Green Transportation a More Eco-efficient Option

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Abstract: Due to our lifestyle and way of using energy, especially in transportation systems, increase in green house emissions has become a threatening reality at present time and its impacts will be worse in the near future. Green transportation system aims to maintain a pollution free environment with lesser emissions and less impact on human health and on the natural environment. An eco-efficient transportation system means improving environmental quality, efficiency, and profitability by reducing unnecessary inputs and outputs in production and operation processes of transportation system. According to World Business Council on Sustainable Development, eco-efficiency is being achieved by the delivery of competitively priced goods and services that satisfy human needs and bring quality of life, while progressively reducing ecological impacts and resources intensity throughout the life cycle, to a level at least in line with the Earth's estimated carrying capacity. Eco-efficiency is a bridge between economy and the environment and is about increasing resource productivity and decreasing environmental pressure. Green transportation depends heavily on the energy linked to vehicle movements. Energy efficiency is affected by vehicle design, road infrastructure and operations. Every one of these factors should be reviewed from eco-efficiency perspective and environmental issues should become a prominent element in green transportation strategies, operations and technologies. Article will end with some recommendations towards green transportation, which is more eco- efficient option.

Keywords: *Green transportation, global warming, GHG emissions, eco-efficiency, energy intensity, factor 4, factor 10 and factor*

1. Introduction

Due to our lifestyles and way of using energy, especially in transportation system, increase in green house emissions has become a threatening reality at present time and its impacts will be worse in near future. It is about two decades that concept of eco-efficiency is developed by the World Business Council for Sustainable Development (WBCSD). The prefix 'eco' stands for both ecological and economic performance and the cross-efficiency between the economic and the ecological dimensions are the ratio between the change in value and change in environmental impact added Burritt & Schaltegger (2001).

Definition: According to WBCSD, eco-efficiency is being achieved by the delivery of competitively priced goods and services that satisfy human needs and bring quality of life, while progressively reducing ecological impacts and resources intensity throughout the life cycle to a level at least in line with the Earth's estimated carrying capacity WBCSDI (2000). Organization for Economic Cooperation and Development defines eco-efficiency as the efficiency with which ecological resources are used to meet human needs OECD (1998). According to OECD, eco-efficiency is the economic value added divided by the impact (the sum of environmental pressures generated by the firm, the sector or the economy).

Economic value added

Eco-efficiency= -----environmental pressure

European Environment Agency defines eco-efficiency as more welfare from less nature and says it comes through decoupling resource use and pollutant release from economic development EEA (1999). Therefore, eco- efficiency is a bridge between economy and the environment costs of purchasing and handling materials, which cause environmental, affects Burritt & Schaltegger (2001).

Philosophy: The main philosophy of eco-efficiency concept is “doing more value with less impact”. Yet there is another justification for presenting eco-efficiency argument and that is reducing wastes as much as possible. Wastes are products that companies manufacture but add no value to either customers or shareholders. From an ecological perspective, zero waste strategies would better align the human economy with the multi-giga years experience of natural systems, where waste does not exist because the waste of one organism is inevitably the food of another Friend (2009). The state of bliss (ideal state) in the context of resource environment, as Barbiroli says, is obtained when, by producing goods, services, value and richness, the amount of utilized material resource and energy is “0” (Figure 1).

Figure 1: Identification of the state of bliss in the case of the utilization of natural resources in an economic activity (at micro or macro level) Barbiroli (2006).

In order to move toward attaining this goal, clean production is recommended which involves the use of renewable energy and materials, the minimal use of resources, the design of sustainable products in a sustainable way, and returnable to the production process. Targets of eco-efficiency, at large are factors 4, 10, and X, by calling for increased welfare and reduced use of nature and for environmental space to be more equally distributed.

- Factor 4 is doubling wealth and halving resources use at the same time, thereby improving efficiency by a factor four. It addresses both consumption and production.
- Factor 10 focuses more on the reduction of resources consumption in economy as a whole. This concept moves beyond Factor Four suggesting that developed countries need to reduce resources use tenfold in order to truly be sustainable.
- Factor X refers to dematerializing of our economies. It has been proposed that material flows in the industrialized countries should be decreased by factor 10 to reach more sustainable level of material use. Aim of this factor is to increase resource productivity and increase the wealth created from the resources Schmidt-Bleek (1993).

Levels and dimensions: Eco-efficiency can be viewed from many perspectives: the macro-economic (national economy), the meso-economic (region) and the micro-economic (company) levels Meckwitz (2006). The WBCSD offers the following guide for increasing eco-efficiency:

- *Reduce the material intensity of goods or services;
- *Reduce the energy intensity of goods or services;
- *Reduce dispersion of toxic materials;
- *Improve recyclability;
- *Maximum use of renewable resources;
- *Greater durability of products;
- *Increase service intensity of goods and services WBCSDI (2000).

How eco-efficiency can be improved? Eco-efficiency can be improved through product and function. Product efficiency can be improved by implementing pollution prevention techniques or by introducing

end-of-pipe devices, reduced use of inputs per unit or through substitution of resources. Function efficiency is the ratio between provision of a function and the associated environmental impact added. It can be improved by substituting products that have low product efficiency with highly efficient products, by prolonging the life span of products, and by improving product efficiency Burritt & Schaltegger (2001).

Action Points: WBCSD has proposed 12 action points for government leaders, civil society, and business leaders. Action points for governments are as follows:

- Set macro-economic eco-efficiency targets and conversion criteria for sustainable development
- Integrate policy measures to strengthen eco-efficiency (by, for example, eliminating subsidies, internalizing externalities and effecting shifts in tax policy)
- Work toward changing international policy rules and systems for trade, financial transactions, etc, to support higher resource productivity and emissions reduction, as well as improvements for the underprivileged.
- The action points for society leaders and consumers are:
 - Encourage consumers to prefer eco-efficient, more sustainable products and services
 - Support political measures to create the framework conditions which reward eco-efficiency
 - Include eco-efficiency and sustainability in high school and university curricula and build it into research and development programs
 - Recognize and reward eco-efficiency and sustainability as investment criteria
 - Help eco-efficient companies and sustainability leaders to communicate their progress and related business benefits to financial markets
 - Promote and use assessment tools and sustainability ratings to support the markets and to help widen understanding of eco-efficiency's benefits.
- For business leaders the action points are:
 - Integrate eco-efficiency into your business strategy, including your operational, product innovation and marketing strategies
 - Report company eco-efficiency and sustainability performance openly to stakeholders
 - Support policy measures which reward eco-efficiency.

2. Importance of transportation

When it comes to eco-efficiency, transportation is among the most important considerations. This is due to the consuming a huge amount of energy and producing a considerable portion of emissions. Transportation usually goes far beyond other areas in pollutions and lags behind in reducing greenhouse gas emissions. Up to now, the measures being taken to achieve a reduction in emission levels are not reliable, as achieved energy saving is much lower than consumption growth (Uson, 2010). The current impacts of greenhouse gas emissions include global warming, more extreme storms, floods in some areas, droughts in others, increased chance of wildfires, and ocean acidification Fraser (2011). The increase of GHG emissions was about 1.5% per year from 1970 to 2000. However, these emissions were rising at over 3% per year for most of the last decade Raupach et al., (2007). Future impacts of GHG emissions include the more common occurrence of heat waves like the ones that hit Europe in 2003, Russia in 2010, and the U.S. mid-west in 2011; rising sea levels; adverse health effects; and mass migrations due to crop failure Fraser (2011). According to European Environment Agency, if the emissions from transport sector had been reduced to the same extent as for society as a whole, the total EU-27 greenhouse gas emissions for the period 1990-2005 would have fallen by 14% instead of 7.9% EEA (2008). Transportation has a significant role in flow function in the urban value chain and the key challenge is to effectively encourage people to shift to the energy-efficient modes of urban transportation and select more eco-efficient options. For example, trains are more efficient than cars. According to mobility, cars are two to three times less efficient than trains or other means of public transport [Uson (2010), Paravantis & Georgakellos (2007). Transportation depends on the energy linked directly to vehicle movements (end use) and to energy linked indirectly to this movement (indirect use) D'Agosto & Riberio (2004). Energy efficiency programs for transport are usually limited to energy end use, where the heaviest efficiency losses are found –e.g., while the whole supply chain of gasoline and diesel oil has an average energy efficiency of 85% Boustead & Hancock (1979), road vehicles energy efficiency rates are between 10% and 25% Poulton (1997). End use energy efficiency is affected by three factors: related to

vehicles design; related to road infrastructure and related to operation.

3. Green transportation

According to Dudow, a green transport service does not endanger public health or ecosystems, in short and long perspective and its characteristics are:

- Causes emissions and waste within the planet's ability to absorb them;
- Uses renewable resources at or below their rates of generation;
- Uses non-renewable resources at or below their rates of development of renewable substitutes;
- Minimizes the impact on the use of land and the generation of noise;
- The users of the system pay their total amount of the social costs of the activity Dudow (1998).

Since meeting all the above requirements are hard in reality, Bjorblund offers a more practical definition which it is adapted in this article: Green transportation service is the one that has lesser or reduced negative impact on human health and the natural environment when compared with competing transportation services that serve the same purpose Bjorklund (2010). The aim of green transportation is to make it eco- friendly and by using proper sources, help in maintaining a pollution-free environment.

Green transportation factors: The following factors are important in greening the transportation systems:

- People's environmental knowledge and sensitivity;
- Managers and employees awareness;
- Laws and regulations;
- Government priorities and requirements;
- Suppliers and manufacturers responsibility for continuous improvement;
- Strive for discovering efficiency opportunities in all the above.

In fact, individuals and governments are responsible for working hard towards greening the transportation systems. According to Fraser, what individuals can do are: conserving energy (walk, bike, use public transportation); use energy efficiently-drive cars with good gas mileage, and use energy-efficient appliances; rely less on gasoline for transportation and more on plug-in hybrid or fully electric cars. What governments and businesses can do are developing sustainable non-food bio-fuels, such as ethanol and biodiesel, and replace coal-fired power with renewable power, for example wind and solar Fraser (2011). The possibilities of greening transportation system would be reinforced if the knowledge of environmental issues promotes and strive to create the innovative efficiency modes and options increases among the stakeholders. Their collaboration as a team would decrease the environmental burden of the transportation system and increase the eco-efficiency in the urban areas.

4. Measures

Eco-efficiency measures are performance measures obtained through the ratio between product/service value indicators (V) and those for environmental influence caused by generation or use of the Product/service (EI) D'Agosto & Riberio (2004).

$VEM = \frac{V}{EI}$

Indicators: Indicators are tools that measure, simplify and communicate important issues and trends and are used throughout society in a multitude of ways. They can be used to translate and communicate complex information into easily understandable units which in turn can aid decision making at all levels Darby & Jenkins (2006). Indicators are important, as MacGillivray in 1998 noted: ...the fact of life means that the things we assess and measure are those we value most. On the other hand, the things we do not measure are all too easily ignored or marginalized Darby & Jenkins (2006). There are two kinds of indicators: the general indicators that are applicable in all businesses, and the specific indicators that fit the particular context of

an activity. According to Verfaillie and Bidwells, the two-eco dimensions of economy and ecology to relate product or service value to environmental influence Verfaillie & Bidwell (2000). The author believes that eco-efficiency should be viewed in a broader perspective, combining economic, social and ecological dimensions, as a whole. Considering these three interrelated dimensions, the following indicators are recommended as eco-efficiency indicators for green transportation. For more accurate green measures, further indicators might be added in each category.

Table 1: Eco-efficiency indicators for green transportation

Sector Indicator	Economy	Society	Environment
1	Infrastructure	Local culture	Toxicity potential
2	Resource use	Education	Atmospheric emissions
3	Income	Health	Carbon intensity
4	Employment	Security	Waste
5	Population biodiversity	Traffic	Destruction of biodiversity
6	Workforce	Life style	Flora & fauna
7	-----	-----	-----
8	-----	-----	-----

5. Conclusion & Recommendations

Since we all want to live in a livable planet, we need to challenge the destructive approach to our planet that represent the status quo, and if we are going to survive in the long run we should focus upon sustainability. This requires simultaneous pursuit of economic prosperity, social equity and environmental quality Adams (2006). The reality is that the worldwide volume of transportation is increasing and the race between improved technology and increased consumption will continue in a global level. This race must bring to an end. While there is significant potential for improving eco-efficiency in transportation systems, there seems to be less appetite among different countries to make the necessary commitments in this important matter. The author believes that the following devices would be helpful in promoting eco-efficiency in transportation and moving it forward to green transportation.

- Transportation sector is responsible for a large amount of emissions all over the world. Reducing GHG emissions from transportation can be accomplished in four main ways: Making cars and trucks more fuel efficient; switching to lower-carbon vehicle fuels; reducing the number of miles traveled; increasing the efficiency of the transportation system PEW.
- Eco-efficiency in transportation can increase by using a system approach which requires considering inputs, throughputs, outputs, outcomes and all the elements that somehow affect the system, ranging from supply chain, processes reengineering and necessary equipments in transportation.
- Public authorities need to initiate rules and regulations that reduce the dependency of green adequate tax on energy use in this sector, most likely would help to use less energy intensive options. Increasing partnership among the different stakeholders would be helpful in this matter.
- Management practices will help in promoting eco-efficiency initiatives. Burritt & Schaltegger believe that top managers need to challenge the destructive approach to environmental resources that represent the status quo. Middle managers need to develop tools to help the integration of
- 'win-win' competencies within a challenging environmental policy framework laid down by top management, and front line managers must be made aware of the entrepreneurial opportunities presented by environmentally benign activity Burritt & Schaltegger (2001).
- Citizens must change their lifestyles and meet environmental requirements more seriously. This can be an effective device if accompanied by technological fixes and improvements in energy efficiency strategies. The development of sustainable lifestyles will have to consider technological and social factors simultaneously and holistically, if a goal of increased eco- efficiency of consumption is to be reached Strndbakken (2009).
- Green enviropreneurs in transportation must be encouraged. These people focus on bringing

creativity and innovative methods in vehicle design, operation and maintenance; fuel efficiency targets; fleet inspection and pollution reduction; traffic control and citizen is training.

References

- Adams, W. M. (2006). The future of sustainability: Re-thinking environment and development in the twenty-first century, Report of the IUCN Renowned Thinkers Meeting, 29-31 January 2006.
- Barbiroli, G. (2006). Eco-efficiency or/and eco-effectiveness? Shifting to innovative paradigms for resource productivity. *International Journal of Sustainable Development and World Ecology*, 13(5)391-395.
- Bjorklund, M. (2010). Influence from the business environment on environmental purchasing- Drivers and hinders of purchasing green transportation services. *Journal of Purchasing & Supply Management*, Elsevier, 2(1).
- Boustead, I. & Hancock, G. F. (1979). Handbook of Industrial Energy Analysis, John Wiley & Sons, New York.
- Burritt, R. & Schaltegger, S. (2001). Eco-efficiency in corporate budgeting. *Environmental Management and Health*, 12(2), 158-174.
- Climate Change (2001). Technological solutions, understanding and responding to global climate change, Published by the PEW Center.
- Darby, L. & Jenkins, H. (2006). Applying sustainability indicators to the social enterprise business model. *International Social Economics*, 33(5), 6.
- D'Agosto, M. & Riberio, S. (2004). Fleet Operation, Science Direct-Transportation Research, Federal University of Rio de Janeiro, Brazil.
- Dudow, A. (1998). Eco-Logistics: Incorporating business transport issues into environmental management systems, International Institute for Industrial Environmental Economics, Lund University, Sweden.
- EEA. (2008). Climate for a transport change TERM 2007; Indicators tracking transport and environment in the European Union, European Environment Agency, Copenhagen, Denmark.
- EEA (1999). Making sustainability accountable: Eco-efficiency, resource producing and innovation, Topic Report No. 11, European Environment Agency.
- Fraser, B. R. (2011). The climate crisis and its solutions, Berkley, California, USA.
- Friend, G. (2009). The truth about green business, Natural Logic, Inc., FT Press, Upper Saddle River, New Jersey, USA.
- Meckwitz, P. (2006). Regional eco-efficiency indicators- a participatory approach. *Journal of Cleaner Production*, 14, 1603-1611.
- OECD (1998). Eco-efficiency, Organization for Economic Co-operation and Development, Paris.
- Paravantis, J. A. & Georgakellos, D. A. (2007). Trends in energy consumption and carbon dioxide emissions of passenger cars and buses. *Technological Forecasting and Social Change*, 74(5), 682-707.
- Poulton, M. L. (1997). Fuel-efficient car technology, Computational Mechanics Publications, Ashurst Lodge, Southampton, UK.
- Raupach, M. R., Marland, G., Ciais, P., Le-Quéré, C., Canadell, J. G., Klepper, G. & Field, C. B. (2007). Natural Academy of Science, <http://www.pnas.org/content/104/24/10288.full>.
- Schmidt-Bleek, F. (1993). The fossil makers, (<http://www.factor10-institute.org>), In: Wikipedia.org.
- Strndbakken, P. (2009). Sociology fools the technicians? Product durability and social constraints to eco-efficiency for refrigerators and freezers. *International Journal of Consumer Studies*, 33, 146-150.
- Uson, A. A. (2010). Energy efficiency in transport and mobility from an eco-efficiency viewpoint, *CIRCLE*, University of Zaragoza, Spain.
- Verfaillie, H. A. & Bidwell, R. (2000). Measuring eco-efficiency, a guide to reporting company performance, WBCSD.
- WBCSD (2000). Eco-efficiency, creating more value with less impact, World Business Council for Sustainable Development.