[*SCENARIO ANALYSIS OF URBAN PASSENGER TRANSPORT ENERGY CONSUMPTION AND EMISSIONS USING LEAP MODEL: A CASE STUDY OF TIANJIN, CHINA*]

[Binbin Peng, College of Management & Economics, Tianjin University, China, +8615822456880, binbinpeng@tju.edu.cn]

Keywords

Energy consumption; Emissions; Urban passenger transport

Overview

With the rapid growth of vehicle population, the urban passenger transport sector is greatly responsible for the increase in energy consumption, greenhouse gases (GHG) emissions, as well as atmospheric pollutants (NO_x, CO, HC, PM_{10}). In this paper, we first develop an urban passenger transport LEAP model at the city level to extrapolate energy consumption and emissions; and then take Tianjin city as an empirical case to calculate final energy consumption, CO_2 emissions and pollutant emissions of Tianjin's urban passenger transport sector during 2010-2040 under three scenarios, i.e. BAU (business as usual) scenario, PP (the 12th five-year plan policy) scenario, and CP (comprehensive policy) scenario. The results show that due to the public transport promotion, energy consumption and CO_2 emissions in 2040 can be reduced by 23.7% and 23.9% in the PP scenario, compared to BAU. The most reduction in energy consumption, CO_2 and pollutant emissions can be achieved under CP scenario, in which vehicle population regulation is the most effective and easy to be implemented. Emission standard regulation is the most effective measure to reduce atmospheric pollutant emissions in all the scenarios and green energy promotion is especially effective to reduce PM_{10}.

Methods

Using a LEAP software to develop an urban passenger transport model at the city level and to extrapolate energy consumption and emissions. Tianjin city is then taken as an empirical case. Scenario analysis is made to study the impacts of different policy measures on energy consumption and emissions in Tianjin's passenger transport sector.

Results

There is a great reduction in energy consumption, CO_2 emissions as well as four pollutants under PP and CP scenarios. In 2040, the energy in the transport sector will consume 25.7 Mtoe and 13.7 Mtoe in PP and CP scenarios, respectively, compared to 33.7 Mtoe in the BAU; the CO_2 emissions will release 73.8 Mt and 37.7 Mt in PP and CP scenarios, respectively, compared to 97.0 Mt in the BAU; the emissions of four pollutants emitted from the transport sector, namely CO, HC, NO_x, PM_{10}, will be 324.8 Tt, 39.3 Tt, 100.9 Tt and 440.2 t in the PP and 205.4 Tt, 23.5 Tt, 54.7 Tt and 257.1 t in the CP, compared to 942.9 Tt, 94.7 Tt, 191.0 Tt and 2663.4 t, in the BAU, respectively.

Conclusions

It is obvious from the results that it is easier to reduce pollutant emissions than to reduce energy consumption and CO_2 emissions. This is because ESR can directly limit the emission factor which is one of the determinants of the pollutant emissions. Therefore, energy conversation and CO_2 reduction should be of the top priority in the urban passenger transport sector in the long run. Due to the restrict control on vehicle sales, VPR will be the most effective measure to save energy and reduce CO_2 emissions in the CP scenario.It can be also revealed from the results that no single measure can achieve all the reduction targets. The measure such as PTP that has a significant effect on energy reduction, may not work well for pollutant emissions; GEP that can largely reduce PM_{10} emissions may not work well for CO emission.

References

Bose, R. K. and Srinivasachary, V. Policies to reduce energy use and environmental emissions in the transport sector: A case of Delhi city[J]. Energy Policy, 1997, 25(14-15): 1137-1150.

Bueno, G. Analysis of scenarios for the reduction of energy consumption and GHG emissions in transport in the Basque Country[J]. Renewable and Sustainable Energy Reviews, 2012, 16(4): 1988-1998.

Davis, S. J., Caldeira, K. and Damon, H. Future CO2 Emissions and Climate Change from Existing Energy Infrastructure[J]. Science, 2010, 329(5997): 1330-1333.

Feng, Y. Y. and Zhang, L. X. Scenario analysis of urban energy saving and carbon abatement policies: A case study of Beijing city, China[J]. Procedia Environmental Sciences, 2012, 13(0): 632-644.

Fuglestvedt J, Bemtsen T, Myhre G, et al. Climate forcing from the transport sectors[J]. Proceedings of the National Academy of Sciences of the United States of America, 2008, 105(2): 454-458.

He, K., Huo, H., et al. Oil consumption and CO2 emissions in China's road transport: current status, future trends, and policy implications[J]. Energy Policy, 2005, 33(12): 1499-1507.

Huo, H., Zhang, Q., et al. Vehicle-use intensity in China: Current status and future trend[J]. Energy Policy, 2012, 43(0): 6-16.

Huo, H., Wang, M., et al. Projection of energy use and greenhouse gas emissions by motor vehicles in China: Policy options and impacts[J]. Energy Policy, 2012, 43(0): 37-48.

IEA (International Energy Agency), 2009. Key world energy statistics, 2009. OECD/IEA, Paris.

IEA (International Energy Agency), 2009. CO2 emissions from fuel combustion, 2009. IEA, Paris.

Kumar, A., Bhattacharya, S. C., et al. Greenhouse gas mitigation potential of biomass energy technologies in Vietnam using the long range energy alternative planning system model[J]. Energy, 2003, 28(7): 627-654.

Lumbreras, J., Valdés, M., et al. Assessment of vehicle emissions projections in Madrid (Spain) from 2004 to 2012 considering several control strategies[J]. Transportation Research Part A: Policy and Practice, 2008, 42(4): 646-658.

Mattila, T. and Antikainen, R. Backcasting sustainable freight transport systems for Europe in 2050[J]. Energy Policy, 2011, 39(3): 1241-1248.

Ong, H. C., Mahlia, T. M. I., et al. A review on emissions and mitigation strategies for road transport in Malaysia[J]. Renewable and Sustainable Energy Reviews, 2011, 15(8): 3516-3522.

Ou, X., Zhang, X., et al.. Scenario analysis on alternative fuel/vehicle for China’s future road transport: Life-cycle energy demand and GHG emissions[J]. Energy Policy, 2010, 38(8): 3943-3956.

Pasaoglu, G., Honselaar, M., et al. Potential vehicle fleet CO2 reductions and cost implications for various vehicle technology deployment scenarios in Europe[J]. Energy Policy, 2012, 40(0): 404-421.

Pongthanaisawan, J. and Sorapipatana, C. Greenhouse gas emissions from Thailand’s transport sector: Trends and mitigation options[J]. Applied Energy, 2013, 101(0): 288-298.

Pradhan, S., Ale, B. B., et al. Mitigation potential of greenhouse gas emission and implications on fuel consumption due to clean energy vehicles as public passenger transport in Kathmandu Valley of Nepal: A case study of trolley buses in ring road[J]. Energy, 2006, 31(12): 1748-1760.

Rentziou, A., Gkritza, K., et al. VMT, energy consumption, and GHG emissions forecasting for passenger transportation[J]. Transportation Research Part A: Policy and Practice, 2012, 46(3): 487-500.

Shabbir, R. and Ahmad, S. S. Monitoring urban transport air pollution and energy demand in Rawalpindi and Islamabad using leap model[J]. Energy, 2010, 35(5): 2323-2332.

Wang, H., Fu, L., et al. CO2 and pollutant emissions from passenger cars in China[J]. Energy Policy, 2011, 39(5): 3005-3011.

Wangjiraniran, W., Vivanpatarakij, S., et al. Impact of economic restructuring on the energy system in Thailand[J]. Energy Procedia, 2011, 9(0): 25-34.

Wohlgemuth, N. World transport energy demand modeling: Methodology and elasticities[J]. Energy Policy, 1997, 25(14–15): 1109-1119.

Yan, X. and Crookes, R. J. Reduction potentials of energy demand and GHG emissions in China's road transport sector[J]. Energy Policy, 2009, 37(2): 658-668.

Zhang, L., Feng, Y., et al. Alternative scenarios for the development of a low-carbon city: A case study of Beijing, China[J]. Energies, 2011, 4(12): 2295-2310.