ECONOMIC, ENVIRONMENTAL AND ENERGY ASSESSMENT OF THE TURIN-LYON HIGH-SPEED RAIL

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ABSTRACT

One of the best known cases of struggle for the commons in Italy, characterized by bitter controversies over the last 20 years, is the popular opposition to the construction of the High Speed Railway line (HSR, "TAV" in Italian) between Turin and Lyon, designed to cross the Susa Valley (at the Italian-French border) and the Alps. This HSR project still carries, in spite of twenty years of continuous updating and reworking, a great deal of unsolved environmental and economic issues. An issue of insufficient cost-benefit balance has recently come to clear evidence, especially in view of the non-negligible passenger and freight traffic decrease along the Turin-Lyon direction. The most important aspects dealing with economic costs and claimed benefits, energetic considerations, legal constraints, environmental impact, health impact potential, and the negative experience of other projects, are discussed: they all suggest that the High-Speed Train Turin-Lyon is not a priority for Italy and France, and its construction should be immediately stopped.

INTRODUCTION

The construction of the High Speed Railway (HSR, TAV in Italian) line Turin-Lyon in the Susa Valley (Italy) has long been surrounded by bitter controversies about the most significant and technical aspects of the proposed project. Beyond the claims and positions in favor or against HSR implementation, this paper aims to explore some of the critical aspects of the proposed project. The HSR project brings with it, after more than twenty years of strenuous and continuous reworking, a large number of environmental issues. Main pollution problems dealing with the railway construction have been put into evidence by several studies and official reports. For instance, the presence in the Susa Valley of geological formations with asbestos and uranium is a particular concern, also considering the final destination of the extracted inert [Lucia Bonavigo, Massimo Zucchetti, 2008]. Aspects related with local hydrogeology and its perturbations, and noise, are also of huge concern [Gianfranco Chiocchia, Marina Clerico, Pietro Salizzoni et al, 2010]. The insufficient cost-benefit balance, especially in view of the significant passenger and freight traffic decrease along the Turin-Lyon direction [Angelo Tartaglia,], has come to better evidence when the French Government (as of July 2012) announced a spending review that could stop the

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construction of the HSR Turin-Lyon and other ones on the French side [report for instance]. Beyond the technical problems related to the HSR, the Susa Valley has become in the recent years the most famous episode of the struggle for the Commons in Italy. In this country, the concept of Commons as resources shared among communities and for which everyone has the right to be involved in decisions that expose them to risk or damage is still far from being widely accepted, even by some scholars that are strongly against this project. These scholars think that local resistance can be easily manipulated in order to demonstrate an "egoistic" attitude of the opponents, of the "NIMBY" type (Not In My BackYard). The No-HSR movement ("Movimento NOTAV" in Italian)[2] has put this question into evidence to the eyes of the Italian public opinion: beyond the question "HSR yes/no", the opposition movement puts forward its struggle as a legal/social/political strategy for reclaiming the Commons (land use change, water availability and quality, hydro-geologic stability, biodiversity affected by the infrastructure, quiet) and protecting them from privatization, claiming for a different concept of democracy and public participation [Donald Gray, Laura Colucci-Gray and Elena Camino,2009]. Last but not least, the concept itself of this type of investment is under deep review, since the huge amount of public money invested or planned in support of such development does not appear to be justified by sufficient economic benefits related with the investment. In other words, not only a sequestration and degradation of the Commons is going to take place, but also there is no advantage at all in economic terms, except probably for the companies involved and, more likely, the banking system. Getting back to the technical questions, we believe that the usual appeal to the Precautionary Principle, in the case of HSR project, is not even necessary. Economic data, energetic considerations, legal questions, environmental impact, the health impact potential, the negative experience of other projects, and especially the common sense, suggest that the High-Speed Train Turin-Lyon is not an actual priority for Italy, and its construction should be immediately stopped.

MATERIALS AND METHODS

The Susa Valley. A brief description of its nature and history. The Susa Valley is located in Northwest Italy at the border with France, from which it is separated by the Alps, 3600 meters high. It is the widest valley in the Western Alps; in fact, it is a natural corridor stretching from East to West. The two sides of the valley benefit from different sun exposure and this makes them quite different from one another. The left side is dry, while the right side is humid, shady and cold. The natural environment, and particularly the flora, are deeply affected by this peculiarity, resulting in a valley with extremely variegated and interesting sites and habitats. In particular, the Susa Valley is defined as a Site of Community Importance (SCI) according to the so-called European Commission "Habitats Directive" (92/43/EEC), within the Natura 2000 Network. The Dora Riparia River runs through the valley, and there are abundant springs and superficial aquifers. In the high part of the valley there are pastures, while at lower heights (1300–1800 meters) there are steep crevasses. The Susa Valley is among the most developed alpine valleys from economic and infrastructural points of view. It is crossed by two main roads through the passes Monginevro and Moncenisio. Moreover, a motorway and an international railway reach France through the Fréjus tunnel. The Valley hosts three hydroelectric dams and is crossed by two electric lines. Many tourist and sport resorts make the valley a tourist attraction (is also was the base of the 2006 Winter Olympics). There are many industries, including mining, and many military roads built in previous centuries that are currently international tourist attractions for walkers and cyclists.

The valley has about 90,000 inhabitants, and it is divided into 39 Municipalities. There is a well-established tourist industry, as it is evident by the presence of "second homes", hotels and motorway traffic. Notwithstanding the heavy human presence, the Susa Valley features wide semi-natural and wild areas, which host many examples of alpine fauna (deer, chamois, roe deer, wild boar, eagles, hawk, partridges and wolves) and a very rich diversity of flower

[1] The first HSR proposal dates back to the end of the eighties, and soon after the opposition in the Susa Valley started. In 2011, the new site for the HSR surveys was chosen in the Chiomonte village (Val Susa). After that, many manifestations took place, while the actual work for the HSR construction has not begun yet. The Association of villages of the Susa Valley (Comunità Montana della Val Susa e Val Sangone: CMVSS, www.cmvss.it) has – during the years – set up a team of scientists and experts, many of them from Italian universities. This team has performed technical analyses and produced reports and papers, which have been briefly summarized here: the cost-benefit analysis, the environmental impact assessment and many other studies have been used by the CMVSS for its action of legal opposition to the HSR construction.

species: there are four natural parks, two natural reserves and many areas of European interest. Livestock rearing, which was very intense until the end of World War II and subsequently declined, is now in a new phase of growth, albeit slow, and consists of about 7000 cattle, 10000 sheep and 500 goats.

The Susa Valley has a very ancient history, and many signs of its past wealth are still visible: archeological sites, Roman villas, churches and abbeys, castles and fortresses, which attract thousands of tourists every year. At the time of the Romans, the alpine crossovers of the valley acquired strategic and military importance: it is believed that Hannibal trespassed in 218 BC and Julius Caesar crossed over in 61 and 58 BC, marching towards Gallia (ancient name of France). After the fall of the Roman Empire, different populations took over each other: Goths, Byzantines and Longobards, until in 774 AC, the French Emperor Charles I the Great conquered Italy passing through the Susa Valley. Around the end of the twelfth century, many abbeys were built, still well preserved and open to visitors today. In 1854, the Turin-Susa Railway was constructed, followed in 1871 by the Fréjus tunnel. After the World War II, the valley remained part of Italy, but the Valle Stretta and the Moncenisio were handed over to France. In conclusion, the geographical location of the Susa Valley makes it a site of considerable wealth of natural resources, which have supported economic and cultural development over many centuries. However, the history of the valley also suggests that this has always been an area of conquests, conflicts and political appetites.

The High Speed Rail Turin-Lyon. The problems. Let us examine why the HSR project [Angelo Tartaglia; Paolo Beria, Raffaele Grimaldi, 2011] has been proposed and why it is still at a preliminary stage after more than 20 years from its beginning.

Concerning freight, the central problem is that rail freight transport in Italy occurs at an average speed of 19 km per hour [Angelo Tartaglia], since trains are often diverted and parked in transit stations, to provide priority to passenger trains. This is the main bottleneck requiring improvement. It's a nonsense for commodities to arrive from France at a speed of 150 kilometers per hour and have to stop and spend most of their time in a transit station when they arrive in Italy.

Concerning passengers, it makes sense to talk of High Speed when the journeys are longer than 250-300 km. In Italy, if we look closely at the rail transport statistics [Angelo Tartaglia; Marco Ponti,2005], we can see that 80% of the demand for passenger transport is for short journeys, less than 100 Km. It's true that Italian trains are overloaded with passengers on certain routes but only very few people go from one end of the country to the other, taking real advantage of the high speed (they tend to use the air services instead).

A study commissioned by the Mountain Community of the Susa Valley carried out by a Transport Engineering Company shows that the line would be justified only by a 40 million tons of freight traffic per year, translating into a total of 350 trains per day, one train every 4 minutes at the speed of 150 km/h**,** alternating with passenger trains at 300 km/h.

The costs that are officially foreseen are for the entire line, not just the basic tunnel. Official estimates are around 22 billion euro, but previous experience shows that forecasts are much lower than real costs. The Italian Milano-Salerno high speed train line, already implemented, cost three times more than the forecast [Marco Ponti,2005]; the benefits for long-distance passengers in terms of time saved cannot be disregarded, but it is balanced by much higher tariffs, and, more than that, in terms of global investment. An ex-post cost-benefit assessment published by Beria and Grimaldi [Paolo Beria, Raffaele Grimaldi, 2011] in 2011 shows that even the high ticket prices on the Milan-Salerno HSR line do not pay back the long-term investment and daily operation costs. The implementation of the Turin-Lyon would probably be even worse, since the expected number of passengers is very low: the line should thus be essentially used for the transport of commodities, a modality that has been declining in the last 10 years [Angelo Tartaglia] and that seems to have limited growth perspectives, due to the future competition by the new Gotthard tunnel at the Italy-Switzerland border, expected to attract the large majority of traffic in the North-South direction. Moreover the existing line, recently renewed and improved, can carry up to 20 million tons [Angelo Tartaglia], a capacity that is much far from being saturated in the short-medium time. Proponents of the Turin-Lyon HSR foresee 14 passenger trains a day, while the line capacity is already 250 trains at present. Moreover, commodity traffic on rail is declining Europewide with very few exceptions, due to the fact that mature economies do no longer exchange heavy raw materials (bricks, wood or coal) as two centuries ago. Today's goods (highly manufactured and technological items, such as fashion, electronics, fine chemicals) are much lighter per unit of economic value, and it is very difficult to carry them by rail, due to a variety of structural, management and distribution reasons. Their amount, however, would not justify a huge HSR investment.

The environmental impact for any new construction project is pretty high: if the project were really very useful, then perhaps the benefits could offset the environmental impact from the construction work. But in this case, given the large uncertainty about the usefulness of the project (very small, if any, shift of road traffic to the rail modality) and

given the high investment cost, the question if the environmental impact is justified by the benefits cannot be avoided.
Concerning construction and operating costs, at the beginning it was estimated that the whole Italian High-Speed network (and not just the Turin-Lyon HSR project) would pay back for 60% of its costs. Then this came down to 40% and finally it was established that the 40% would not include the costs for the "nodes" near the cities, (really expensive). According to simulations in [Marco Ponti,2005], the final estimate would be around 20%. Concerning the Turin-Lyon HSR, even that 20% probably will not be achieved (no financial analysis is available yet), and the State is supposed to pay 100% of the costs. The Turin-Lyon is therefore a monument to dissipation: it will cost 2 or 3 times the planned (and always postponed) bridge over the Strait of Messina (and would be equally useless).
Actually, to develop innovation, we need to focus on technology rather than on cement.
As far as employment is concerned, nowadays, the massive projects have a modest multiplier effect: manual workers are not employed as they were in the 1800's. And it is also well known that Italy has a great tourist value in the future, which prevents from implementation of further landscape degrading infrastructures. Thus, there are more fruitful ways of investing public (and private) money.

RESULTS

The energy cost-benefit analysis. One of the main ecological justifications of the HSR projects would be the energy savings and the expected decrease of pollutant emissions, associated to the shift of a fraction of freight and passenger traffic from road (fuel driven trucks and private cars) to electricity driven railway.
The claimed virtuosity of the train is not always confirmed in real cases, and heavily depends on the energy investment for infrastructure, including the energy embodied in the materials and the necessary management and maintenance over the entire infrastructure life cycle. The ridership is also of paramount importance: in the presence of a small or decreasing traffic, the investment per unit of passenger and commodity transported would never be competitive with other transport modalities (or with a decreased transport demand driven by more local consumption, when such option exists). In the case of a big infrastructure project, such as the Lyon-Turin line between France and Italy, energy and environmental costs require a special attention and a careful analysis of the energy and material flows involved over the entire project life cycle.
Rail transport, however less versatile than road transport, may cause less local impacts and lower energy consumption. But this is only true if society uses and/or improves an existing network to the optimum possible extent and capacity. Instead, if a new line is constructed, with over 70 kilometers of tunnels, 10-20 years of construction work, thousands of trucks trips for transportation of materials to and from the site, million tons of excavated material to be disposed of, thousands of tons of iron and concrete requirement, heavy interference with underground and surface water, to mention only a few aspects, in addition to the energy necessary to keep the system operating, the consumption of raw materials and energy and related emissions could be so high as to completely nullify the potential advantage of the transport modality shift. A detailed assessment of these aspects is provided for instance in [Federici, S. Ulgiati, R. Basosi,2008; . Federici, M., S. Ulgiati, R. Basosi, 2009] and [Chester, M.V., and A. Horvath, 2009]. Concerning passenger transport, we can compare the total energy spent to carry a passenger for one kilometer, expressed in units of megajoules (MJ/p-km) through different transportation patterns. A bus has the lowest energy consumption (and related GHG environmental impact), with only 0.33 MJ/p-km. A car with one person on board is no doubt the worst solution, with 1.87 MJ/p-km. A conventional intercity train shows a much better energy performance (between 0.62 and 0.77 MJ/p-km, depending on load factor), while the HSR is characterized by a much higher energy demand and indirect GHG emissions (between 1.02 and 1.44 MJ/p-km). For freight, the best solution is represented by truck transport (1.25 MJ/p-km), while conventional train modality shows a consumption between 1.79-2.5 MJ/p-km. The HSR shows consumption ranging from twice to three times (2.17 to 3.09 MJ/p-km). Of course, results are affected by ridership and load factors. Calculations from [Federici, S. Ulgiati, R. Basosi,2008; . Federici, M., S. Ulgiati, R. Basosi, 2009] are based on present load factors from official statistics. A decreasing traffic would only have the effect of increasing the unit transportation costs and emissions. Claims of HSR proposers foresee increasing traffic in the next 30-50 years, which is not supported by present trend data and may rather be ascribed to fairy tales books. By the way, the present offer by the Italian railway companies (FS and NTV) is about improving comfort for a limited category of users (business and executive class coaches), with about 40% decreased number of seats. Decreasing ridership inversely affects energy and environmental costs.

Environmental impact analysis. The HSR construction carries a number of environmental problems, that have been highlighted by several studies [Lucia Bonavigo, Massimo Zucchetti 2008; Angelo Tartaglia; M. Federici, S. Ulgiati, R. Basosi; Claudio Cancelli, Giuseppe Sergi, Massimo Zucchetti, ed. 2006; Federica Appiotti, Fausto Marincioni,2009; Massimo Zucchetti, 2012].
We limit here to point out the presence, in the Susa Valley, of geological formations with asbestos and uranium: a case of particular concern, also considering the final destination of the extracted inert. The tunnel excavations will be more than 100 km in total, and will pass through zones with high presence of asbestos and uranium, interacting with the hydrogeological environment.

Radioactive excavation materials. Concerning Uranium, it is foreseen that a fraction of the resulting material from excavations will be disposed of in two open-pit mines in the Valsusa, Meana and Caprie [Massimo Zucchetti, 2012]. This would imply the dispersion into the environment of about 3.3 10^9 Bq of radioactivity, with likely water and soil contamination. Due to the action of meteorological agents, resuspension, and wind, such a dispersion of radioactive pollutants would expose the local population to collective doses of several thousands of Sv/person [Massimo Zucchetti, 2012].
Concerning excavation of tunnels in uranium-bearing rocks, even with quite low concentration, the main source of radiation exposure is radon (^{222}Rn), a radioactive gas, and radon decay products. Radon is colorless, odorless, and chemically inert; it is formed by the radioactive decay of uranium in rock, soil, and water, and has a half-life of about four days. When radon undergoes radioactive decay, it emits ionizing radiation in the form of alpha particles. It also produces metallic short-lived decay products, like: ^{218}Po, ^{214}Pb, ^{214}Bi, ^{214}Po, ^{210}Bi, ^{210}Pb. Their chemical reactivity and electric properties make them stick to dust and other tiny particles in air. These dust particles can easily be inhaled into the lung and fixed to pulmonary mucosae. The deposited atoms decay and eventually damage cells in the lung. A considerable amount of evidence has established that prolonged exposure to the α- emitting decay products of radon increases the risk of lung cancer [Lucia Bonavigo, Massimo Zucchetti Lucia Bonavigo, Massimo Zucchetti,2008] . Accurate measurements of concentration are mandatory by law in workplaces, and, in some cases, adequate countermeasures too. Compliance with dose constraints must be demonstrated by gas measurements and may be verified or predicted with dose assessments. The dose received by an individual working for the excavation of the HSR Tunnel is estimated, using the code RESRAD-BUILD [Lucia Bonavigo, Massimo Zucchetti,2008].
Natural radionuclide concentrations in the Susa Valley can reach quite high concentrations in some selected locations, due to the presence of several uranium-rich geological formations and even some former sample uranium mines dating from the fifties. For instance, the Regional Agency for the Environment of Piedmont, Italy (ARPA) measure concentrations up to 100 Bq/g in samples of rock collected in Venaus (Susa Valley) [ARPA Piemonte, 1997]. We however refer to more moderate values, far from the above peak values. In particular, the world average concentration of U in rocks is estimated to be 0025 Bq/g, while worldwide mean values for other natural radioactive species are: 0.028 Bq/g (^{232}Th) and 0.37 Bq/g (^{40}K). We, therefore, assume a concentration equal to 0.0265 Bq/g, that is around 3800 times lower than the peak values above. This value is in agreement with measurements conducted by ARPA during the excavation of a service tunnel, carried out by the Italian Energy Authority AEM, not far from the village of Exilles in the Susa Valley [ARPA Piemonte Report, 1998].
According to these values, the absorbed dose for workers due to the permanence inside the tunnel exceeds the lowest threshold (1 mSv/h) imposed by the Italian law [Italian Law, 1995] in the absence of adequate ventilation: in particular, the dose equivalent value of about 197 mSv/yr without any ventilation can be reduced to 1 mSv/h with an air exchange rate of 0.87 (1/h), i.e, all the air content of the tunnel must be completely changed almost every hour. It is an amazing result, considering that we assumed a quite moderate concentration of uranium just slightly superior to the world average: in presence of real uranium-rich formations that can be found in many places in Valsusa [M. Zucchetti, 2005]; these values would scale up to unsustainable levels.

Asbestos excavation materials. Concerning asbestos, HSR proposers claim that about 170,000 m^3 of asbestos-bearing rock with "relevant concentrations" [Italian Government,2012] can be found 500 m from the base tunnel. This assumption can be proved to be a huge underestimate of the real case, by at least a factor 10. First of all, let's note that "very low levels" are defined in [Italian Government, 2012] as "the ones under a 5% concentration of asbestos in rocks encountered during excavation", while the legal limit is about 0.1% according to the Italian Law; the latter banned asbestos from any use since 1992 [Italian Law, 1992], since even a few fibers can cause serious health damages: if such more appropriate threshold concentration is assumed for asbestos then the estimated amount of asbestos-bearing rocks in excavation material would be much higher than 170,000 m^3. Moreover, in 1995-1998 the Turin University [R. Sacchi, 2004] performed evaluations in the Susa Valley showing the presence of chrysotile and tremolite, both asbestos minerals. It is important to point out that the study was commissioned by Alpetunnel, the first company responsible for the design of the Tunnel. The most recent surveys carried out by the HSR proponents [Italian Government, 2012] and claiming the absence of asbestos are instead questionable. The sampling activities were carried out in points where no asbestos presence was expected: the tectonics structure of the Western Alps in the Susa Valley zone is very complex, having been involved in various geological events; as a consequence, sampling results would have been very different in the surrounding areas. Surveys of the University of Siena found asbestos fibers "with high tendency to defibrillation" [R. Sacchi, 2004] in 20 out of 39 rock samples tested in the Susa Valley. Further studies [Mario Cavargna, 2006] concerning the presence of chrysotile veins identified non-negligible asbestos concentrations in many serpentinite rocks in Val Susa. Tremolite veins are common in small masses of serpentinite schists in the Piedmont area, especially in the upper Val Susa. Rocks are potentially asbestos-rich also in other lithological contexts, the serpentinized peridotites of the "Mount Musinè" in Susa Valley [. Compagnoni e C. Groppo, 2006] and in the ultrabasic complex in Lanzo between Almese and Caselette in lower Susa Valley. The same rocks form the mountains above Chiusa San Michele, Sant'Ambrogio and Avigliana, municipalities included in the route of the international and domestic tracks of the HSR.

Hydrological risk.An assessment of hydrological risks connected with the HSR construction may be summarized as follows. In 2006, about 30 superficial water springs have been identified by the HSR proponents [23] along the old version of track of the national segment rail line, in many villages in the Susa Valley. Same situation appears in the Municipalities impacted by the international segment, where the number of water sources and creeks is quite high, with the complication that several of them are used as drinkable water supply. Therefore, two kinds of problems emerge:
• The excavation activities can drain or divert the springs leaving population without water
• The sources can be polluted, becoming undrinkable and unusable.
In the presence of very deep tunnel design, sampling surveys are not so easy because of the depth of some sites and because of the difficulty to reach the surface sampling sites located in the upper mountain. Just to mention an example related to the Susa Valley, during the activities for the construction of the "Pont Ventoux" hydroelectric power plant, a large number of high pressure water jets have been found, together with an underground lake of hundreds of thousand cubic meters. Moreover, the artificial lake of the Mont Cenis, a 333 million cubic meters water reservoir at 2000 meters of altitude, supplying power plants in France and in Italy, is located in the area. Interception of very high-pressure jets cannot be excluded a priori during excavations.

Carbon emissions. Train transportation modalities are claimed a priori to be carbon free or, at least, less carbon intensive. It is certainly true that a train does not directly release any CO_2 during its operation. However, the construction of the infrastructure (excavations, tracks, viaducts, concrete for tunnel walls reinforcement, electric lines) and vehicles, maintenance operations, and electric power all require huge amounts of energy that mainly are direct fossil fuels and fossil powered electricity. Considering the non linear increase of energy consumption of a running vehicle up to more than 3-4 times when speed increases from 100 to 300 km/yr [Burgess, E., 2011], due to the kinetic energy loss while braking and aerodynamic resistance; considering also the need for strong, complex and much more sophisticated infrastructures compared with regular IC trains, and finally considering the much lower occupancy per trip, CO_2 emissions per p-km and t-km come out to be more than 30% higher for HSR than for IC train [M. Federici, S. Ulgiati, R. Basosi,2008] and likely to be even higher than highway track transport in times of dramatic decline of traffic along the Turin-Lyon corridor. Infrastructure-related energy costs and emissions account for about 40-45% of total life cycle [M. Federici, S. Ulgiati, R. Basosi ,2008; Grossrieder, C., 2011], depending on the electric and energy mix of a country.
Calculations from the Italian Government's cost-benefit assessment [Italian Government,2012] point out – for the entire, not yet existing, East-West EU Corridor 5 - an annual decrease of CO_2 emissions equal to 3 million ton/yr avoided by the year 2055 with a net release until 2038; in that year the foreseen (although not supported by any present real traffic data) increase of traffic and related savings on road transport should offset the emissions associated to the infrastructure and operation of HSR. Surprising it may appear, these calculations do not include the emissions related to infrastructure construction, which means that about 40% of total life cycle emissions are not accounted for, thus making the break-even point much beyond the claimed year 2038.
Last, but not least, the Frejus highway in the Susa valley is presently used by approximately 3000 big transport trucks per day. The estimates supporting the HSR realization assume that there will be such a traffic increase that – as a result - more than 2300 more truck trips per day would occur, with a clear environmental pollution and traffic impact: therefore, in front of a future benefit difficult to evaluate and very uncertain, the final result would be, if the traffic forecasts were realistic, more trucks than now on the Valley roads.

Actually, all the results show that the traffic previsions used to support the HSR construction are unrealistic. It seems therefore very hard to support the claim that the construction of the HSR Turin-Lyon would be consistent with the requirements of the Kyoto Protocol, the EU Climate and Energy strategy (so-called 20-20-20 Directive) [Directive 2009/28/EC], and future similar low-carbon agreements.

CONCLUSION

Recently, a down-sized project was presented by the Italian Government [F. Pasquali, 2012], costing one third of the original one, and limited to the base tunnel, i.e. without any improvement of the existing line outside it ("Low-Cost Solution"). In practice, this makes the overall time savings very modest, eliminating any possible relevance for the passenger traffic. No analysis has been presented yet, but for sure this downsizing is the consequence of the local opposition, the lack of public funds, and the widespread skepticism of the academic world. For sure, all the relevant impacts will also be proportionally reduced, although this "success" does not make the expenditure any more justified.

Can the opposition against HSR be defined as "against Progress" [Claudio Cancelli, Giuseppe Sergi, Massimo Zucchetti, ed. 2006]? Results suggest the opposite to be true. Progress and wellbeing must not be confused with infinite growth. The territory of Italy is small and over-populated. Natural resources (water, agricultural land, forests, minerals) are limited. Pollution and waste are increasing. Fossil energy supplies are coming to an end. Progress means understanding that physical limits exist to our mania to construct and transform the face of the planet. Progress means optimizing, increasing the efficiency and durability of already existing infrastructures and built environment, cutting out what is superfluous and investing in intellectual and cultural growth more than material one, using minds more than muscles. The HSR represents the exact opposite of this idea: wasting resources for no benefit.

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