Rome Workshop Summary (19th to the 21st of September 2011)

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1 Introduction

The aim of this summary is to synthesize the discussions held in Rome for the CATCH-MR workshop from the 19th to the 21st of September 2011 during the European mobility week.

It was organised in two sessions according to the two themes: mobility management strategies and strategies for renewable energies take-up in transport. Each session had first a set of presentations and then the workshop participants were asked to discuss the themes in groups.

This brief document underlines the commonalities emerged and tries to draw overall conclusions. It is structured as the workshop and reports first the key messages given by the speakers talking about the mobility management measures; then the outcomes of the discussion in groups on mobility management; then few technological solutions to better manage mobility not mentioned in the workshop but worth of consideration; then the key messages the speakers gave on renewable energy and their use; then the outcomes of the discussion in groups on renewable energies; and finally it draws some conclusions.

Both group sessions were following the same set of topics to be discussed:

- criteria to select policies and measures,
- challenges encountered,
- solutions,
- financial framework,
- and vision.

Group discussions are reported following this structure.

2 Mobility management measures

Presentations were given by Vienna, Rome, Ljubljana and Budapest to introduce the mobility management measures they either implemented or plan to implement.

Mobility management measures to promote a modal shift toward more sustainable modes can be organised in two groups: pull measures, those which make more sustainable modes more attractive, and push measures, those which make less attractive the use of less sustainable modes. Such less sustainable modes are normally private cars, because of congestion, environmental impact and consumption of space and motorbikes mostly because of their disastrous effect on road safety.

Though measures and their application differ from cities to cities they can be summarised in four groups of pull measures and one single group of push measures.

The four groups of pull measures are:

- better public transport (PT),
- cycling,
- information,
- feeding public transport.

The first group is the most traditionally addressed. To achieve a low modal share on private cars and motorbikes an efficient public transport system is necessary. Measures to improve PT quality and comfort range from the reorganisation of the network, to the construction of new PT-dedicated infrastructures, to the reservation of corridors on previously shared infrastructure to the improvement in service frequency and rolling stokes quality for greater comfort and “green” appeal. However if a low quality public transport pushes people to use private modes an high quality public transport does not normally attract more users; for that a combination of other measures is also necessary. A good quality PT is the basis to build upon a sustainable mobility strategy but cannot be the only measure in the strategy.

Under the heading cycling there are a number of measures to improve the modal share of cycling in cities. Different cities decided to make cycling more attractive in different ways; some tried to diffuse bike sharing, some decided to improve their cycle route network, some to increase cycle parking spaces at train or metro stations. However the common view emerged is that cycling, in medium to large cities, needs to be complementary to public transport as it cannot cover the entire length of all trips. Intermodal trips Cycling+PT are necessary to attract a significant modal share for this mode and to improve also the share of public transport.

Information groups the largest number of measures which range from ICT (Information and Communication Technologies) for public transport to give users real-time information, to integrated multimodal trip-planning services via web and for mobile phones, to providing better and better integrated static information for commuters. The common idea of all these measures is that public transport and intermodality require more knowledge than private cars to be used effectively and that such knowledge needs to be made easily accessible.

Feeding public transport is specifically relevant for greater urban areas where outer peripheries tend to be sprawled. Providing high frequency and high quality public transport in such areas is expensive and inefficient and new forms of public transport are often necessary. Such new form range from on demand services to car-sharing one-way to car-pooling to ride-sharing. They all share the same need of intensive use of ICTs and are the field for which innovation is absolutely needed.

Push measures, on the other hand, were almost always mentioned as necessary but the only mentioned push measure, beside parking pricing which is already extensively adopted wherever and is no longer even seen as a demand management measure, is road pricing. Many of the cities did consider the possibility to introduce either congestion charging schemes in central urban areas or environmental charging. Some cities already have in place rationing policies to access in central areas of the city. Non-mentioned push measures, which might be worth considering, are car-ownership restriction policies (in Tokyo cars can be bought only by those residents who can prove to own a parking space) or car circulation restriction policies according to the time of the day and many other measures directly acting on the possibility of citizens either to buy or to use their private cars. All such measures share the same problem of being very unpopular among the car owners and users risking to hamper re-election of the politicians supporting them.

2.1 Discussion on mobility management

The workshop participants broke into four tables and were asked to discuss their mobility management strategies. To guide the discussion 5 questions were asked. In general questions were considered difficult to answer and to discuss but the outcomes of groups discussion where very interesting and are summarised below.

2.1.1 Genesis of a policy

First question was about how policies are generated in cities and whether there is any structured process which starting from a problem examines different options and chooses the policy (or combination of policies) most suited to solve the problem.

The common answer to this question was no.

A policy can be generated in many different ways and it is not always clear how it is generated. Policies can be inherited from the past, they can be the choice of a politician or they can be pushed by interest groups.

Seldom policy generation descend from a scientific process which investigates the best possible technical solution for a given problem. Costs, and financial problems in general, are often the main drivers.

At local level some choices are forced by targets set at national or regional level and policies are therefore imposed sometimes.

2.1.2 Challenges

Second question was on the main challenges which are encountered to adopt a policy or in general a coherent strategy featuring different policies and measures.

Challenges for local policies have been classified in three groups: administrative, behavioural and knowledge related.

Administrative barriers are mostly related to the limited time horizon of an administration, the good and the bad of democracy after all, and to boundaries and policy conflicts with the neighbouring territories. Before the elections policies are often directed to "please" the voters more than to upset them; unpopular though necessary policies are therefore seldom adopted especially when elections are nearing. On the other hand a change in the administration often means a change in policies even regarding those policies which are considered as necessary, though unpopular, by most technicians. The second main administrative problem is the problem of boundaries. At the administrative border the policy can significantly change often with devastating effects on the effectiveness of the policy in the territory; an example is given by an harsh anti-car policy which might prove useless if the neighbouring territory is creating parking spaces and use this policy-difference to attract more residents and jobs.

Behavioural challenge is mostly related to the acceptance of policies which requires citizens to change their behaviour. It is the case for most measures on mobility which requires changes in many aspects of citizens life. Furthermore to be effective most policies cannot just induce behavioural changes in few individuals. They need to affect a majority which is, if possible, even more complex.

Finally lack of knowledge relates to two main aspects:

- often it is not clear which is the real transport and air quality situation;
- not everybody can be informed about all the technological and latest discoveries.

The first is the key issue of data collection in transport. Information and Communication Technologies are helping local administration to collect and store data on mobility and air quality but cause-effect-relations are not always clearly identifiable as it is not always possible from such information to extrapolate the effects of policies from demographic and economic trends.

The second is about technology progresses which tend to be slow in the uptake because they require first the diffusion of the necessary culture to chose, design and implement innovative measures.

2.1.3 Solutions

The solutions considered for the different challenges are organized following the same classification in groups used for the challenges.

The two administrative challenges can only be solved increasing cooperation. On one hand the cooperation between neighbouring governments is necessary to choose common goals and to define policies together; on the other hand opposition and minority parties should be involved at least in the long term planning to avoid policy-overturn at any physiological change.

Behavioural adaptations need to be strongly pushed with a mix of "stick and carrot" (a combination of push and pull measures). On the other hand not everybody can change the behaviour so deeply in a short time and any new policy to affect behaviour has to take into account the needs of everybody and foresee well justified exceptions.

Lack of data knowledge can be solved by building common databases with all data collected from different sources and at different geographical levels. In this way data can be cross-examined and data-mining techniques applied to identify correlations.

Knowledge about technological progresses can be spread through international cooperation to look for best practices. CATCH-MR project is a good example of such cooperation.

2.1.4 Financial framework

Any policy and any measure has to be economically and financially sustainable. Especially because local administration have always been experiencing a chronic lack of money. They tend to have smaller budgets than would have been needed to manage mobility. This is even more true when policies involve investments, even on measures which promise to return the investment in the medium term but any investment can seldom be decided at local level and specific financing needs to be asked-for to higher level administrations.

In this already difficult framework the international economic crisis is worsening money shortage making it more and more difficult for the administrations to think on longer term investments.

A key issue is the role of private investors in managing mobility. If on one hand private investors are a resource because they can bring fresh money in the framework of local mobility; on the other hand they also are a problem because their only driver is profit and they do not look at the bigger picture. Private investors also cause a problem of governance because if it is possible for an administration to implement a policy it is much more difficult when the implementation of such policy would conflict against contracts signed with private parties.

2.1.5 Vision

Two long term visions emerged from the discussion:

- technology will solve most of the energy and emission problem of the vehicles but will leave local administrations to deal with congestion;
- attitude toward car-ownership for down-town residents is slowly changing; who knows it might be contagious.

2.2 Technologies not mentioned in the workshop but worth of consideration

Technological progresses allow today vehicle to drive themselves on normal roads. Though legally there are still a number of barriers (few initiatives at EC level are already in place to remove them) automation opens a number of possibilities in terms of transport services which can be provided and which previously were too expensive.

This is especially true for feeding services and in low demand areas where conventional public transport is weak and innovation is desperately needed.

Even without going to full automation partial automation already allows new forms of public transport for those areas. For example a one-way car-sharing service featuring ride-sharing to increase vehicle occupancy can be organised to feed train or metro stations in dispersed peripheral areas. Instead leaving vehicles at the station they are driven back where they are needed. One single driver, using the platooing system which allows a vehicle to follow another one automatically, can drive up to 5 vehicles redistributing them where they are needed. Such vehicles can be also used in areas where demand is higher but very concentrated at peaks; they can be in car-sharing mode in off-peak and using the platooing a 5 vehicle-platoon can become a bus in peak hours. This latest concept is the CRISTAL concept; developed in Switzerland and subject of the CATS project.

Going up to full automation a number of new systems can be conceived. A collective-taxi like service, on demand both in time and route, can substitute the traditional feeder bus services. For those bus lines which share part of the route, frequent platoons of smaller vehicles can run on the common part and at the detaching point each small vehicle will follow its own route on demand. All such concepts, also known as CTS (Cybernetic Transport Systems), are possible thanks to the cybercar technology; technology and concept studied and demonstrated in a number of European projects (CyberCars, CyberMove, CityMobil and CityNet-Mobil just to mention few of them).

Beside automation technology developments can be used to train drivers to better behaviour. Drivers are in city responsible for about 20% of fuel consumption (CTL – Centre for Transport and Logistics Sapienza University of Rome – experimental measurements in Rome). Information technology can be used to control bad driver behaviour. On-board data logger can collect driver behaviour, real consumption and minimum consumption achievable in the same traffic conditions giving to drivers a benchmark to drive better. The other option would be to use the same technology to calculate the environmental impact of the driver and to increase the car-ownership tax with the bad behaviour.

3 Renewable energy measures

Presentations were given by Göteborg, Akershus, Oslo and Berlin-Brandenburg to introduce the measures they either implemented or plan to implement to foster the adoption of renewable energies in transport.

Two technologies, biogas and battery electric vehicles, were deeply discussed. Others like hybrids, hydrogen, biodiesel were mentioned as well.

Biogas has been mentioned as a promising technology because produced from wastes (landfill and agricultural wastes) and can be used as an already working technology.

To be used in vehicles it can either be at aeriform or liquid state. Liquid biogas has an higher energy density but requires a bulkier storage facility it is therefore much more indicated for freight applications where space is less of a problem and higher energy densities are required.

The use of biogas can be fostered adopting the eco-labelling of vehicles and fuels. When the vehicle uses biogas it has an eco-label which on one hand allows it to access restricted zones and on the other hand identifies it as an eco-transport. This second fact is part of the "regulation through revelation" policy which in principle would increase the use of eco-labelled vehicles and fuels because customers would choose mainly the eco-labelled transport forcing more and more carriers to get the eco-label.

Battery Electric Vehicles (BEV) are one promising technology to decouple energy production from energy use in transport. The burden of reducing CO2 (and other) emission is transferred from vehicles to electricity generation.

To foster the diffusion of BEVs some Metropolitan Regions have developed a number of incentives to encourage their purchase and use: reserved car-parks; free-parking; bus lane access; less taxes; ....

A possibility to increase the usability of BEVs is the intelligent charging at all locations allowing to plan even complex and long trips solving the autonomy problem which remains to date the Achilles heel of BEVs.

On the evaluation side a thorough exam of BEVs and their impact on local and global ecosystem is needed because not in all places BEVs are a sustainable solution; there is the need to make a thorough eco-balance to calculate whether substituting a trip by internal combustion vehicles with one by BEVs is really providing an overall eco-benefit. Furthermore, it is important which kind of energy (from renewable sources or not) is used to run BEVs to make them a sustainable solution.

3.1 Discussion on renewable energies

After the presentation the assembly broke into groups to discuss renewable energy and their application in the cities; similarly to the discussion on mobility management 5 questions were asked to the groups to guide the discussions.

3.1.1 Genesis of a policy

Similarly to the discussion on mobility management the question was considered difficult to answer; and the genesis of the policy on renewable energies has similar considerations to those made for mobility.

Furthermore while cities do have jurisdiction on mobility most of them do not have jurisdiction on private vehicles to force them to change fuelling.

Any policy in this field is inspired by the common driver of reducing CO2 emissions.

A commonly accepted idea is that planning of mobility, energy and land-use should be integrated but it seldom happens. Transport and land-use is becoming more and more integrated but energy has only recently become part of the equation.

3.1.2 Challenges

Second question was on the main challenges encountered to foster the adoption of renewable energy in mobility.

The main challenge is user acceptance; most users do not understand the need to shift from "traditional" vehicles to those using renewable energy and mostly they do not want to adapt their behaviour if the use of such new technology requires an adaptation.

Second challenge is the presence of appropriate infrastructures to recharge BEVs or refuel bio-fuelled-private-vehicles. This constitutes a barrier to the diffusion of such technology for private use and makes much easier to start diffusing such technologies in public fleets.

Legal barriers are not seen as a main problem for many technologies; some legal problems are seen just for compressed hydrogen storage and refuelling.

Opposition of interest groups is always a problem. Any new technology needs support to make way in a competitive market and its progresses can be seriously hampered by the opposition of consolidate interests working against its diffusion.

Renewable energy is not infinite. In most cities the energy consumed is already more that the maximum energy that can be produced in loco from renewable sources. If on one hand the boundaries of cities need to be broadened on the other hand energy consumption needs to be decreased; switching from fossil to renewable energy sources is not enough in itself.

Most of the solutions successfully tested are not immediately transferable to other cities and other contexts. This makes it even more difficult to identify the correct set of measures to adopt in any city because it is not just a matter of adopting policies which have been proven successful elsewhere it is necessary to tailor the policy to the specific environment.

3.1.3 Solutions

To reply to the challenges above a number of solutions have been identified.

People need training about new technologies to use them effectively and to learn to appreciate and select them instead of the conventional alternatives. Awareness campaigns are often really necessary to foster the adoption of any technological innovation.

Long term planning, possibly a shared planning agreed upon by different political parties and in neighbouring territories, is necessary to correctly plan infrastructures and to draw business plans convincing enough to attract private investors and force, where necessary, a legal change.

Children education is always necessary; main technological changes have been driven in the past by generation changes which made a technology previously unnecessary an absolute must.

Discussions with the opposing interest groups are necessary and sometimes incentives for those groups suffering the most from the new policy may be necessary.

Finally to answer to renewable energy shortage a rationalisation of energy use favouring less energy intensive modes, can be a good policy to make renewable energy enough to satisfy the needs.

3.1.4 Financial framework

The main financial problem with any innovation is that a new technology is often not economically convenient. Adoption of renewable energy in transport is no exception to this. A set of incentives, practical and financial, need to be put in place to start the market. The market should have a perspective of self sustainability.

3.1.5 Vision

In the long term renewable energy will replace conventional; the key issue is just to know when and how best accelerate the process.

Any technical solution may be the most successful; in the long term this is not a technical question but a political question and the technology which will succeed will probably be the one which has had more policy attention.

In a financial-crisis such as this one the bigger economic picture will need to be considered. Costs will have the biggest influence on choosing the future technological solution.

4 Conclusions

The workshop of the CATCH MR project held in Rome from the 19th to the 21st of September 2011 had the main objective to discuss mobility management policies and policies to diffuse the use of renewable energies in transport. It was organised in two sessions according to the two themes and each session had first a set of presentations and then a discussion in four groups.

The main overall conclusions emerged from presentations and discussions are the following.

Long term planning is essential for both mobility and energy and it should be harmonised:

- with the different government levels;
- with the neighbouring local government;
- with the opposition parties who will in future have governing roles.

Modal shift is “the” solution to reduce energy consumption from transport but very different approaches are needed to shift down-town trips and countryside trips. Technology is often necessary to this modal shift especially where transport demand is less intense and conventional public transport is less effective.

Energy consumption reduction is essential to shift toward renewable energy because there is not enough renewable energy in most cities to maintain our current consumption standards; therefore mobility management strategies to induce a modal shift and energy strategies have to be combined.

The winning renewable energy to use it in transport can significantly change from location to location. Winning technological strategies are not immediately transferable but need to be tailored to the local needs and resources.

5 Site visis

5.1 The Malagrotta Case: treatment plants for biogas use in vehicles

Extending on more than 200 ha of surface, the Malagrotta landfill is the largest one in Italy and certainly one of the largest waste dumps in the European Union. It started operation in the second half of the ’70s.

For more than 15 years, the Malagrotta landfill site has been disposing waste from Rome, the “Vatican City” and the adjoining municipalities of Fiumicino and Ciampino international airports, accounting for a global yearly amount of some 1.5 million tons. In addition, a special unit treats about 150,000 tons of sludge from domestic waste water treatment plants.

The engineering, construction, and operation of the Malagrotta landfill have meant – and still entail – such a significant amount of investment, research, testing, human resources, and technology that the site has been appropriately nicknamed "the city of environmental industries".

Since the early '90s, particular focus has been placed on the use of biogas as an alternative energy source.

The first attempt in this field was a system co-designed by S.I.C.E.S. S.r.l. and Eniplan Ltda. to produce fuel similar to oil products for road transport use: in addition to responding more than adequately to this purpose, biomethane releases significantly lower emissions into the environment than conventional fuels.

5.1.1 The process

The treatment process consists in purifying biogas derived from controlled MSW (municipal solid waste) landfills. The purification process can be applied to biogas of different origins, like biogas produced from the anaerobic fermentation of industrial organic waste, biogas from fermentation in sewage treatment plants, and so on.

5.1.2 General information on landfill biogas

The production of biogas from MSW is a spontaneous process that demands no energy input from outside thanks to the anaerobic digestion of MSW itself.

The production of biogas from MSW landfills results from the anaerobic digestion of organic materials in landfill sites, performed by highly-specialised bacterial populations contained in

MSW. These micro-organisms degrade organic matter through a number of phases leading to the production of intermediate products, which are gradually metabolised and eventually converted to methane and carbon dioxide.
Biogas production processes are spontaneous. The pace at which these processes occur depends on waste composition and landfill management. There are three main phases in biogas production:

a) *Hydrolysis and acidogenic fermentation*
This phase consists in the hydrolysis of organic compounds – such as carbohydrates, fats, proteins –, which are transformed into smaller molecules. Compounds like starch and cellulose are hydrolysed into oligosaccharides and monosaccharides; fats are hydrolysed into long-chain fatty acids; proteins are hydrolysed into amino acids.

b) *Acetogenesis*
The organic compounds produced in phase a) are transformed into acetate (CH3C00-+H+) through oxidative metabolism and dehydrogenation processes, which demand low concentrations of hydrogen.
The hydrogen produced in the first phase can be removed by bacteria that produce acetic acid from carbon dioxide and hydrogen.

c) *Decarboxylation of acetic acid and CO2 reduction*
At low concentrations of hydrogen, methane is mainly generated through acetate decarboxylation by methanogenic bacteria (Methanotrix, Methasarcina) that produce methane and carbon dioxide in a 1:1 ratio.

About 70% of the methane produced will normally result from this reaction.

The hourly production rate of biogas that can be captured is defined on the basis of the average output assumed in a 15-year time frame. Considering the actual biogas output trends and that MSW dumped over an average period of 3 years is gathered on the same lot, the actual production rate is expected to be higher than assumed at design stage for the first 7-8 years of biogas capture.

5.1.3 Energy recovery from biogas and environmental safeguard

BIOGAS derived from the anaerobic fermentation of organic waste (MSW) has a significant energy content. As a matter of fact, its 50 - 60% methane content provides it with a heating value (HV) of 4000 - 5000 kCal/Nm^3 and corresponding energy content.

Alongside methane, the so-called raw biogas contains inert compounds and, most of all, polluting and corrosive compounds such as hydrogen sulphide (H_2S), hydrochloric acid (HCl), hydrofluoric acid (HF), silicon compounds, and other compounds such as acetic acid, butyric acid, aldehydes, etc. Moreover, it is saturated with humidity, which increases corrosiveness even in relatively inert gases like carbon dioxide (CO_2).

The direct utilization of raw biogas, especially in internal combustion engines for automotive applications or electric power generation, will imply:

- low efficiency owing to the relevant amounts (30 - 50%) of inert gases
- adjustment difficulties owing to the variable behaviour of non-combustible compounds

and most of all:

- low operational life time of vehicles owing to the high corrosiveness of this gas
- high maintenance costs owing to the need to frequently replace parts and, above all, lubricating oil that is easily degraded and contaminated by the gas pollutants.
- higher operational costs owing to greater difficulties in maintaining engines adjusted.

On top of these economic issues, there are ENVIRONMENTAL IMPACT problems related to the air pollution caused by the use (burning) of raw biogas. As a matter of fact:

- The massive content (about 40 %) of CO_2 (carbon dioxide) in raw biogas results in an increase of NO_x and toxic CO in engine combustion chambers.
- Although hydrogen sulphide (H_2S) can be found in small amounts [50-200 ppm (vol.)], when it is burnt, it converts into SO_2 (sulphur dioxide) and SO_3 (sulphur trioxide). If there is humidity, SO_2 and SO_3 convert into sulphurous acid and sulphuric acid, which are the main causes of ACID RAIN. Moreover, H_2S is a highly poisonous gas.
- Despite their negligible concentrations in biogas, hydrochloric acid (HCl) and hydrofluoric acid (HF) are, in engine exhaust gases, major causes of ACID RAIN owing to their high reactivity.

5.1.4 Raw biogas purification

Recovering energy from biogas requires a purification plant that reduces the pollutants released into the atmosphere by conveying them to the leachate treatment plant, from where they are then disposed of in special units, thereby obtaining purified biogas that allows to optimise the operation of endothermic engines and keep air pollutant emissions largely within standard limits.

Hydrogen sulphide results from the anaerobic fermentation of products containing sulphur compounds. It is almost completely washed out in scrubbers and then conveyed to the treatment plant, thus preventing if from being both released into the atmosphere and carried to endothermic generators.

Also hydrochloric acid and hydrofluoric acid are fully removed by converting them to sodium and calcium chlorides and fluorides, which are then forwarded to the treatment plant.

5.1.5 Origin of the technology

This technology has been developed since 1983, starting from existing technologies, with the purpose of offsetting the drawbacks of traditional processes, such as the poor purity of the gas obtained and its humidity content that is particularly harmful in case of use in vehicles.

Starting from the existing gas scrubber, which operated by washing the gas with water (or aqueous washing liquids), the technology has been upgraded by adding molecular sieve selective absorption. After building a pilot installation (50 Nm^3/h of pure gas) that has made it possible to fine tune the technology, industrial installations have been engineered (500 - 1000 Nm^3/h of biogas).

As a consequence, the current biogas treatment technology can be said to be the result of well-established lasting experience from more than 10 years of operating industrial installations.

5.2 Tiburtina railway terminal: a new city centre

5.2.1 The New Railway Station as a City Centre: Reconnecting the Nomentano and Pietralata Districts

Designing the New Tiburtina Railway Station – as suggested by the call for projects – offers an opportunity to build a new city centre, which may be spatially and physically reconnecting two districts that have been historically separated by the railway tracks.

Starting from the provisions of the Urban Development Plan, the project design enhances some existing local layouts and axes that have become the reconnecting points of the New Railway Station to the physical context of the two districts it extends on. The large pedestrian arcade built on the railroad bridge may thus create a bridge terminal as well as a city monumental indoor boulevard capable of joining the Nomentana and Pietralata city districts through a complex and sophisticated system of squares and pathways that establish continuous urban space by connecting the big station building to the smallest areas of those local contexts. The overall design aims to combine the inevitable "*atopia*" of any major international passenger transport terminal with the inescapable needs of city physical settings as well as with the innermost and most fragile meaning of local contexts and the historically accomplished identity of individual places and the city. The big borderless railway terminal will be connected to the urban fabric by redeploying it to the city scale, by means of its structural axes and the design of its public spaces.

5.2.2 The New Railway Station as a Chance for Environmental Redevelopment.

This project design aims to consider the New Tiburtina Railway Station as a chance for the city environmental redevelopment and infrastructure endowment. This mission is pursued by means of a strategy that is globally aimed at identifying the environment as a major framework of infrastructure endowment to be systematised by the project design. The pedestrian arcade is meant to be a large city boulevard that will make it possible to reconnect the Nomentana district and the Pietralata park, by having the latter incorporate the environmental fragments of the former. The big city boulevard will link the park natural landscape to the city urban landscape by forming the initial sequence in the park new design setting.

This goal is achieved by dedicated pathways both on the Pietralata district side – which directly join the park from the bridge arcade through pedestrian walkways – and on the Nomentano district side (where the southern square and its steps reconnect the arcade level to that of the large environmental fragment where two farmhouses subject to restriction are to be found).

Moreover, the boulevard arcade is designed as a large environmentally friendly structure also from an architectural and technological perspective, thanks to the use of experimental technologies in the fields of bioclimatic architecture and overall environmental sustainability control.

5.2.3 The New Railway Station: General Architectural and Integrated Engineering Concepts.

The Bridge Railway Terminal is herein designed as a large elevated arcade that serves the dual purpose of an international railway station and a major city boulevard. These two purposes are made mutually compatible by the concept of extremely high indoor space that is fully adaptable to the most varied layout needs.

The spatial concept of a big container of floating suspended spaces is of course consistent with the structural requirements that suggest a "suspended" organisation of space capable of optimising the structural bays of upper floors and solving any criticality resulting from the vibrations transmitted to the current platform-based structures by the passing and stopping of high-speed trains.

The idea of freely floating spaces in a container that can interact with the outdoor environment from a climatic standpoint is also consistent with the general bioclimatic approach of the design.

The concept of an arcade without structural constraints at an elevation of +9.00 allows for true flexibility in using space by means of free layouts where shopping areas and waiting rooms can be actually integrated like in big airport terminals.

The bridge arcade is built over the existing floor, which the new design has fully utilised across its length and width. Volumetrically speaking, it is a big parallelepipedal glass structure of 50 x 240 ml and a constant height of 9.80 ml. The parallelepipedal glass structure is supported by an upper net-like external structure, to which both the side windows and the flat roof (which is also partly in glass) are hooked. This big net-like external structure is built over and outside the glass building. Along its southern and northern sides, it rests on two rows of circular pillars of 2.00 ml across, which are in line with the side reinforced concrete walls that support the existing floor, thus forming a mesh of about 50 ml clear span.

The side windows are made up of a stretched supporting structure and special plate glass windows linked to stay wires by means of a steel hook. The glass used is a Thermal Insulating Material (TIM) in order to ensure proper insulation from sun rays and noise. The big arcade will be covered by a suspended flat roof made up of alternating transparent and opaque plate glass. On top of transparent plate glass windows, laminar shading devices are mounted on the external net-like structure in order to shield the parallelepipedal glass structure from the sun reaching the zenith in summer while letting winter sun through.

The big suspended areas host facilities and amenities (VIP lounges, internet access points in catering areas, a restaurant, offices to rent, a small conference centre, an electronic traffic control room, and so on), which are usually to be found on the upper levels of airport terminals.

These are eight separate suspended areas, each one having its own direct entrance by staircase and lift on the arcade floor at an elevation of +9.00. These separate areas are connected at a higher level by the suspended maintenance gangway that runs centrally across the glass station building lengthwise, at an elevation of +15.00.

5.2.4 The Bridge Terminal as a Smart Building

Following the obligations undertaken by parties to the Kyoto Protocol, the recent White Paper (7th April, 2000) of the European Commission outlined an integrated and coordinated action plan aimed at significantly reducing greenhouse gas emissions. Moreover, the increasingly considerable role devolved to local governments in resource management demands a new comprehensive strategy for energy conservation and proactive environmental protection. In this regard, Law No. 10/91 – which was passed to implement the National Energy Plan – is presently becoming a reference framework in promoting with greater emphasis the rational use of energy (RUE) by practitioners on the one hand, and energy saving habits among consumers on the other hand.

With regard to the former, Law No. 10/91 compels designers to meet the energy demand of public buildings by using renewable energy sources or similar options, barring technical and/or economic obstacles. The term "similar options" is understood in a broad sense and also includes energy saving achieved by acting on the building envelope (bioclimatic architecture) and on technological equipment.

5.2.5 Bioclimatic Architecture

The design of the New Bridge Railway Terminal – namely the arcade – stems from the use of effective bioclimatic strategies. In particular, the following systems have been adopted:

- solar radiation *active control systems;*
- *passive control systems* to obtain natural cooling in summer time and heating in winter.

All the systems used are easy to manage and maintain, and do not require any specific human intervention.

The big parallelepipedal glass arcade is an engine that constantly produces hot air by greenhouse effect. The hot air produced is used directly in winter time, while in summer time, the thermal lift properties of hot air are used to trigger off convective air recirculation that provides the arcade with continuous fresh air delivery.

In summer time, in particular, solar radiation is shielded by active control systems. Being set back from the flush of the upper structure, at the passage of emergency vehicles, the southern side of the arcade is self-shielded. As explained above, protection from sunlight at zenith is ensured by systems of laminar grids mounted on the outdoor net-like structure. The slope of the laminar systems will ensure complete shading from summer sunlight at zenith, while allowing the solar heat radiation to go through when the sun is low in winter time. Owing to its thermal properties, the hot air produced in summer time will flow upwards out of the roof-top ventilation stacks anchored to the outdoor net-like structure. These ventilation stacks are designed to pull indoor air out of the building thereby creating a depression that is fuelled by the controlled intake of outside air. Outdoor air delivery exclusively relies on the bioclimatic system installed all along the edge of side windows, at the base of the plate glass. Through this system, the outdoor air that is pulled into the building is made to flow through a cooling radiative system. This radiative air cooler utilises the cooling power of sprinklers that spray water onto the internal surface of a radiative plate, whilst incoming air flows on the external surface of the plate. Without coming in contact with the water circuit, outdoor air is gradually cooled and pulled into the building by the continuous flow of hot air escaping from ventilation stacks, thus forming a continued convective cooling loop.

In winter time, instead, hot air is produced by the greenhouse effect of solar radiation not being shielded by the outdoor horizontal laminar shading devices. Like in summer time, hot air flows out of ventilation stacks by thermal lift, thereby creating depression in the arcade building. This depression is balanced by the outside air pulled in: in winter time, cool air comes into the bioclimatic system at the base of the arcade side windows. During the winter season, the cooling radiative system will be off, while the heating coil installed in the last chamber of the unit will be on, thus letting pre-heated air in and triggering a continued convective heating loop.

5.2.6 Rational Use of Energy (RUE): Informative Criteria for the Integrated Design of Technological Equipment

The New Tiburtina Terminal design has been elaborated using renewable energy sources and state-of-the art energy saving technology, the aim being to optimise and balance design options according to an integration approach.

Below are some informative criteria on the use and features of renewable energy sources as envisaged in the preliminary design.

Low-Temperature Solar Thermal Energy
This technology consists of a very advanced compound parabolic concentrator that offers a great potential for integrated and multipurpose use. In the New Tiburtina Railway Terminal, solar energy will be used to produce hot water as well as to supply refrigerating energy by means of absorbers and/or to provide geothermal heat pumps with additional energy.

Cogeneration
The combined – rather than separate – production of heat, power and cooling is becoming more and more widespread owing to the thermodynamic efficiency of cogeneration units. In particular, in such a complex scenario as a railway station that is constantly under strain in terms of energy supply and consumption, cogeneration makes it possible to reverse the consumer/producer relationship, by only resorting to the national transfer network for complementary and/or emergency supply in critical situations.

The results of the technical-economic analysis can be found in the Technical Report.

Photovoltaic Energy
The use of specially designed photovoltaic panels installed on the large flat roof on top of the external net-like structure – which will make it possible to benefit from regional subsidies covering up to 75 % of the total incurred cost – will supply energy to some of the electric engines of technological equipment, such as motor pumps and fans.

Geothermal Heat Pumps
Geothermal heat pumps use the ground as a natural heat source that is available at a relatively constant temperature: as compared to outdoor air, it is higher in winter and lower in the summer. In particular, this technology is supposed to be used to provide alternative and/or supplementary energy supply for low-temperature installations (radiant panels, heating appliances, and air treatment systems).

Building Management System (BMS)
A BMS is a computer-based control system that manages the integration of traditional and alternative energy sources by interacting in real time with the building and its equipment through a neural control and information network. It should be considered, for all practical purposes, as a "virtual energy saving system" in that it monitors, handles, and optimises all the energy management systems in a building throughout their life cycle around the clock. Specifically, the system envisaged should:

- ensure continued environmental safety control of all the areas in the building 24 hours a day;
- automate equipment operation by means of automatic adjustments, optimised start and stop, time and event sequences, and so on;
- allow for the remote control of technological equipment and scheduled maintenance management;
- integrate several autonomous sub-systems such as fire detection, access control, intrusion detection, and so on.

In conclusion, BMS is the system intelligence of the sophisticated New Railway Terminal, where the combination of system engineering and architecture makes it possible to draw, convey, modify, manage, and return alternative and supplementary energy so as to strike a balance between the building and its environmentally friendliness.

N.B.
The project design presented herein won the “Tiburtina Railway Terminal” international contest.

In 2002, the design was awarded the "EUROSOLAR Italia" prize and is the Italian nominee for the European corresponding award.