heaters can be switched off or dimmed.

This analysis must then be presented to the staff and the people in charge of the heating system maintenance to define how the system can be optimized without downgrading the operations and/or comfort for staff. Once the time schedule has been defined, the automatic heating monitoring must be adjusted. In case where the system works manually, new heating procedures must be defined and the staff must be regularly informed. It is also very important to have regular contacts with the subcontractor in charge of the maintenance to control that the settings are correctly adjusted.

The cost of this action is relatively low as it will not require any investment. Man-hours must be foreseen for the analysis of the situation and for defining the proper functioning of the heating. A regular control of the equipments must be planned. Some staff resources must also be foreseen for organizing awareness campaigns in the buildings: information sessions, posters, flyers, …

It must be pointed out that the experience of the T2K partners has shown that it is relatively difficult to change the heating comfort in depots and workshops due to different reasons:

- the heating comfort depends from each individual

- staff complains rapidly if the temperature is too low
- air streams due to a poor isolation are critical
- staff can change the settings of manual systems

5.1.4 Case studies

5.1.4.1 Gas heating adjustment in depots and workshops (RET)

The heating installations in the RET depots and workshops used to be operated most of the time without clear strategy for energy efficiency. The gas consumption figures (consumption and billing information) for the years 2006 to 2008 were gathered and analyzed and an enquiry has been made among 10 key persons working in these buildings to identify opportunities and raise their environmental awareness. A plan was then developed to reduce the consumption in the buildings by limiting the use of the gas heaters only during normal working hours on days with temperatures below 15 degrees Celsius. All gas heaters have been adjusted for optimal operation during regular maintenance work of the heating installations, thus requiring no specific budget. The goal of the action was to achieve a 25% saving of gas consumption and this objective has been reached. Information campaigns have been organized for the 600 staff members to make them understand why and how the company wanted to achieve this goal. This action needs to be continually monitored to avoid people returning to their old habits.

Figure 23 : View of a metro depot and workshop in Rotterdam

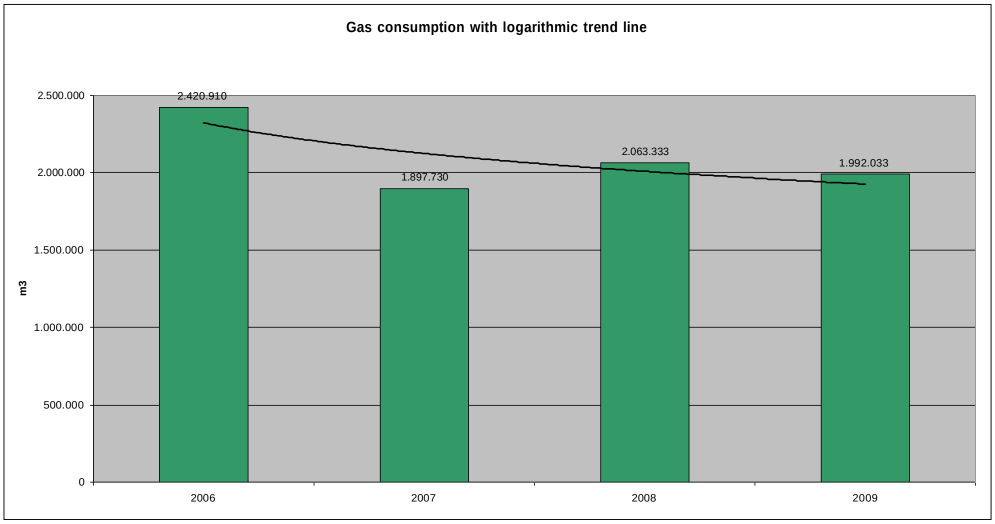


Figure 24 : Evolution of the gas consumption of the RET buildings, expressed in m^3

Note: Gas consumption went up in 2008 and 2009 because of longer and colder winter periods than 2007, but the overall direction is a downward line.

SUMMARY		
Investment	None	
Staff resources	None	Organised during normal maintenance work.
Energy savings (%)	25%	
Energy savings (kWh)	4,665,000 kWh	For seven depots/workshops
Cost savings (€)	200,000€	
Payback time (years)	Less than one year	

5.1.4.2 Optimizing heating system regulation in the RATP headquarters

In its energy policy, RATP made a commitment to respect and to implement the commitments of law "Grenelle de l'environnement": to reduce energy consumption by at least 40 % for the tertiary buildings. The RATP headquarters, with a 56,000 m² surface and 2,600 persons working there, was the highest energy-consumer site of RATP.

Figure 25: View of the RATP headquarters

RATP decided to optimize the heating system regulation by choosing a set point temperature according to occupational constraints, the installation of electricity meters and regular analysis of the consumption. No complaints were received due to thermal discomfort. About 7 persons of the facility management team worked on the project.

The savings were well above expectations with 4,000,000 kWh, 360 teq CO_2 and 290,000€ saved in one year. The measured return on investment is 2 years.

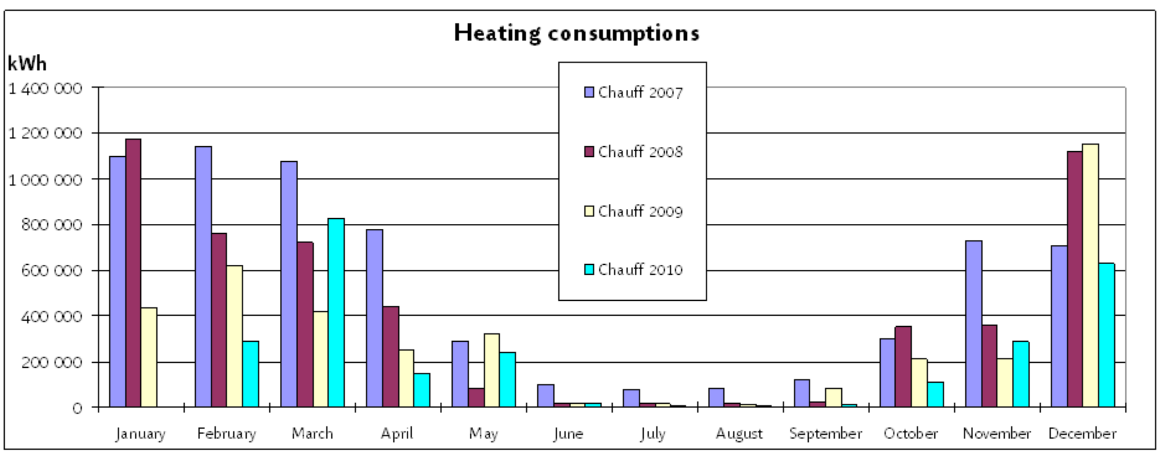
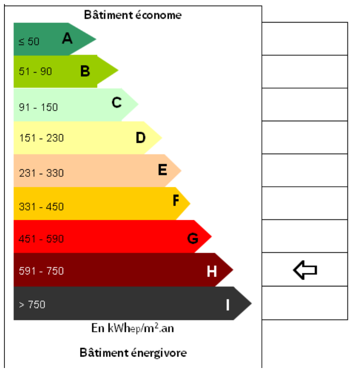
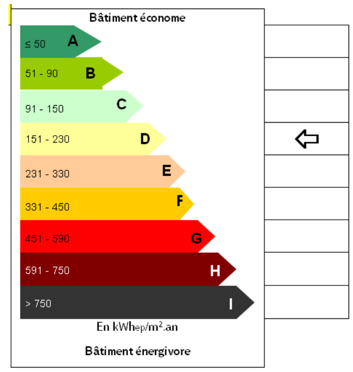


Figure 26: Evolution of the heating consumption in the RATP headquarters

The results were converted to allow an evaluation in the French Energetic Performance Diagnosis. The building was rated at the H level (580kWhep/m²/year) before implementation and is now at the D level (250kWhep/m²/year).

DPE 2007 : 

DPE 2010 : 

SUMMARY	
Investment	None
Staff resources	7 EFT during several months
Energy savings (%)	55%
Energy savings (kWh)	4,000,000 kWh
CO_2 emissions avoided (tons)	360 TCO_2
Cost savings (€)	290,000 €
Payback time (years)	2 years

5.2 Controlling ventilation in depots and workshops

5.2.1 Concept

Ventilation must be ensured in bus depots and workshops to make sure that gas exhausts are correctly evacuated outside of the building to prevent poisoning of the staff. This is particularly critical at peak times where most buses leave or enter the depot facilities, especially with a cold engine in the morning. Depots and workshops are usually fitted with an automatic ventilation system composed of extractors controlled by automatic timers. Traditionally, ceilings are also equipped with manual openings in the case where the ventilation system is out of order. Unfortunately, ventilation systems are often not well configured so that important energy and heating losses can occur.

5.2.2 Objectives

- Decrease the energy consumption of ventilation extractors
- Decrease heating needs and the subsequent energy consumption
- Reduce air pollution and greenhouse gas emissions
- Reduce maintenance by lowering the use of the ventilation extractors
- Improve human health and comfort by reducing heat losses and air currents.

5.2.3 Implementation

The first step regarding the optimization of the ventilation is to have a good understanding of how the depots and workshops are operated to identify where and when it is possible to modify the way extractors work. In most cases, ventilation could be switched off when maintenance activities are not operated in the building i.e. at night and during the weekend.

This analysis must then be presented to the staff and the people in charge of the ventilation system maintenance to define how the system can be optimized. Once the time schedule has been defined, a specific timer can be added to the installation or the settings of the system can be adjusted. As far as openings in the ceiling are concerned, a user manual must be made available that defines precisely when those openings can be opened. A control system can also be implemented to warn when openings remain open when unnecessary. The awareness of the people working in these buildings will be of uttermost importance as their involvement will be key to success.

The budget for this action is relatively low. Some man-hours must be foreseen for the analysis of the situation and for defining the proper functioning of the ventilation. A regular control of the equipments must be planned. Some man-hours must also be foreseen for organizing awareness campaigns in the buildings: information sessions, posters, flyers, …

5.2.4 Case studies

5.2.4.1 Switching off ventilation in bus workshops in Paris (RATP)

RATP has several bus depots and workshops where ventilation was functioning permanently. Moreover, openings in the ceiling were often left open even in winter leading to significant heating losses and subsequent energy consumption.

The analysis showed that switching off the ventilation system would only be possible during the weekend from Friday 11.00 p.m. until Sunday 11.00 p.m. as during the night, staff is working in three shifts.

It is difficult to show the specific results related to the optimization of the ventilation due to the fact that these measures have been taken simultaneously to others such as modifying heating settings and improving the insulation of the building. Between 2009 and 2010, several measures were taken to reduce the energy consumption of several bus and tram workshops: switch-off of ventilation during the weekend, less heating in the weekend, adapting the temperature for each area according to the staff's needs (warmer in offices than in the workshop).

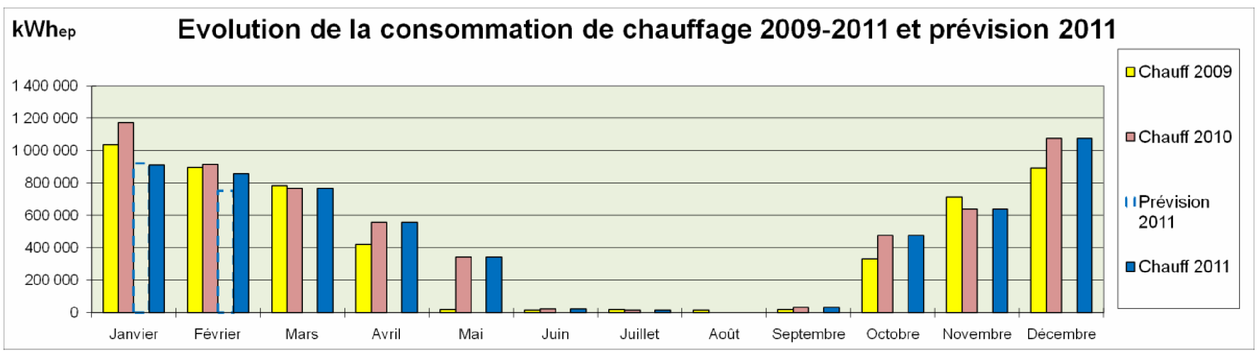


Figure 27 : Evolution of the heating consumption in the workshop Saint-Denis (RATP)

Although optimizing the ventilation system appeared as an efficient solution for reducing the energy consumption, workshops' managers showed little enthusiasm for making efforts, as they would not benefit directly from these energy savings. Another obstacle was to impose new rules to the subcontractors in charge of maintaining the equipments, as it was not defined in the original tender.

5.3 Investing in automated fast-closing doors

5.3.1 Concept

Depots and workshops are industrial sites where public transport vehicles (buses, trams, metros) and technical vehicles must enter and leave the building several times across the day. Most of the time, the door remains open once the vehicle has left and must be closed manually.

5.3.2 Objectives

- Decrease heating and air-conditioning needs by avoiding heating losses caused by inappropriate ventilation
- Reduce air pollution and greenhouse gas emissions
- Improve human health and comfort by reducing heat losses and air currents.

5.3.3 Implementation

The installation of fast-closing doors enables to reduce the time needed for opening and closing the doors so that the loss of heat in the maintenance hall can be significantly reduced. A sensor detects metal in front of the door and opens automatically. After driving in/out of the hall a second sensor on the ceiling measures the length of the vehicle and closes the doors directly after the end of the vehicle.

The installation of a folding gate is more complex than a rolling gate (sectional door) but require less maintenance of the mechanical parts. Fast-closing doors can be implemented in any maintenance hall but require to have a compressed-air supply. In the case of trams, it must be pointed out that specific systems must be used due to the catenary. Once the doors have been replaced, no further action is required.

Besides reducing the heating and cooling needs, such an initiative can also avoid additional manual work related to the opening and closing of the doors.

5.3.4 Case studies

5.3.4.1 Folding gates in the bus workshop (moBiel)

moBiel bus workshop has manual doors (rolling gates) that must to be opened and closed manually every time a bus has to leave or enter the facility. Most of the time, the doors remain open unless someone closes them manually. The aim of the project was to reduce the energy costs by minimizing the loss of warm air (in winter) and cold air (in summer) escaping out of the depot. The doors have been fitted with an automatic system to enable a fast closing of the doors.

moBiel started a test with a fast-closing door in the maintenance hall. The door was also fitted with double-glazed windows, thus providing better insulation.

The installation of the folding gate revealed to be complex and mobilised 2 persons during 2 days to remove the old door (made by moBiel) and 2 persons during 2 days for installing the folding door (made by an external company).

Figure 28 : View on the moBiel bus workshop entrance in Bielefeld

The advantage of the new system is definitely the short opening and closing time of 5 seconds, in comparison with previous rolling gate requiring around 20 seconds. As a result, warm losses can be significantly reduced. The maintenance of the new door is lower as moBiel checks the door on an annual basis whereas the conventional doors required inspection twice each year. In addition, because of the mechanical parts (rolls, springs, tows etc) the maintenance work for the rolling gates is quite high.

Energy savings can hardly be quantified at this stage due to the fact that only one door is currently installed. moBiel decided to fit all the doors with fast-closing systems so that figures can be obtained when all the doors will have been replaced.

Due to their large size, these doors are custom-made products. The price is around 23,000 € per door

SUMMARY	
Investment	23,000/door
Staff resources	4 working days/door

5.3.4.2 Automatic gates in workshops (STIB)

STIB is progressively replacing manual doors by automatic gates in its workshops. Every time a vehicle is detected, the gate opens and closes automatically. It is difficult to measure the proper savings of this action but based on theoretical calculations, the savings of one system could go up to 20,000 kWh/year accounting for cost savings of around 1000€/year.

5.4 Insulation and green roof

5.4.1 Concept

In summer, when temperatures are high and the sun is shining, the rooftop of buildings can become very hot thus increasing the global temperature inside. In order to keep a comfortable temperature for workers, HVAC systems are used for air-conditioning purpose. But those equipments consume a high amount of energy. The same happens during wintertime where the roof can get very cold and impact on the temperature inside of the building.

A green roof is a vegetative layer grown on a rooftop. Green roofs provide shade and remove heat from the air through evapotranspiration, a physical process that lowers temperatures of the roof surface and the surrounding air by using heat from the air to evaporate water. On hot summer days, the surface temperature of a green roof can be cooler than the air temperature, whereas the surface of a conventional rooftop can be up to 50℃ warmer.

The placement of green roof will also be the occasion to optimize the insulation properties of the roof.

5.4.2 Objectives

- Decrease the energy consumption
- Remove air pollutants and greenhouse gas emissions through dry deposition and carbon sequestration and storage
- Improve human health and comfort by reducing heat losses and air currents.
- Enhance water management by slowing stormwater runoff in the urban environment
- Improve water quality by filtering pollutants from rainfall.
- Improving quality of life by providing aesthetic value and habitat for many species.

5.4.3 Implementation

Green roofs can be installed on a wide range of buildings, from industrial facilities to offices. One can distinguish extensive green roofs that are shallow, composed of rocky and dry vegetation and more lightweight from intensive green roofs that are deep, composed of flowering plants and/or flowers and requires a specific irrigation system to keep the roof from getting waterlogged. Modular systems can greatly lower the cost of installing a green roof but will require structural reinforcement. In general, flat roofs are easier to implement than sloped ones.

While the initial costs of green roofs are higher than those of conventional materials, public transport companies could be able to offset the difference through reduced energy and stormwater management costs, and potentially by the longer lifespan of green roofs compared with conventional roofing materials.

Type	Estimated costs
Extensive green roof	15 – 60 €/m^2
Intensive green roof	60 – 120 €/m^2

5.4.4 Case studies

5.4.4.1 Green roof at the RATP headquarters in Paris (RATP)

The roof of the headquarters building of RATP was originally isolated in 1995. Following an energy audit, the company found out that HVAC was responsible for 8% of the total energy consumption of the building. It was then decided to place a green roof when conducting the renovation works of the roof after 15 years. The extra cost amounted to 100.000€ and the energy consumption has been reduced by around 25%, with cost savings of 12,500€ per year.

Figure 29 : Green roofs on RATP headquarters building, Quai de la Râpée – RATP

SUMMARY		
Investment	100,000€	
Energy savings (%)	25%	
Energy savings (kWh)	97,000 kWh (heating) 108,000 kWh (air conditioning)	Energy savings for the floor below the green roof
Cost savings (€)	12,500€	
Payback time (years)	Around 8 years	Lifetime of a green roof is 15-20 years

5.4.4.2 Green roofs on metro stations in Rotterdam (RET)

RET has installed a green roof on several metro stations in Rotterdam. No specific measures are available regarding energy consumption. The project aimed also to improve the visual aspects of the buildings.

Figure 30 : Green roof on metro stations in Rotterdam (RET)

A University of Michigan study compared the expected costs of conventional roofs with the cost of a green roof and all its benefits, such as stormwater management and improved public health from the absorption of nitrogen oxides. The green roof would cost 360.000€ to install versus 260.000€ for a conventional roof. However, over its lifetime, the green roof would save about 150.000€. Nearly two-thirds of these savings would come from reduced energy needs for the building.

6 Lighting

6.1 Lighting control systems

6.1.1 Concept

In many places such as stations, interchanges or workshops, lights can be switched off where and when there is sufficient natural light. However most traditional systems were not configured to react dynamically to adapt the lighting power over the day.

Lighting control systems are simple and cost effective and are widely used on both indoor and outdoor lighting of commercial, industrial, and residential spaces to provide the right amount of light.

6.1.2 Objectives

- Decrease the energy consumption
- Reduce air pollution and greenhouse gas emissions
- Lengthen the lifetime of the devices by reducing their daily use
- Reduce maintenance by lowering their use.

6.1.3 Implementation

Lighting control systems are of different types and their choice will depend from every location:

- **Occupancy control** consists in using a sensor to determine when people are in the vicinity, and reduce or eliminate unnecessary lighting if areas are empty.
- **Daylight responsive control uses** photosensors that assess the amount and quality of natural daylight in a particular space. When natural light is sufficient, artificial lighting can then be reduced.
- **Time clock control** allows for the automatic control of lighting depending on the time of day (or night). Time clock control ensures that lighting levels are automatically set correctly for the coming time period. The settings can be based on a time of the day or on the astronomical time (sunrise/sunset).

As an example, the following table indicates the lighting control systems used in TfGM estates in Manchester:

Location	Occupancy Controls	Daylight Controls	Time Controls
Office	√	√	
Meeting room	√	√	
Toilet	√		
Corridor and stairwell		√	√
Kitchen and canteen	√	√	
Server room	√		
Ticket office	√	√	
Bus stand		√	√
Travel shop			√
Retail shop			√
Waiting areas		√	√
Car park and external areas		√	√

One critical aspect regarding switching off some lights during daytime or night time is that lighting must be kept at a certain level to make sure security cameras (CCTV requirements) are working properly. This needs to be addressed to get the full benefit of the controls.

The placement of lighting controls requires switching off electricity in the estate for security purposes. A good planning must be foreseen as the works will have to be undertaken during the night and many actors will need to get involved: technical staff, security services, … All lighting power supplies shall be derived from dedicated lighting distribution boards provided with a sub-meter that can be connected to a Building Management system (BMS) and/or monitoring and targeting system.

It should be kept in mind that lighting controls are not always a good investment for minor locations as the payback times may be long. Training people to turn lights off whenever necessary remains the most cost effective solution in those situations.

6.1.4 Case studies

6.1.4.1 KYOLIGHT project – Switching off lighting in metro stations during the night (STIB)

Due to the low energy costs in the eighties, the lighting in the metro stations was not switched off during the night. The KYOLIGHT project consisted in switching off the operational lighting in 20% of the metro stations of the metro lines in Brussels (representing 17% of the potential savings). A workgroup has been established to identify what were the constraints related to the project and how they could be eased in order to reduce the lighting needs when the stations are not in service. It has been decided to match the lighting switch off with the automatic closing of the gates, i.e. between approximately 1am and 4.30am. This did not require any specific equipment but a close cooperation between maintenance and security services within the company. Extra staff costs amounting to 1200€ were necessary for programming the lighting system of the network.

The project also highlighted that some lighting equipment was not correctly wired to the main power circuit. This enabled STIB to control all the power circuits in the stations and to repair some failing equipment. This was managed during the planned maintenance of the lighting systems. Given the security rules, the minimum lighting level of each station had to be checked before approval.

The energy savings for the pilot sites amounted to an average of 11,650 kWh per month resulting in cost savings of 980€ and CO_2 savings of 2,65 tCO_2. This represents some 9% of the energy consumption of a metro station. This pilot project has been a clear success and all metro stations have now been equipped with the automatic switching system with energy savings estimated to 1.560.000 kWh annually.

SUMMARY		
Investment	None	
Staff resources	1.200€	Programming the lighting system of the network
Energy savings (%)	9%	
Energy savings (kWh)	1.560.000 kWh	When implemented in all stations
CO_2 emissions avoided (tons)	246 tCO_2	
Cost savings (€)	125,000€	
Payback time (years)	Less than one year	

6.1.4.2 Lighting control in the Shudehill interchange in Manchester (TfGM)

TfGM improved the lighting controls of the Manchester shudehill interchange composed of a tram stop, bus-station and a car park. TfGM installed a range of lighting controls, including photocells, timeclocks and passive infra-red (PiR) controls. These were installed following site energy audits, which identified the most suitable types of controls and the corresponding energy savings. The project allowed some 10% reduction of the lighting energy over a year, with peaks above 20% on specific days. No other major energy saving initiatives were done at this site during this period so the reductions can be attributed almost entirely to the lighting control system. TfGM achieved the biggest reductions during the summer months. This may seem counter-intuitive as you usually use less lighting in summer, however the old system was so faulty that the lights were always on when they shouldn't' have been, which means greatest reductions in the summer, when the lights will be turned off for even longer than in winter.

SUMMARY		
Investment	16,500€	
Energy savings (%)	10%	Estimation based on 6 months.
Energy savings (kWh)	150,000 kWh	Estimation based on 6 months.
CO_2 emissions avoided (tons)	82 TCO2	
Cost savings (€)	8,800€	3,500€ extra savings for maintenance
Payback time (years)	2 years (energy costs alone)	1.4 years if maintenance costs savings are taken into account

6.1.4.3 Lighting (and HVAC) optimization of metro service areas in Rotterdam (RET)

RET has carried out a pilot project in the Stadthuis metro service area, a room where metro staff can work, organize meetings or simply rest or have lunch. The project consisted of an integrated approach aiming at reducing the energy consumption of the room. The original lighting was replaced by LED's because they are more energy efficient, generate fewer disposals and require less maintenance. The rooms are also equipped with occupancy sensors switching off the lights when no one is inside and simultaneously reducing the heating. This project delivered exceptional results as the new installation saves about 76% of the energy use compared to the old installations. The maintenance cost are also expected to be much lower because the lighting has a much longer life expectancy than the old TL8 light sources and the HVAC system only operates at full power when needed.

Figure 31 : Views of the Stadhuis metro service area (RET)

SUMMARY	
Investment	15,000€
Energy savings (%)	75%
Energy savings (kWh)	3,300 kWh (lighting) 26,000 kWh (HVAC)
Cost savings (€)	2,500€
Payback time (years)	6 years

6.2 Relighting

6.2.1 Concept

Many public transport companies operate old estates (depots, workshops, stations) with inefficient lighting, which has as strong impact on the energy efficiency due to the long operational hours of such buildings. Relighting consists in replacing and/or optimizing the lighting systems of a building. More energy-efficient lighting technologies have come to the market. LED technology especially is improving rapidly and now offers genuine opportunities for significant further savings, both in terms of energy and cost. However, it remains an emerging market, with relatively high product costs and variable product quality.

6.2.2 Objectives

- Decrease the energy consumption by the use of more efficient lighting devices
- Reduce air pollution and greenhouse gas emissions associated to the production of electricity
- Lengthen the lifetime by investing in long-lasting equipment
- Reduce the maintenance costs by investing in low-maintenance technologies.

6.2.3 Implementation

Public transport operators have several opportunities for replacing old lighting equipments by more energy-efficient technologies such as LED lighting. Retrofitting outdated lighting components with energy-saving alternatives promotes sustainability and offers significant benefits. Not only can relighting improve the overall quality and functionality of light, it also can make spaces safer, easier and less costly to maintain, and more comfortable to work or stay.

6.2.4 Case studies

6.2.4.1 Relighting of the main station in Bielefeld (moBiel)

The periodic maintenance of the former existing lighting installation at the underground station Hauptbahnhof (main station) in Bielefeld was extremely intensive. The Plexiglas's body with screws and bolts had to be opened and the inner lamp unit loosened from its screwed position to do the maintenance or to be repaired. The action consisted in replacing the old lighting (160W per unit) by new fluorescent lamps (108W per unit). In doing so, there are two positive effects: firstly, the maintenance rate is extended from 2 to 4 years and secondly there is a better light efficiency, which leads to energy reductions. The replacement of the lamps took place during normal maintenance work without interrupting the operations in the station.

The budget for relighting amounted 25,500€ (464 per unit – 55 units). The project enabled energy savings of 21,000 kWh resulting in a 3,000€ cost reduction.

SUMMARY		
Investment	25,500€	Replacement of 55 lamps
Staff resources	None	Done during normal maintenance work.
Energy savings (%)	32,5%	
Energy savings (kWh)	21,000 kWh	
CO_2 emissions avoided (tons)	11 TCO_2	

Cost savings (€)	3,100€ (energy savings) 2,250€ (maintenance savings	
Payback time (years)	5 years	

6.2.4.2 Installation of LED lighting in bus stations in Manchester (TfGM)

Following the success of small trials of LED lighting products delivering savings above estimates, TfGM decided to undertake a larger scale trial installation and replaced the traditional lighting at the Hyde bus station with LED lighting. Only internal high-level lighting was replaced as decisions were made based on which products offered the greatest return on investment and the total budget available of around 35.000€

The LED's were installed at the end of March 2011, so the savings over the financial year can be attributed entirely to the LED's. Based on a comparison between 2010 and 2011, the total energy consumption has been reduced by 20% on average over the months since the system was installed and fully commissioned. Energy savings amount to 30,000 kWh and costs savings amount to 3,650€, however lighting maintenance costs savings will also be achieved, estimated at 6,000€/year. The total payback time is likely to be 3,7 years.

Figure 32 : Energy savings with LEDs at Hyde Bus Station

SUMMARY	
Investment	35.000€
Energy savings (%)	20%
Energy savings (kWh)	30,780 kWh
CO_2 emissions avoided (tons)	16 TCO_2
Cost savings (€)	3,650€ for energy savings +/- 6,000€ for maintenance
Payback time (years)	3,7 years

7 Vehicles

7.1 Bus and corporate fleet ecodriving

7.1.1 Concept

Due to inappropriate driving behaviours, bus and corporate vehicles drivers consume more fuel than they should, resulting in higher energy expenditures for the company. Ecodriving means smarter and more fuel-efficient driving. It requires strong behavioural changes that can only be obtained by training people and raising their awareness about the benefits linked to a more sustainable way of driving.

7.1.2 Objectives

- Decrease the energy consumption
- Reduce greenhouse gases emissions and local pollutants
- Decrease noise and vibrations
- Improve driver and passengers comfort
- Lower vehicle maintenance costs
- Improve road safety

7.1.3 Implementation

Ecodriving is a training used for improving drivers awareness of their driving behaviour and thus for improving their driving style. The use of a display indicator is recommended as it gives drivers information about their driving behavior in "real time" in order to help them improve their driving style. It also enables the company to monitor the driving style and the fuel consumption of each vehicle.

The following steps should be followed:

- Train a trainer inside the company or hire a professional trainer
- Define a training plan for the drivers (theory and practice sessions)
- Install specific metering equipment on some vehicles for training purpose
- Communicate on the ecodriving programme and its objectives
- Evaluate the interest among the drivers after the training
- Motivate the drivers on the long term and give a feedback on the global fuel savings
- Evaluate the costs and benefits of equipping all buses with an ecodriving display indicator

The telematics system can be easily removed and installed to another vehicle in the case of fleet replacement.

7.1.4 Case studies

7.1.4.1 Ecodriving on the bus network in Bielefeld (moBiel)

The project of the ecodriving program was to make bus driving more fuel-efficient and to improve road safety. Since 2006, a one-day training has been organized for each of the 300 bus drivers. Two buses have been fitted with a dedicated ecodriving equipment to collect data on the driving style of the trained drivers.The training course started with a theoretical session for 5-6 drivers explaining what were the key points for reducing fuel consumption. The following aspects were explained during the course:

- to analyse and explain the consumption curves of the motor
- to understand the after-treatment of exhaust gases
- to achieve economic relations between speed and the transmission gear
- to know the physical laws and limits of the vehicle
- to optimise the fuel consumption of the vehicle.

Then a practical session with a bus, fitted with an ecodriving display indicator, showing the driver the impacts of his driving behaviour on the vehicle consumption. An external company was commissioned to prepare the training presentation and the training sessions have been organized internally.

moBiel found out that it was not possible to check the individual driving style of the bus drivers after the training because not all the buses were equipped with the evaluation equipment. moBiel intends to repeat the training sessions and to keep an eye on the fuel consumption in regard with kilometres driven each year.

SUMMARY	
Investment	1.800€ / course
Staff resources	Staff for obligatory driver qualification
Fuel savings (%)	10%
Fuel savings (liter)	252.000 liters
CO_2 emissions avoided (tons)	660 TCO_2

Cost savings (€)	3.500€/bus

7.1.4.2 Ecodriving on the bus network in Brussels (STIB)

STIB implemented an ecodriving program for its bus fleet. It consisted in equipping the buses with a display indicator showing the driver the best driving behavior and in a training to teach them the proper way of driving and the way to use the indicator. The indicator gives drivers information about their driving behavior in "real time" in order to help them improve their driving style, warning them systematically for exceeding preconfigured settings. It provides audio and visual warnings on the behavior, as if there was a virtual instructor permanently present in the driver's cab. The visual and auditory signals attract the attention of drivers on speeding, over-revving, brutal acceleration, sudden braking and excessive idling. The use of such an indicator drastically reduces the number of abnormal behavior of each driver, resulting in a reduction in fuel consumption, increase efficiency drivers, improved passenger comfort, reduced wear parts, reducing the number of accidents and lower CO_2 emissions.

All events related to the vehicle and driver are stored in the onboard computer and sent to a hosted server through the GPRS network. A web application provides access to data relating to the vehicle and driver, for purposes of analysis.

R: Over-revving

I: Excessive idling

B: Sudden braking

A: Brutal acceleration

S: Speeding

Figure 33 : RIBAS ecodriving display indicator (SAFIR)

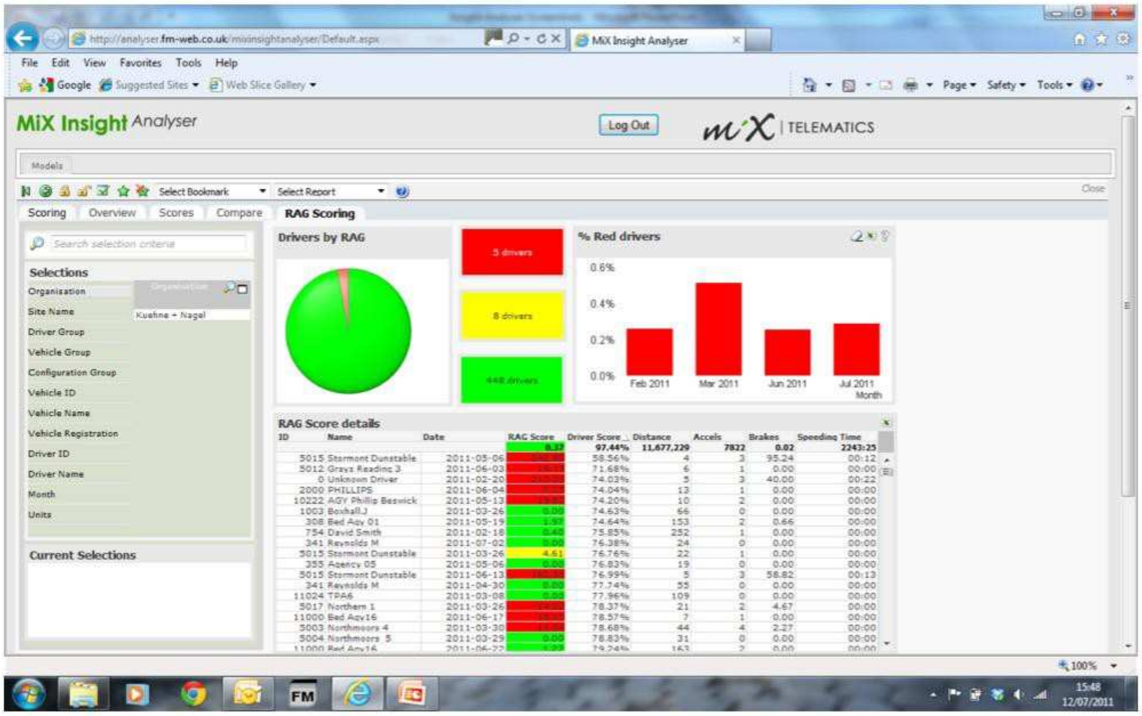


Figure 34 : Mix Insight web application for analysing the drivers behaviour (Mix Telematics)

During the pilot phase, STIB has been able to reduce the bus fleet consumption by 5% resulting in fuel savings of around 500.000 litres annually allowing a cost reduction of around 500.000€. Based on these results, the payback time of investing in ecodriving equipment and training is around two years.

SUMMARY	
Investment	300,000€
Fuel savings (%)	5%
Fuel savings (liter)	500,000 litres
CO_2 emissions avoided (tons)	1,500 TCO_2
Cost savings (€)	500,000€
Payback time (years)	2 years

7.1.4.3 Optimizing the corporate fleet vehicles use in Manchester (TfGM)

Learning from the T2K partners, TfGM has taken numerous steps to reduce its corporate fleet energy consumption and carbon emissions. As TfGM does not operate any transport, this relates to TfGM's fleet of technical vehicles only and not the wider bus fleet. TfGM has around 150 corporate vehicles used by technical staff to look after the public transport network facilities. TfGM has implemented different actions to optimize the fleet use.

The procurement of a software to track the vehicles and to monitor their consumption led to a 15% fuel savings with no training but communication campaigns. The telematics system is a logger installed in the vehicles. This enables the fleet team to instantly view fuel and driving data. The system has been used to see which vehicles were the most inefficient and polluting and how frequently vehicles were utilised. A decision was taken to get rid of some vehicles which had the highest costs and emissions, based on the data available. This also allowed the cut of unnecessary fuel usage by staff like going to a shop. TfGM also developed a driver handbook that outlines what is expected of drivers including maintenance and driving style. This has been communicated to all fleet users using "toolbox talks" and a seminar.

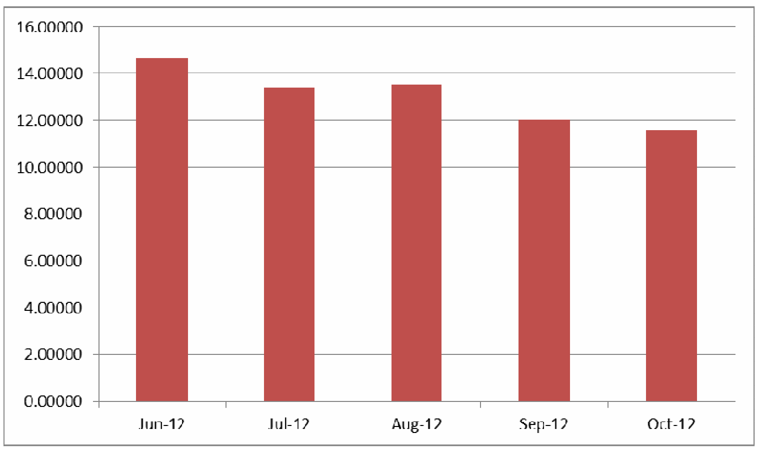


Figure 35 : TfGM corporate fleet consumption evolution in 2012

Vehicle	Vehicle Type	Fuel Type	Performance Against Monthly Target %	Performance Against YTD Target %	Monthly Rank	Yearly Rank
PN54 OUA	Transit	Diesel	-1.00	-0.89	1	1
PN54 ZDF	Transit	Diesel	-0.99	-0.62	3	2
PJ03 FXA	Transit	Petrol	-1.00	-0.56	1	3
MJ58 URR	Transit Connect	Diesel	-0.72	-0.51	5	4
MJ58 URO	Transit	Diesel	-0.44	-0.37	7	5
PJ03 FWU	Transit	Petrol	-0.77	-0.35	4	6
PN54 ZDK	Transit	Diesel	-0.29	-0.35	13	7
PN54 ZDA	Transit	Diesel	-0.30	-0.35	12	8
MJ58 URY	Transit	Diesel	-0.50	-0.34	6	9
V427 EVM	Seat Alhambra	Diesel	-0.22	-0.31	15	10
MJ54 AVG	Toyota Prius	Hybrid	-0.36	-0.24	9	11
PN54 ZCO	Transit	Diesel	-0.34	-0.07	10	12
PE54 HGX	Transit	Diesel	0.06	-0.05	19	13
PE54 HGJ	Transit	Diesel	-0.07	-0.04	16	14
MV07 POA	Transit	Diesel	-0.42	-0.04	8	15
MV07 POF	Transit	Diesel	0.14	-0.03	21	16
MJ58 URS	Transit Connect	Diesel	-0.31	-0.03	11	17
MF07 TUV	Transit	Diesel	0.31	-0.02	22	18
PN54 ZDR	Transit	Diesel	0.48	-0.02	23	19
MT56 KCO	Transit Connect	Diesel	-0.24	0.02	14	20
PJ55 UOL	Transit	Diesel	-0.03	0.04	17	21
MT56 KHB	Transit Connect	Diesel	0.07	0.08	20	22

Figure 36 : TfGM corporate fleet results

SUMMARY		
Investment	14,000€ 7,200€	Cost of telematics Annual software costs
Fuel savings (%)	13,5%	15% savings expected in the long term (further actions still being progressed)
CO_2 emissions avoided (tons)	40TCO_2	
Cost savings (€)	11,500€	
Payback time (years)	3 years	

7.2 Rail vehicles ecodriving

7.2.1 Concept

Most tram and metro vehicles have been designed with a top speed, which network operators want to reach during operation for minimizing the journey times. However, the design of older vehicles often did not take into account the energy consumption required for attaining this top speed. This is especially useless when the distance between stations is short due to the fact that the vehicle will be accelerating to a high speed right before braking.

7.2.2 Objectives

- Decrease the energy consumption
- Reduce greenhouse gases emissions and local pollutants
- Improve driver and passengers comfort
- Lower vehicle maintenance costs
- Allow flexibility for catching up a short delay

7.2.3 Implementation

Technical preparation

The first step consists in running simulations to investigate the consumption of the metros at various speeds. Then the potential delays on the metro network resulting from the ecodriving scheme must be assessed. These two investigations are decisive to decide whether this action can reduce the energy consumption while keeping a sufficient quality of service. Then it is necessary to adapt the metro regulation software to integrate the ability to set parts of the network in ecodriving mode and install the appropriate signalling in tunnels to inform drivers about their driving conditions.

It is recommended to have a metro regulation system, which can be tuned to add new constraints. It is also useful to have a sufficient number of metros to add extra vehicles in order to compensate for the small decrease in metro speed.

Training program

Once the infrastructures are adapted, the metro drivers have to be trained to understand how to adapt their speed when seeing the “Ecodriving” signal in the tunnel. This short training will be ideally integrated into the drivers’ annual training. This training is a good opportunity to raise the awareness of the drivers on the goal followed by the company in terms of energy savings.

7.2.4 Case studies

7.2.4.1 Ecodriving on the metro network in Brussels (STIB)

This ecodriving project started at STIB in 2008 and consisted in training the metro drivers, installing a new signaling and enhancing the metro network analysis tools. The program consists in limiting the maximum authorized speed of metro vehicles to 60 km/h instead of 72 km/h (high speed) and 50 km/h instead of 60 km/h as depicted by the figure below.

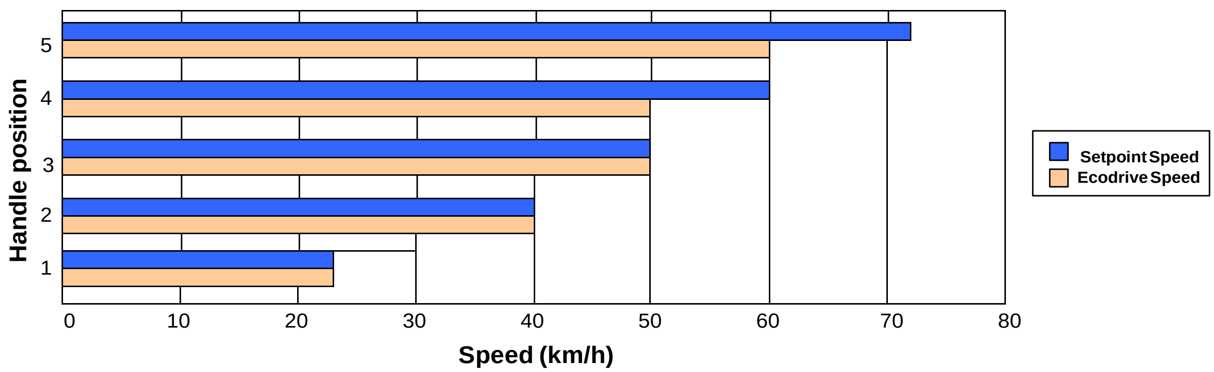


Figure 37 : Authorized speeds in normal and ecodrive modes (STIB)

This reduced speed mode is called "Eco Mode" and is disabled when delays are observed on the metro network, enabling the drivers to catch up the delay by driving faster. The regulation system is able to divide the network into subparts, each with a different speed mode (Ecodrive or standard mode), based upon the congestion observed in this subpart. During a metro journey, the driver can transit through different regulation modes. The Eco Mode is indicated by a simple "Eco" signal in the tunnels.

Figure 38 : View of the Brussels metro vehicles and ecodrive signalling

An additional metro vehicle has been added to the network in order to compensate for the slight delay that is added to the network as a result of the slower speeds and to increase the robustness of the network in case of any vehicle/technical failure.

This Ecodriving project is different from usual experiences, which focus mainly on the training of drivers to make their driving economically and more environmentally friendly.

In terms of benefits, STIB has observed an energy reduction of 12% of the traction power required. This project also improved the metro regularity at the cost of a slightly longer time to transit (three extra minutes for the entire line) and had a positive impact for the drivers, who are under less stress since they can recover their delay when the Eco Mode is disabled. The passengers also feel more comfortable since the maximum speed is reduced, avoiding the vibrations associated with high speeds. Finally, rolling material may last longer by avoiding high speeds and vibrations, thus reducing the wear.

In a second phase, STIB evaluated the benefits of optimizing the metro regulation system (SyReM) for energy saving purpose. The action consists in maintaining the metros in “Eco Mode” all over their journey even if they have been delayed at some point for regulation purpose. This could bring 1 to 2% additional savings. Measurements are currently underway.

SUMMARY		
Investment	35.000€ for the training 30.000€ for network measurements	
Staff resources	50 working days	1 hour of training for each driver + organization of the project
Energy savings (%)	12%	
Energy savings (kWh)	11,500,000 kWh	
CO_2 emissions avoided (tons)	3,060 TCO_2	
Cost savings (€)	934,000€	
Payback time (years)	Less than 1 year	

7.3 Reducing temperature in vehicles during wintertime

7.3.1 Concept

Conventional vehicles (cars, trucks or buses) are powered by petrol/diesel engines, which have an efficiency of 30-40%. The remaining energy is converted into heat, which can be partly used to heat the vehicle interior. As a tramway is driven by electric motors, which have an efficiency of up to 97 %, there are very few thermal losses. Therefore, the energy for heating the interior has to come mostly from the electricity supplied from the overhead wire.

In wintertime, the heating temperature in vehicles is generally set to a specific temperature and is not adapted dynamically to the changing weather conditions. Since passengers are usually dressed according to the outside temperature, excessive heating in the vehicles can be a source of discomfort, especially at peak time. The action consists in reducing the temperature in the vehicles in order to decrease the energy consumption.

7.3.2 Objectives

- Decrease the auxiliaries consumption (less heating energy)
- Reduce greenhouse gases emissions and local pollutants
- Increase comfort for passengers

7.3.3 Implementation

This action applies to rolling stock with a heating system that has a heating control to vary the temperature. It requires a feasibility study to identify the constraints both from the operator point of view (settings, maintenance) as from the passengers point of view (comfort): the right temperature must be set according to thermal comfort rules and equipment possibilities. Once the decision has been taken, the settings of every vehicle must be adapted. This can usually take place during normal maintenance tasks. Finally, energy consumption must be monitored before and after implementation for comparison purpose.

This action also gives the opportunity to examine all equipment and to replace the defective temperature sensors at the same time. On the other side, the replacement costs of too many defective sensors can be prohibitive and hinder the project.

7.3.4 Case studies

7.3.4.1 Optimizing temperature set point in regional trains in Paris (RATP)

RATP operates an extended regional rail network with three types of regional trains.

Figure 39: RATP regional train rolling stock (respectively MS61, renewed MI79, MI84

The temperature was originally set at 18 degrees Celsius during wintertime in all vehicles. The project consisted in lowering the point temperature from 18 degrees Celsius to 15 degrees Celsius. Measurements were done during operating times to estimate the potential of energy savings for each rolling stock model. The energy savings ranged from 6% to 32%. The results of the measurements depend on the external temperature and hence on the climate conditions during the measuring period. The duration of the measurement was about one month.

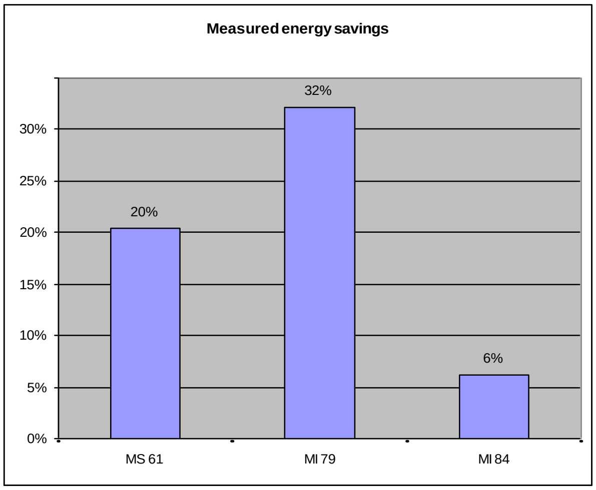


Figure 40: Measured energy savings of RATP regional trains

The energy savings amounted to an average of 40,000 kWh per train every year and the resulting GHG emissions could be reduced by 1,7 TCO_2 for each vehicle. This resulted in cost savings of around 2,400 Euro per train annually. As far as staff resources are concerned, 4 persons worked during 1 month to adapt all vehicles.

SUMMARY	
Investment	None
Staff resources	A few man-hours/vehicle
Energy savings (%)	From 6% to 32% depending on the vehicle
Energy savings (kWh)	40,000 kWh/vehicle
CO_2 emissions avoided (tons)	1.7 TCO_2/vehicle
Cost savings (€)	2,400€/vehicle
Payback time (years)	Less than 1 year

7.3.4.2 Optimizing temperature set point in trams in Flanders - Belgium (De Lijn)

Originally the thermostat of the interior of the De Lijn tram in Flanders was fixed at 19 ℃ independently of the outside temperature. De Lijn proposed lowering this established set point, depending on the outside temperature, and according to the scale shown in the diagram below.

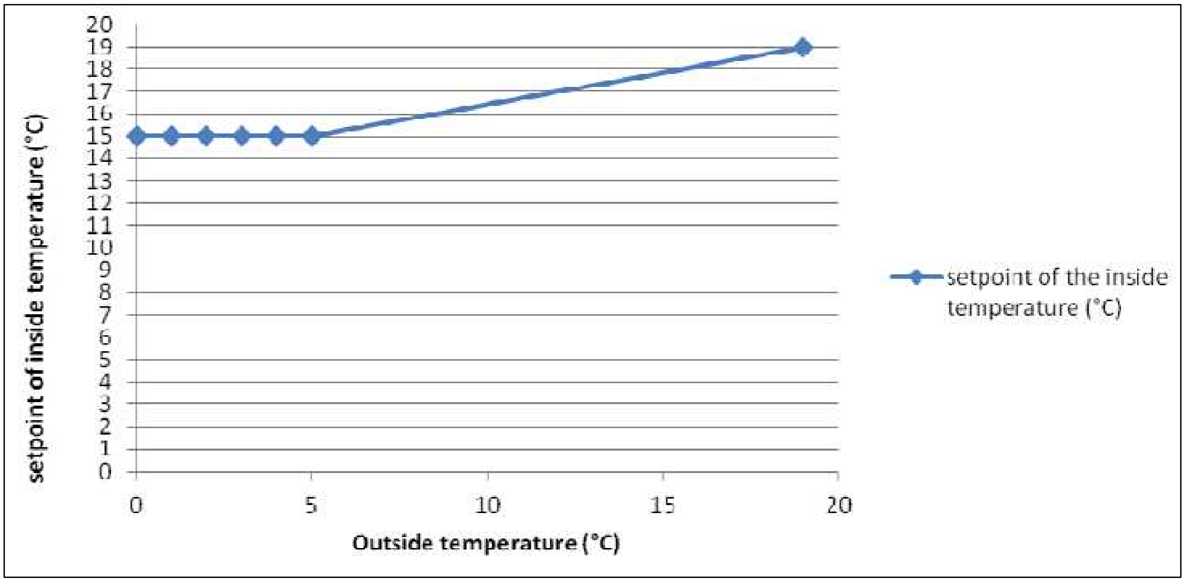


Figure 41: Correlation between measured outside temperature and inside temperature set point

First, the company modified the software parameters to reduce the energy needs: if the outside temperature is below +5 ℃, the set point of the minimum interior temperature is set to 15 ℃; above + 5 ℃, the set point is determined linearly until the maximum interior temperature of 18℃ is reached. Secondly, when the tram is in heating mode, the use of the heating ventilators is reduced when one or more doors are opened. Finally, the electrical resistors heat outside fresh air needed for renewing the ambient air before forcing air in the interior cabin. Using those relatively small measures, De Lijn reduced the annual energy consumption by 20 %, which for De Lijn's 112 low-floor Hermelijn trams corresponds to an annual saving of 500,000€ (CIVITAS – ELAN)

Figure 42: View of a Hermelijn tram (De Lijn)

More information :
http://www.civitas.eu/docs/1_13_D1_Report_on_energy_audit_results_and_future_energy_use_optimizing_plans.pdf

7.4 Uncoupling metro cars during off-peak time

7.4.1 Concept

On many transport networks, metro cars are coupled to offer sufficient capacity especially during peak-time. When suitable, the **uncoupling** of metro cars at specific times or on specific days can bring significant energy savings due to the fact that fewer vehicles are operated, thus reducing the traction energy. This is mostly possible for older vehicles as new metro systems are often composed of a unique train allowing passengers to walk through the different cars.

7.4.2 Objectives

- Decrease the energy consumption (less traction energy)
- Reduce greenhouse gases emissions and local pollutants
- Lower vehicle maintenance costs
- Increase security onboard by shortening the vehicle size

7.4.3 Implementation

This action is only suitable on networks where metro cars can be relatively easily uncoupled during operation.

The following steps must be taken:

- Investigate the passenger load during off-peak hours and during the weekends
- Organise meetings with all departments involved in the operations planning process
- Estimate the staff needs required for the additional shunting operations
- Adapt the timetables and vehicle operation planning
- Monitor the energy consumption before the implementation of the action (baseline scenario)
- Evaluate the benefits by measuring the energy consumption after the implementation of the action

7.4.4 Case studies

7.4.4.1 Uncoupling metro vehicles during off-peak time in Rotterdam (RET)

RET made an investigation into the passenger load during off-peak hours to analyse whether the metro vehicle length could be reduced. RET operates roughly two types of metro cars:

- **SG2/1 –MG2/1 type** (set of 2 cars): 30,5 meter length and a capacity of 217 passengers
- **SG3 type** (set of 3 cars): 42 meter length and a capacity of 271 passengers

The metro cars are usually coupled to form longer trains and to provide more capacity during peak times. The results of the investigation on the passenger load led to the conclusion that during:

Off-peak hours in weekdays (10am – 3pm): the average occupancy rate was over 75%. This is denoted as "quite busy", and can lead to delays, passenger complaints and ultimately failure and loss of earnings. On weekdays it appeared too busy and impossible to uncouple metro vehicles on the lines and operate only with a single set.

Evening (8pm-11pm): In the evening, the occupancy of the metro lines is much lower. The occupancy rate is approximately 50% of the capacity of a standard metro, in other words: all seats filled. The use of a single set seemed quite acceptable for all lines.

Weekends: On Saturday and Sunday, the average occupancy is also lower. The use of a single set was decided for lines A, B, C whereas two sets of 30m were selected for D-line because the number of passengers was too important between 11am and 6pm.

The table below shows the average passenger load considering only a SG3 single set (or 2 B type) is operated.

Line	ABC	D	E
Off-peak	78%	118% (84%)	p.m.
Saturday	52%	70% (50%)	p.m.
Sunday	64%	70% (50%)	p.m.
Evenings	50%	54% (38%)	p.m.
Late opening	71%	99% (71%)	p.m.

Then, the project considered how the changes would impact on the existing timetables and shunting activities. Since there is no option to disconnect the vehicles during the day, shorter metros need to be available from the start of operation on Saturday morning. This resulted in extra shunting activity on Friday evening and Sunday evening. These extra shunting activities were also needed on weekdays during the evening.

On Saturdays, RET observed annual savings of more than 740,000 vehicle-kilometres and on Sundays about 570,000 vehicle-kilometres. This provides for (budgeted 0.50€ per km) 650,000€ in total savings, excluding any necessary additional staffing. The savings from shortening during the evening are smaller. Around 260,000 could be saved, but require additional staff for the exchange and retrieval of the coupled cars. The total annual savings amounted to 890,000€ per year. The reduction in terms of kWh was estimated to 5,600,00 kWh (Estimation of 7% of 80 GWh).

Additional staff was needed for disconnecting, connecting, swapping back and riding metros to different locations. RET estimated that this required at least 3.5 FTE.

SUMMARY		
Investment	None	
Staff resources	3.5 FTE	For shunting operations
Energy savings (%)	7%	
Energy savings (kWh)	5,600,000 kWh	
CO_2 emissions avoided (tons)	n.a.	
Cost savings (€)	890,000€	
Payback time (years)	Less than one year	

8 Equipment

8.1 Power transformers

8.1.1 Concept

The power transformers used to feed rail networks consume energy when idling. This is especially the case during the night when no vehicle is running on the network. The action consists in switching off one or more transformers when there is no load on the electrical network in order to reduce the energy consumption.

8.1.2 Objective

- Decrease the energy consumption
- Reduce air pollution and greenhouse gas emissions associated with the production of electricity
- Optimize the sizing of the equipment

8.1.3 Implementation

Switching off power transformers for energy saving purpose requires having a good knowledge on how the electricity network is used and sized. In most cases, some power transformers can be switched off during the night.

If the power network has been oversized (which is often the case for redundancy purpose), it is also possible to disconnect a transformer when the required power on the network is low. It can be useful to regularly evaluate the global dimensioning of the electricity network to make sure that some equipment is not unnecessary. In the case of old transformers, operators must be cautious because regular disconnections can harm the systems and reduce their lifetime.

8.1.4 Case studies

8.1.4.1 Switching off power transformers during the night in Brussels (STIB)

STIB investigated to see whether power transformers could be switched off during the night and off-peak time. The cut off of the transformers has been programmed in the power management software for high voltage equipment. This required around one day for the technician. The savings amounted to 0,16% of the total high voltage consumption, resulting in savings of 343 MWh/year and 30,000€/year. Nevertheless, a study made by Laborelec concluded that the switching off of old transformers could potentially decrease their lifetime and increase the case of failures.

SUMMARY

Investment	None	
Staff resources	8 hours (400€)	For programming the power management software
Energy savings (%)	0,16%	
Energy savings (kWh)	343,000 kWh	
CO_2 emissions avoided (tons)	54 TCO_2	
Cost savings (€)	30,000€	
Payback time (years)	1 year	

8.2 Escalators

8.2.1 Concept

Escalators located in public transport stations and buildings operate around 19 hours per day and are designed to support their maximum load of up to two persons on each stair. However, escalators run most of the time with no load or very low load and therefore offer significant energy-saving potential.

8.2.2 Objectives

- Decrease the energy consumption by the use of more energy efficient escalators and a regular monitoring of their wear.
- Reduce air pollution and greenhouse gas emissions associated with the production of electricity
- Reduce maintenance by lowering the use of the escalators
- Decreasing air conditioning needs by reducing the motor waste heat

8.2.3 Implementation

They are several strategies for improving the energy efficiency of escalators:

- Fitting old escalators with sensors detecting the presence of passengers. In this way, escalators will only run when needed;
- Reducing the supplied voltage to partially loaded motors to increase their efficiency. Power voltages can be supplied through a monitoring system, which constantly measures the power demand and changes the provided voltage accordingly;
- Installing less powerful motors;

- Defining a slow start mode in order to reduce the high load required for starting the escalator;
- Keeping the escalators in slow motion, which is more energy-efficient for heavy-duty locations with many passengers and highly frequent start-stops;
- Optimizing the heating system used for avoiding the escalator to get blocked when freezing. A temperature sensor can deactivate this feature when needed;
- Training agents to detect any defective escalator.

A good monitoring of the escalators consumption can help planning the maintenance as an escalator not working properly will consume more energy.

8.2.4 Case study

8.2.4.1 Training staff for an optimal use of escalators in Brussels (STIB)

STIB has equipped most of its escalators with movement sensors to avoid their continuous functioning and the subsequent energy consumption. However, some escalators can become defective over time. STIB trained the station agents to enable them recognize defective escalators and inform the dispatching centre for repairing. The training documents have been updated and the station agents instructors have been trained. This action resulted in fewer escalators running continuously and estimated annual savings of 96,000 kWh. This action requires regular training and information of the agents to ensure its effectiveness on the long term.

SUMMARY		
Investment	None	
Staff resources	A few man-hours	Updating training documents and training the agents instructor
Energy savings (%)	n.a.	
Energy savings (kWh)	96,000 kWh	
CO_2 emissions avoided (tons)	n.a.	
Cost savings (€)	7,700€	
Payback time (years)	1 year	

8.3 Green computing

8.3.1 Concept

Many computers remain turned on when unused significantly increasing their energy consumption. Standby power used by older devices can be as high as 10 to 15 watts per device. Although the power needed for functions such as displays, indicators, and remote control functions is relatively small, the large number of such devices and their being continuously plugged in resulted in an increased energy usage for a company. An organisation such as a large office, with 4,000 employees, would be able to make CO_2 emissions savings of over 800 tonnes and about 150,000€ per year in energy savings.

8.3.2 Objectives

- Decrease the standby energy consumption of computers
- Reduce the need for replacement

8.3.3 Implementation

The power management system of a traditional computer is based upon an idle timer. If the computer is idle for longer than the preset timeout then the PC may be configured to sleep or hibernate. Traditional systems use a combination of user activity and CPU activity to determine when the computer is idle. However, in many cases, applications can unnecessarily prevent power management from working and can be a significant barrier to successfully implementing power management.

There is a significant market in third-party PC power management software offering features beyond those present in the operating system.

8.3.4 Case studies

8.3.4.1 Power management software in Manchester (TfGM)

TfGM investigated the installation of power management software, which will allow automatic control of PC and laptop power management settings. TfGM plans to move to Windows 7 in the future. However, Windows 7 power management options remain quite limited. The company compared the energy savings achieved with the cost of a power management software and also to the cost and savings achieved through manually checking whether staff turn machines off. The trial proved that investing in a software would be the best investment and have the biggest impact on energy usage.

TfGM noticed during the trial that a lot more energy was saved in the first few days, when this was communicated, but this tailed off. This means that a large chunk of savings occurred from behavioural change and that the use of a software, with efficient end user information is important for helping the employees stick to their good habits. The ability to see power management policies enables them to spot potential issues.

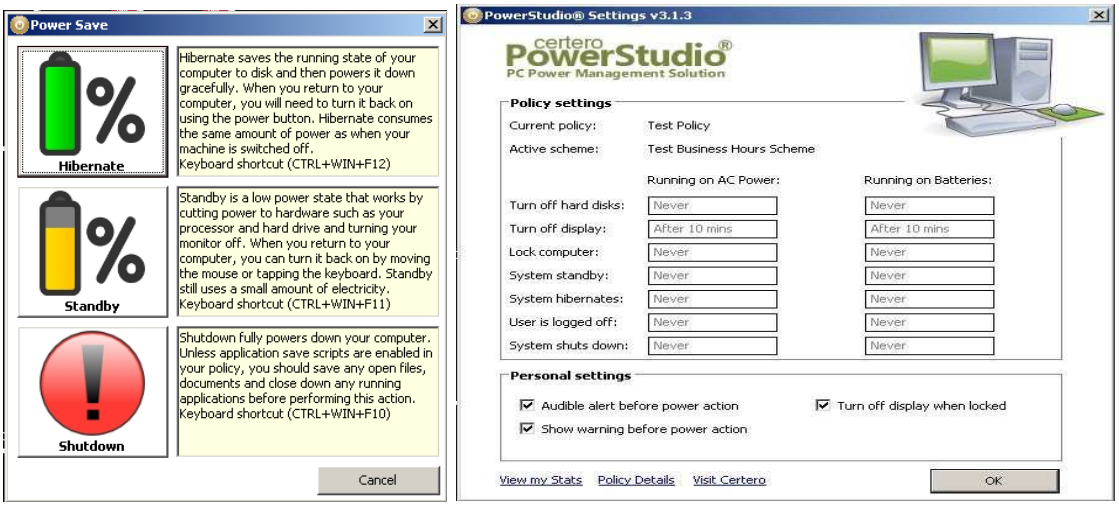


Figure 43: Screenshots of the power management software (Certero)

SUMMARY		
Investment	6,000€	For 800 licenses
Energy savings (%)	7,5%	Of head office's energy usage
CO_2 emissions avoided (tons)	21-24 TCO_2	
Cost savings (€)	6,500€	
Payback time (years)	Less than 1 year	

8.3.4.2 Sleep office project in Paris (RATP)

The sleep office project consists in defining the solutions of tomorrow for energy-sober IT systems. This is a combination of Power Over Ethernet[3] (PoE) and a software solution. IP phone sets and Wi-Fi Hotspots can be set automatically in a standby mode when not in use. The first results show an energy

[3] Power over Ethernet or PoE describes any of several standardized or ad-hoc systems, which pass electrical power along with data on Ethernet cabling. This allows a single cable to provide both data connection and electrical power to devices. PoE standards provide for signalling between the power source equipment (PSE) and powered device (PD). This signaling allows the presence of a conformant device to be detected by the power source, and allows the device and source to negotiate the amount of power required or available.

consumption reduction of 15% resulting in 19 TCO_2/year. This project intends to make a demonstration of the potential CO_2 savings of CO_2 in tertiary buildings in order to transpose the concept into the computer and telecom systems of the whole subway and regional train (RER) network.

This involves a large number of users and the need to make sure that the settings in stand-by mode do not create problems in the working processes.

SUMMARY		
Investment	n.a.	
Energy savings (%)	15%	Of head office's energy usage
CO_2 emissions avoided (tons)	19 TCO_2	

8.4 Temperature optimization in computer server rooms

8.4.1 Concept

Computer servers produce heat and must be cooled by the use of ventilation systems. As computers became larger and more complex, cooling of the active components has become a critical factor for reliable operations. Cooling devices consume a lot of energy to maintain a suitable temperature for the equipment and work on a 24 hours basis. Transport operators should take action to avoid excessive heating in the computer rooms by ensuring a proper isolation in order to reduce energy consumption.

8.4.2 Objectives

- Avoid warming effects and overheating problems of the computer servers
- Reduce energy consumption related to cooling

8.4.3 Implementation

The action consists in analyzing whether the computer servers' room is well insulated and whether temperature rises occur during summertime. If it is the case, windows can be blanked to avoid warming effects through the sunshine. Posing blanking plates on the windows or investing in automatic shading systems can help reducing the temperature in the room. The use of blanking panels/plates is also recommended as it increases the cooling efficiency by sealing off unused rack spaces to prevent cool supply air to mix with hot server exhaust. Changing the layout of the room and installing partition walls around the servers will minimize the amount of space to be cooled.

Theoretically, it could also be useful to recover the heat generated by the computers and to use it for warming an adjacent room or a water boiler. The concept is very attractive, but practically, it is a complex system, depending on what type of HVAC systems currently serve the building. Usually this type of heat recovery is cost prohibitive, because the upfront capital costs are more than a conventional system that rejects the heat outdoors.

8.4.4 Case studies

8.4.4.1 Server rooms efficiency improvements in Manchester (TfGM)

TfGM identified a need to manage the energy use in server rooms more efficiently and worked with both its IT department and external suppliers to develop an action plan. The key energy demands are the servers themselves and the energy used in cooling the server room to the constant temperature required. The first stage was to discuss with IT what actions could be taken and to prioritize future energy saving actions. The second stage was to conduct research into IT server room efficiency, identifying further potential actions and also identifying risks, lessons learned by others and assistance in the technical details such as optimizing layouts and suitable temperature settings. The server room has a dedicated cooling system, which was originally set to 18^{o}C. TfGM installed blanking plates, reconfigured the layout and reset the set points in the server room to a higher temperature, to reduce energy consumption. At the beginning of the project, the temperature set point was adjusted to 25^{o}C and closely monitored. It quickly became clear that the solar gain in the room from the large, glazed external wall was causing issues maintaining this temperature, so the set point was then adjusted down to 22^{o}C in order to ensure that the temperature stayed within the optimum range[4]. The servers have automatic alarms so they can alert staff if the temperature is outside of the ideal range, this enabled close remote monitoring of the situation. Further actions were also taken, such as administrative actions (writing a new procedure so people could change the set point in the event of a temperature auto alarm event) and layout changes, such as building a partition wall in the server room. This minimized the amount space that needed to be cooled to just the area that contained the servers. TfGM also had to develop a clear asset register of IT equipment in order to accurately assess the potential energy, carbon and costs savings.

TfGM used the **SusteIT tool**, which enables automatic calculation of potential energy and carbon savings from IT changes to help quantify project impacts- attached.

More info : http://www.oucs.ox.ac.uk/greenit/oxford-central-machine-room-design.xml

There was no specific budget for this project and existing staff resources were used for delivery. Not all server room efficiency improvements have been implemented yet- such as installing new cooling system to maximize free cooling from external air. Once completed, all server room efficiency actions are

[4] There is some debate over the temperature that servers rooms need to maintain in order to function correctly and minimize damage to equipment, historically servers did require a lower constant temperature than the equipment available today. Server manufacturers and suppliers can advise as to the optimum temperature for their equipment. There is still considerable debate on optimum server room temperatures, and it will depend on the servers and their age, however it is generally accepted that most modern servers are fine up to 28^{o}C.

estimated to cost 21,000€ and will save an estimated 45,000kWh energy annually. This represents a payback of 4 years or less.

SUMMARY	
Investment	21,000€
Staff resources	A few man-hours
Energy savings (kWh)	45,000 kWh
Payback time (years)	4 years

8.5 Voltage optimization

8.5.1 Concept

The electricity supply in the United Kingdom is, as a result of European Harmonisation in 1995, 230V with a tolerance of +10% to -6%. However, the average voltage supplied from the national grid (in mainland UK) is 242V, compared to the nominal European voltage of 230V. This overvoltage[5] can impact the energy efficiency of equipment manufactured for Continental Europe and rated at 230V and used in the UK. It causes a reduction in equipment lifetime and increases in energy consumed with no improvement in performance. By efficiently bringing supply voltages to the lower end of the voltage range, voltage optimisation technology can yield energy savings at least between 10% and 15%.

8.5.2 Objectives

- Improve the efficiency of an equipment
- Decrease the energy consumption
- Increase the lifetime of an equipment

8.5.3 Implementation

Voltage optimisation works by regulating the voltage supplied to energy using equipment to improve efficiency. The best potential for saving is mostly with older lighting (incandescent or fluorescent lighting). Therefore older

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ltage higher than the voltage at which equipment is designed to operate most commercial and office premises are likely to have a better saving potential than modern buildings or industrial sites. The implementation of voltage optimization systems is very easy.

When lighting loads are in use for a high proportion of the time, energy savings on lighting equipment are extremely valuable. When voltage is reduced, incandescent lighting will see a large decrease in power drawn, a large decrease in light output and an increase in lifetime.

As far as heating is concerned, heaters will consume less power, but also give less heat.

The installation is very similar to the installation of meters: the power has to be turned off for approximately 45 minutes and a strong coordination and communication is required in advance to identify and resolve any technical or operational issues. Bypass switch should be installed in case of future faults.

8.5.4 Case studies

8.5.4.1 The use of voltage optimization systems in Manchester (TfGM)

Voltage optimisation has been installed at Wigan, Ashton and Leigh bus stations to reduce energy use. As TfGM had no prior experience of these systems, suitable trial sites were identified to accurately assess the savings that could be realised. All three sites are relatively low energy users and so only required small 80 amp units, which could be easily fitted in the space available. These bus stations also have older inefficient lighting, which would require significant investment to completely replace, and represented around 70% of the total electricity costs of the sites. Voltage optimisation is a low cost alternative to improve energy efficiency without significant capital investment, and therefore represented the best return on investment of the sites that were investigated.

The average cost for one site was 6,500€ and the annual energy savings amounted to 3,800€ resulting in a 1.7 years payback time. The energy savings realised since installation are almost exactly the same as the predicted savings, averaging at around 24%. At times of peak demand, savings have been as high as 45% from previous average usage. In addition, further lighting controls were installed at two of these sites as part of the project, leading to total estimated savings of 27% of the total electricity spend across all three sites.

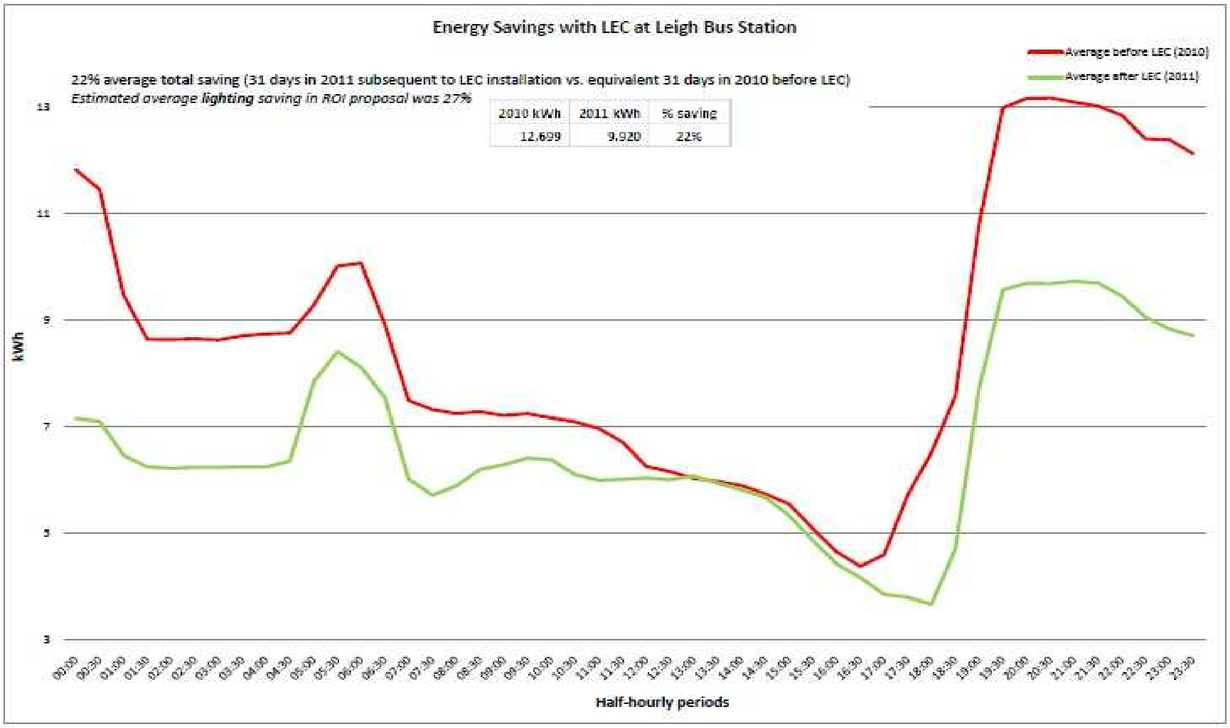

Figure 44 : Energy savings with a voltage optimization system at Leigh Bus Station

SUMMARY	
Investment	6,500€ per site
Energy savings (%)	24%
Energy savings (kWh)	38,752 kWh per site
CO_2 emissions avoided (tons)	21 TCO_2 per site
Cost savings (€)	3,800€
Payback time (years)	1 to 2 years

9 Awareness campaigns

9.1 Energy week

9.1.1 Concept

An **energy week** is an annual event aiming at raising awareness on energy at the corporate level during a limited period of time. Encouraging changes in people's behavior is known to be an effective way to reduce energy consumption due to the amount of energy wasted through unnecessary usage. The organisation of awareness campaigns drive behavioral change in staff and see if measurable results can be achieved during a short period. The objective is to ensure all staff members understand that they have a role to play in reducing the company energy use and to encourage them to take small measures towards improving the energy efficiency at their place of work. In addition, raising staff awareness makes it more obvious for them they can report energy waste.

A joint Energy Week has been organized for all Ticket to Kyoto partners from 30th January 2012 to 5th February 2012. This was intended to be a dedicated campaign to raise awareness of energy waste and encourage behavioural change amongst staff.

9.1.2 Objectives

- Encourage staff to change their behaviour to save energy and reduce carbon emissions
- Measure the change in energy use and carbon emissions as a result of behavioural changes
- Use the results to justify the provision of further resources to support awareness and communication work

9.1.3 Implementation

The implementation of an Energy Week requires a good communication plan aiming at identifying all the actions to be taken to maximise the awareness campaign. The following aspects must be adressed:

- Target audiences
- Key messages
- Campaign evaluation
-

9.1.3.1 Target audiences:

The target audiences of an Energy Week may vary, but below is a list of key groups to target communications at:

General Staff: For general staff, the key is to inform them of actions that they can take to reduce energy waste, encourage them to take these actions using innovative methods such as competitions, and then inform them of the effects their actions had during the week. This is very important, in order to keep up the momentum following the Energy Week. These actions need to be tailored to their place of work, and their ability to impact energy use. For example, office based staff should be encouraged to turn off their computer and open blinds to allow lights in. Staff at properties with manually controlled lights should be encouraged to always turn them off when not required. However, staff who are not office based and do not use a computer as part of the role, will need different messages, such as those focused on efficient driving, reporting energy waste to the appropriate people etc.

It is important to ensure that advice is relevant. It is useless to encourage staff to turn off lights if they are automatically controlled etc. General staff may have varying levels of knowledge about energy and carbon saving, so there need to be messages aimed at varied levels as well. For example, some staff may be particularly interested and want either more detailed information or an opportunity to do more. This could be addressed through information seminars for those who wish to have more information or through encouraging people to be energy champions for their particular site (see energy challenge below). Some staff may be resistant to the idea of carbon saving, so they need to be targeted through competitions or emphasis on the cost savings because everyone understands saving money.

Site Managers: Site managers need all the same information and incentives as general staff however they require more detailed, specific information relating to their sites. If not already available to them, the Energy Week should include providing them with the following: easy access (indeally on-line access) to detailed data on the energy use at their site, training (where required) on what the data can show them. In addition, other options to consider with site managers include: a site by site competition, working with them to agree actions to reduce energy waste over the year, tailored energy audits with site managers to identify barriers to effective site energy management, putting actions into their performance objectives or delivery plans, providing them with tips of easy actions to reduce energy waste.

Site managers are often very busy, and do not have incentives to reduce the energy use at their site if they are not the budget holder. In addition, there may be internal barriers preventing them from managing energy use effectively, such as poor maintenance or inadequate understanding of the systems at their sites.

Corporate vehicle users: corporate vehicle users can be targeted during the week by focusing on both how they drive, and why they drive. The first consists in organising a driver training or tips on driving efficiently. The second relates to the procedures of why they are driving and whether it is the appropriate mode of transport. Systems to approve fuel expenses can be put in place. In addition, communications can focus on whether a journey is necessary and whether an alternative public transport mode is more appropriate. If good data is available internally, there could even be a competition for the most efficient driver, or the department that reduces its fuel usage the most during the week.

Senior Management: Senior management should be targeted with key messages regarding the actions planned for the week to ensure there is high level support for the project. Specific briefings promoting the week and its actions must be sent to senior managers to encourage them to inform and engage with their staff about the project. Following the energy week, senior management should receive detailed feedback on the success of the project, analysing costs and staff resources required compared to the impact the week has on energy use and costs. This will enable effective analysis of the payback for promotional campaigns, and ideally provide all partners with a business case for future annual awareness events.

Stakeholders and press: It may also be useful to target local stakeholders and the press, particularly regarding the successes that emerge following analysis of the results.

9.1.3.2 Key messages and supports

The Energy Week is a great opportunity to communicate on all aspects related to energy efficiency and use and must be promoted in advance. Different media can be used for raising the awareness of the employees:

- Posters and stickers to inform staff before the Energy Week to give them background information on the initiative
- Writing of articles in the internal journals and on the Intranet
- Distributing of information packs including information on energy usage and tips to save energy
- Daily energy saving tips can be emailed to all staff, as well as further e-bulletins and internal communications with information on energy saving.
- Organising of lunchtime seminars on specific topics
- Rewarding with a prize those who have made an effort (i.e. leaving a chocolate bar for those who turned off their computers)
- Organising energy savings competitions and quiz.

Below is a table to use to summarise the key communications messages to get across, to help organise an Energy Week and give the communications teams a clear idea of the support that will be needed from them.

Activity	Purpose	Content / Message	Audience	Timing
Intranet page	Staff link for further information. Central point for information.	▪ Why an Energy Week ? ▪ How staff can engage? ▪ Presentation of on-going energy efficiency projects. ▪ Presentation and results of competitions	All staff	To be prepared before the event and updated during the week
Competition between sites	Motivate staff with a competition between the sites	▪ Tell staff how they can easily reduce energy use. ▪ Inform staff of the competition, prizes and how results will be measured. ▪ Inform staff of the results, to encourage them to keep up the behavioural change actions.	All staff	During the energy week
Posters	Promote Energy week in the buildings	▪ Why an Energy Week ? ▪ How staff can engage? ▪ Presentation of on-going energy efficiency projects. ▪ Presentation and results of competitions	All staff (especially those who don't have access to the Intranet)	During the energy week
PC monitoring	Encourage staff to turn off computers	▪ Post-it saying "Thank you for turning off your computer during "Energy week"	All staff	Every evening during the Energy week
Driver training	To encourage fuel savings via efficient driving	▪ Learn how to drive efficiently ▪ Help the company save costs and carbon ▪ Improve the passengers comfort ▪ Help you save fuel costs at home too	Driving staff	During the energy week

9.1.3.3 Campaign evaluation

Measure the change in energy use: It is very useful to have some methods to measure the success of activities, not only for follow up communications, but also to ensure the business case for future promotional work can be supported with a strong financial argument. It is helpful to have some control sites' excluded from the campaign for this purpose, to highlight the difference between sites that were targeted and those that weren't; this also enables quantification of the activity. Smart metering data can be used to analyze the impact of the week. The change in energy use, carbon emissions and cost must be measured and the results be communicated to all staff. Any energy savings that pay back in less than 12 months should be regarded as a successful Quick Win.

Measure the change in equipment turned off overnight: The number of equipment properly turned off is an interesting indicator to measure the effects of the Energy Week. The company could be conducting walk-round surveys to measure the no of equipment (PC's monitors, printers, lights etc) left on overnight both before and after the week to measure the impact on this specific behavior.

Measure the change in staff awareness: an electronic survey can be conducted in advance of the week and another one afterwards to measure the change in awareness and attitudes. The survey must be brief and asks staff what they know about existing initiatives and objectives in the company and about their current behavior such as turning off equipment when not in use. It is also important to note that in properties where staff have a limited ability to influence energy use, such as those with significant automatic controls, a campaign of this type may not be beneficial in the same way.

Feedback from staff: Feedback from staff could be sought in a variety of ways, in order to both help evaluate the success of the project and to help inform and improve future awareness projects. The use of an idea box is recommended.

Identify key actors: the Energy Week is an excellent opportunity to identify the employees that have a key role in setting up projects for reducing the energy consumption.

The organisation of an Energy Week is time consuming and someone must be responsible for ensuring that all the activities can take place during the same week. A good coordination is required with the communication department.

9.1.4 Case studies

A joint energy awareness week has been organized by all Ticket to Kyoto partners from 30th January 2012 to 5th February 2012 to raise awareness of energy waste and encourage behavioral change amongst staff. Each company organized several actions to promote a better use of the energy, each company focusing on some aspects of the energy management. Every company also encouraged the employees to propose other actions by the use of a suggestion box. The strength of the week is that it is a joint effort of all five project partners and that it took place simultaneously in all cities. The partners have worked together prior to the energy week for exchanging ideas and resources. This has resulted in a consistent style of communication in all companies. The ambition was to show how these actions could impact the global energy consumption of each company. Due to very cold climate conditions, the results were below expectations and no clear conclusion could be drawn from this event. However, awareness campaigns have proved to be successful by all partners.

9.1.4.1 Energy week in Manchester (TfGM)

TfGM estimates that the event took approximately 5 days staff time each from 4 staff members. This involved meetings and development work, but also time during the week to deliver activities. The budget available was initially 229€ for prizes and printing, although this did not include any staff resource costs. Part of the benefits of the activity for TfGM was the lessons learned as to how similar activities could be improved in the future. It is important that such activities are seen as part of a wider, ongoing process to inform and encourage change in staff behaviour. TfGM recommend developing an ongoing annual communications plan, for wider energy and carbon related promotions, is completed to ensure the momentum from a single promotional week is not lost. TfGM also found that many people find issues of energy and carbon confusing and actually want basic information that explains the key concepts and how the different issues are interlinked.

9.1.4.2 Energy week in Rotterdam (RET)

The energy week in Rotterdam consisted in various activities including an energy quiz, a workshop on energy management, ecodriving lessons for drivers and a roadshow (stands and a promotional team) in the different buildings. A total of 22 employees filed a sustainable energy idea during the week. Most of the ideas had to do with dealing with efficient lighting.

The objective of the energy week was to answer those two basic questions:

- What does the company to save energy?
- What can you do yourself as an employee?
-

The cost of the energy week amounted to 9.500€, staff excluded.

9.1.4.3 Energy week in Paris (RATP)

The RATP energy week focused on good practices for 4 tertiary sites. Employees were encouraged by the use of an exhibition to change their habits in order to reduce the energy consumption, mostly in terms of lighting and heating.


Due to the very cold weather, the results were not as convincing as expected. The graph below shows a comparison of the energy consumption of the RATP tertiary site of Val de Fontenay in Paris during the energy week 2012 and during the same week the year before. The impact of the cold winter has had a direct impact on the energy consumption.

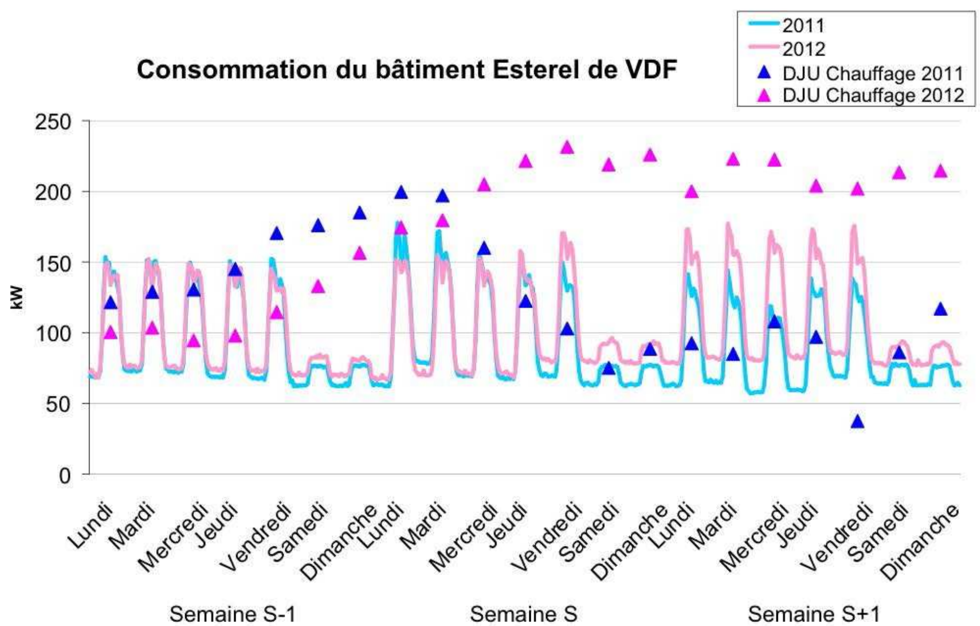

Figure 45 : Energy consumption comparison of the Val de Fontenay site during the energy week (RATP)

One of the conclusions was also that new ideas raised by the agents during the week were also sources of inspiration for the company and the corporate social responsibility of the company policy must take greater account of these aspects (procurement of equipment, new technologies, estate management, …).

9.2 Energy challenge

9.2.1 Concept

People will best change their behaviour when they are encouraged to do so by offering them clear incentives. The organization of an **energy challenge** is a great way to mobilize the employees of a company towards energy savings. Performance-based rewards are useful to educate staff on energy efficiency measures.

9.2.2 Objectives

- Motivate staff to change their behaviour to save energy and reduce carbon emissions
- Reward the best performance
- Develop a strong community involvement within the company and/or department
- Measure the change in energy use and carbon emissions as a result of behavioural changes

9.2.3 Implementation

The following activities shall be carried out to launch an energy challenge in a new location:

- Identify potential best practices to be implemented (suggested internally and inspired by other actions);
- Call for nominations for the position of energy watchers: local workers interested in becoming contact persons for environmental activities;
- Organize a field visit with the entity maintenance manager and ensure that the facilities are in good condition;
- Achieve the required repairs;
- Ensure managerial support: Go to the site manager, present the project and request their validation and support. They will be requested to follow-up the meter readings, free some time for energy watchers and to help motivate the staff;
- Perform the energy accounting monitoring (kWh performance, historical consumption to ensure comparability of results);
- Build up a communication plan
    - Build awareness tools with members of the communication entity
        - Awareness poster
        - Consumption poster with the tip of the week

- Start a media coverage of the project
    - Intranet: Post articles and flashes
    - Company magazine;
- Start the energy challenge;
- During the whole heating season (from October to May) provide a weekly support for the energy watcher on site. Meet with the energy watchers; discuss weekly analysis and display consumptions, advices, support, analysis etc;
- Organize a closing event taking place in the workshop. Invite the company hierarchy and foresee a media coverage. Prizes can be distributed during that closing event to recognize success, but the most important are the acknowledgements to the teams participating to the project.

An important aspect of the challenge is the ability to be able to conduct rigorous energy accounting so as to ensure that a good follow-up is possible and that efforts are recognized. The following elements are useful for this purpose:

- An energy accounting system with historical energy consumption data
- Smart meters
- Functional installation, without any significant dysfunction. The risk is high that if a facility is defective, the dynamics of the project will be impacted.
- Benchmarking of energy consumptions and comparison with similar buildings (in kWh²/m² or kWh/m²)

9.2.4 Case studies

9.2.4.1 Energy challenge in depots and workshops in Brussels (STIB)

The Energy challenge project aimed at improving the behaviour of employees in relation to the environmental impact of their activities through the promotion of good practices, whilst keeping a low project cost. The concept of this competition has helped to improve accountability within the sites and has highlighted the influence of behaviour on energy consumption.

This project, which started at STIB in 2008 has been inspired by a European initiative, the Energy Trophy (http://www.energytrophy.org/). Since this project focuses on behaviours, it does not require any significant investment, but does call for the long-term involvement of one person with responsibility for the project and the support from the company hierarchy to ensure the full cooperation of all participants.

Energy challenges have been implemented in several depots and workshops. In terms of benefits, STIB has observed energy reductions of around 15% (ranging from 7% to 20%) for different sites. This value mainly depends on the potential improvements as well as the motivation of the participants. Once the right behaviors have been adopted, results remain stable if regular (monthly) reminding actions are foreseen. Energy consumptions must be monitored all over the years to make sure that the employees stick to their good habits.

An energy challenge has been organized during the winter 2011-2012 in the Jacques Brel metro and bus depot. Gas savings amount to 472 MWh/year and electricity savings amount to 419 MWh, reducing the energy bill by around 50.000€ per year. In terms of human impact, some participants have shared that behavioural change at work also led them to change their attitudes to energy consumption at home. This project also improved the links between the maintenance team and the participants of the project, achieving a long-term impact.

Figure 46 : Poster showing energy savings objectives and energy challenge results

SUMMARY	
Investment	6.000 for prizes
Staff resources	50 working days per year
Energy savings (%)	15%
Energy savings (kWh)	472 MWh (gas) 419 MWh (electricity)
Cost savings (€)	50,000€
Payback time (years)	Less than 1 year