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walk the rail talk

Environment Sustainability of Rail Transportation

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ABSTRACT

The concept of "Sustainability" is one of the most hot topics related to the technological development in the modern era. It aims to satisfy the present needs without compromising the needs of next generations.

In order to measure the health of the planet compared with the technological progress, a set of sustainable environment indicators are available.

Noawadays, it's proved that each of these indicators is dramatically affected by the contribution of transportation. In particular, about 20% of the world's total delivered energy and conseguentially CO_2 emissions, is used in the transportation sector, but only 2% of this amount is caused by rail.

Since train can be considered the transport mode of the future, national railway company and European Union currently work for a continuos upgrading of sustainable rail transportation, in order to guarantee the best quality of life to European citizens.

KEYWORDS: Sustainability, Environment, Ecology, Green Mobility, Urban mobility

1. INTRODUCTION

In the last years, people realised the full impact that businesses and individuals can have on the environment, with the serious risk for every man to compromise the quality of life of their child.

At the same time, the "eco-friendly years" are the same in which the exponential growth of the global market pushes men to move covering wide distances through different transport modes.

It could seem a contradiction, since the fact that about 20% of the world's total delivered energy and conseguentially CO_2 emissions, is used in the transportation sector.

The answer to this conflict is the technology research aimed at sustainable transport modes, ie moving in the interests of protecting the natural world, with particular emphasis on preserving the capability of the environment to support human life.

How can any of us contribute with ecological trips, in order to win the sustainability challenge?

Taking a train instead of a car or a plane might be a good starting point!

2. ENVIRONMENTAL SUSTAINABILITY AND MEASUREMENT CRITERIA

Environmental Sustainability has been defined by the United Nations in 2005 as: *"Meeting the needs of the present without compromising the ability of future generations to meet their needs. Encompasses, e.g. keeping population densities below the carrying capacity of a region, facilitating the renewal of renewable resources, conserving and establishing priorities for the use of non-renewable resources, and keeping environmental impact below the level required to allow affected systems to recover and continue to evolve".*

In order to guarantee a sustainable environmental exploitation, man has considered a set of sustainable environment indicators, which can generally be understood as tools that analyse changes, while measuring and communicating progress towards the sustainable use and management of environmental resources.

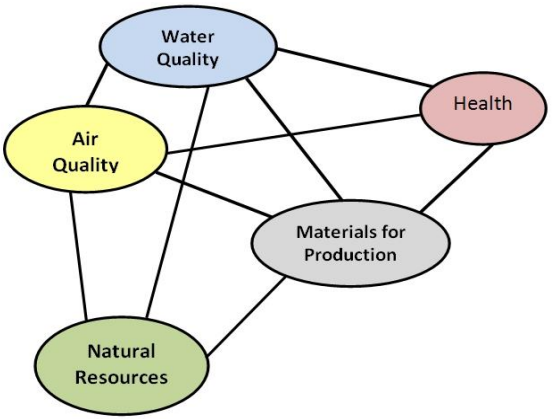

Figure 1: Indicators of Environmental Sustainability

An indicator complies must be compliant to the following

- **Specifity** (it must relate to the desired outcome, i.e. fit thepurpose for measuring)
- **Measurabiliy** (it should preferably be open to measurement in a quantitative manner);
- **Sensitivity** (it must readily change as circumstances change);
- **Reliability** (The information that an indicator is providing must be reliable. Data upon which the indicator is based must therefore be collected using a systematic method). [13]

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3. IMPACT OF TRANSPORTS ON ENVIRONMENTAL SUSTAINABILITY

Technical and economic developments during the last years have given rise to increased of people and goods that everyday need to move covering considerable distances.
As a result, the transport sector has undergone great expansion during this period.
Even if it heavily contributes to an exponential growth of the global market and allows faster and more confortable journeys to all travelers in the world, its environmental impact is significant because its usage of energy and burned petroleum. These factors create air pollution and contributes to global warming through emission of carbon dioxide.
Noawadays, it's proved that each sustainable environment indicator is dramatically affected by the contribution of transportation. In particular, about 20% of the world's total delivered energy and conseguentially CO_2 emissions, is used in the transportation sector.

3.1 COMPARISON AMONG TRANSPORT MODES

In the modern era, when man has finally understood that world's resources are not unlimited and the environment preservation is the foundation of life for current and next generations, how can any of us contribute with ecological trips, in order to win the sustainability challenge?
Let's start to analyze the different transport modes that bring passengers from a source to a destination, trying to understand how to compare them, in order to choose the most convenient and echological solution for our trip.

The most important transport modes (urban and extra-urban), can be mainly divided among road, aviation and rail. The most using common vehicle types and propulsion systems are listed in the following Table 1.

Transport Mode	Vehicles	Propulsion Energy
Road	Passenger Cars	Gasoline, Diesel
Rail	HighSpeed trains, Incercity, Regional and suburban trains	Electricity and Diesel fuel
Aircraft	Air planes	Kerosene
Feeder	Busses, Metro, Taxis	Diesel, Electrity

Table 1: Transport modes, vehicles and propulsion system

Table 1 shows also that the main energy carriers used in passenger transport are gasoline, diesel and electricity.
In order to compare the environmental impacts of transport processes with different energy carriers, the total energy chain (shown in Figure 2 for fuels and electricity) should be considered.

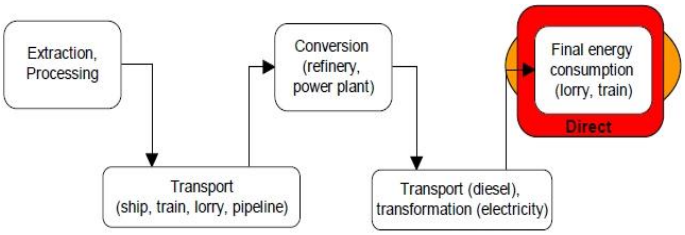

Figure 2: Energy chain for fuel and electricity

For every process step, energy is required. Most of the energy demand is covered with fossil primary energy carriers. But also renewable energy carriers and nuclear power are applied. The latter is associated with low emissions but other environmental impacts on human health and ecosystems.
The energy consumption over the total energy chain depends on the efficiency of the individual steps of the chain. [5]

3.2 ECOPASSENGER.ORG

Obviously, the process and concepts shown by Figure 2 is not so simple as to be easily understood and used by every passengers in Europe, so in order to be closer to citizens a good service has been provided by UIC, in cooperation with IFEU (the German Institute for Environment and Energy) and technical providers of European routing systems and software, Hacon and IVEmbH (routing system and software), with the release of the user-friendly internet tool *EcoPasseger.org*.

EcoPassenger is a calculator based on a sound scientific methodology, developed in order to compare the energy consumption, CO2- and exhaust atmospheric emissions for planes, cars and trains for passenger transport in Europe.
The user chooses a specific route, day and time for his journey. Based on the calculations of the energy consumption, the EcoPassenger generates for the specific route:

- the CO2-emissions (greenhouse gas)
- the particulate matter (human toxicity, greenhouse effects)
- the nitrogen oxides (acidification, human toxicity, summer smog)
- the non methane hydrocarbons (summer smog / human toxicity) for the train, a car and a plane on this distance.

Figure 3 shows the results for the route "Amsterdam – Munich".

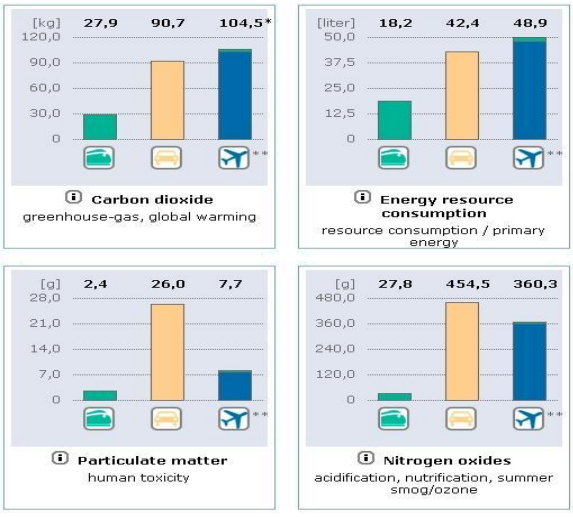

Figure 3: Transport modes comparison by EcoPassenger.org

3.3 COMPARISON RESULTS

Comparing the contribution to pollution for different transportation vehicles, the most important data is that emissions are dominated by road, followed by aviation and

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shipping. Thus, the train performs far better than the car and the plane on energy consumption.
Figure 3 shows that rail accounts only for 2% of CO_2 emissions within the transport sector. [2]

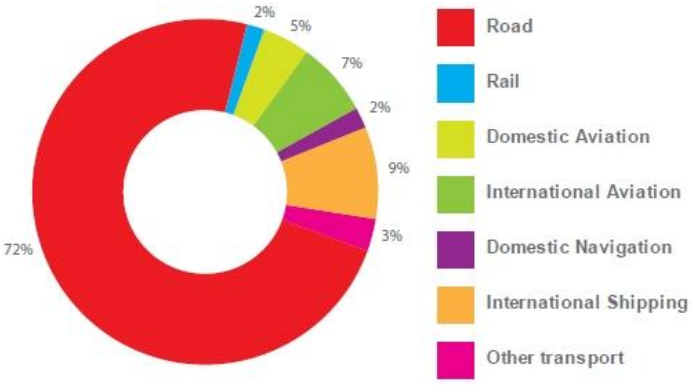

Figure 4: Polluting Emissions of different Transport modes

4. THE KEY ROLE OF RAIL TRANSPORTATION

Since the comparison results, we can understand why in years to come rail will have a central role in the development of sustainable transport systems.
Furthermore, railways, which carry many people and products at one time with less energy, will play an indispensable role in society, not only from the perspective of sustainable development, but also in terms of creating low-cost and energy efficient cities as well as impriving the quality of life itself in the regions. [2]

4.1 RAIL SUSTAINABILITY IMPROVEMENT: STRATEGIES

Asserting that rail is currently the most sustainable transportation mode, doesn't mean that it can not be further improved. For this reason, European Union and railways across Europe are working to meet stringent new emissions controls, both for new and existing vehicles. Let's try to briefly describe a couple of them, in order to understand the way of thinking and designing transportation in the next future.

4.2.1 EXTRA-URBAN MOBILITY

Regarding Regional and High Speed Lines, national railways and European Union has set ambitious long-term goals for CO2 reduction.
In particular, the following targets should be reached:
- **2020:** reduction of CO_2 from train operation by 30%
- **2030:** reduction of CO_2 from train operation by 50%
- **2050:** carbon-free train operation

4.2.2 URBAN MOBILITY

In 2009 an action plan on Urban Mobility was adopted by European Union. It provides a coherent framework in order to get 20 EU-level actions, implemented in the next years, until 2013.
European towns and cities face ever growing challenges to improve the performance of their urban transport systems, to reduce the negative impacts of transport activities on the climate,the environment and citizens' health, and to render urban mobility more sustainable. These actions all aim to support and enable efforts at the local level, rather than prescribe one-size-fits-all or top-down solutions. [3]
Here, we mention some of the most important actions, divided into themes:

Theme 1) Promoting integrated policies
- Accelerating the take-up of sustainable mobility plans
- Sustainable urban mobility and regional policy

Theme 2) Focusing on citizens
- Platform on passenger rights in urban public transport
- Access to green zones

Theme 3) Greening urban transport
- Research and demonstration projects for lower and zero emission vehicles
- Internet guide on clean and energy-efficient vehicles
- Information exchange on urban pricing schemes

Theme 4) Sharing experience and knowledge
- Upgrading data and statistics
- Contributing to international dialogue and information exchange

4.3 From theory to application: Alstom CITADIS

The tramway has become far more than a simple means of transport. It is also a means to develop sustainable urban mobility, rethink cities, revitalise districts and enhance architectural heritage.
Alstom proposes *Citadis*, a range of solutions for cities building new tramway networks as well as for those wishing to modernise existing networks. *Citadis* is a tramway technology platform built around environmental and social concerns:
- Visual pollution is reduced thanks to a design reflecting the city's image
- Noise and energy consumption levels have been reduced to a minimum
- Generous interior circulation and low floors throughout make the Citadis more accessible to all.

Figure 5: Alstom CITADIS 3D Model

5. CONCLUSION

About 20% of the world's total delivered energy and conseguentially CO_2 emissions, is used in the transportation sector. Comparing the contribution to pollution for different transportation vehicles, emissions are dominated by road, followed by aviation and shipping.

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Since rail accounts only for 2% of CO_2 emissions within the transport sector, it should be considered the most eco-friendly transport mode in the world.
Spite of this results, national railways and European union continuosly work togegher for a progressive upgrading of rail technologies, with the aim to adopt a sustainable development for the current and next generations.

6. NOMENCLATURE

$C0_2$ Carbon Dioxide
EU European Union
UIC Internation Union of Railways

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8. BIOGRAPHY

Maurizio Palumbo is the founder of railwaysignalling.eu, where he's also known as *Vesuvius*.
He was born in Naples, Italy, on 26 September 1986. He got , at the end of 2010, his degree in Computer Engineering from the University *Federico II* of Naples.
He's a curious, smiling and enthusiastic engineer.
Since the beginning of 2011 he has worked at Alstom Transport SPA in Bologna headquarter, as technical consultant for Alten, one of the European leaders in consulting and engineering. He has been involved in two ERTMS/ETCS L2 projects. In particular, he has specialized in the trackside subsystems, working both on Italian (Bologna-Florence High Speed Line) and Danish (Fjernbane East railway) projects.

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