



Urban form and long-term fuel supply decline: A method to investigate the peak oil risks to essential activities

Susan Krumdieck^{a,*}, Shannon Page^a, André Dantas^b

^a Department of Mechanical Engineering, University of Canterbury, Christchurch 8140, New Zealand

^b Department of Civil and Natural Resources Engineering, University of Canterbury, Christchurch 8140, New Zealand

ARTICLE INFO

Article history:

Received 3 February 2010

Accepted 26 February 2010

Keywords:

Peak oil

Transport energy demand

Risk assessment

Essential travel

Wellbeing

ABSTRACT

The issue of a peak in world oil supply has become a mainstream concern over the past several years. The petroleum geology models of post-peak oil production indicate supply declines from 1.5% to 6% per year. Travel requires fuel energy, but current transportation planning models do not include the impacts of constrained fuel supply on private travel demand. This research presents a method to assess the risk to activities due to a constrained fuel supply relative to projected unconstrained travel demand. The method assesses the probability of different levels of fuel supply over a given planning horizon, then calculates impact due to the energy supply not meeting the planning expectations. A new travel demand metric which characterizes trips as essential, necessary, and optional to wellbeing is used in the calculation. A case study explores four different urban forms developed from different future growth options for the urban development strategy of Christchurch, New Zealand to 2041. Probable fuel supply availability was calculated, and the risk to transport activities in the 2041 transport model was assessed. The results showed all the urban forms had significantly reduced trip numbers and lower energy mode distributions from the current planning projections, but the risk to activities differed among the planning options. Density is clearly one of the mitigating factors, but density alone does not provide a solution to reduced energy demand. The method clearly shows how risk to participation in activities is lower for an urban form which has a high degree of human powered and public transport access to multiple options between residential and commercial/industrial/service destinations. This analysis has led to new thinking about adaptation and reorganization of urban forms as a strategy for energy demand reduction rather than just densification.

© 2010 Elsevier Ltd. All rights reserved.

1. Introduction

The peak and subsequent decline in world oil production is no longer a subject of speculation, it is emerging as a relevant planning issue. Over the past several years, the issue of peak oil has generated questions about long-term fuel availability (Deffeyes, 2001). It is becoming increasingly probable that the production rate of conventional oil will enter a phase of permanent decline in the near future. There have been no analysis reported that demonstrate how alternative energy sources (non-conventional oil, coal, solar, wind, biofuel, etc.) will be available to fill the gap between conventional oil supply and continued demand growth at a historically economical price (BTRE, 2005; Hirsch et al., 2005). When fuel supply availability

* Corresponding author. Tel.: +64 3 364 2987; fax: +64 3 364 2078.

E-mail addresses: susan.krumdieck@canterbury.ac.nz (S. Krumdieck), shannon.page@canterbury.ac.nz (S. Page), andre.dantas@canterbury.ac.nz (A. Dantas).

is lower than demand, there will be adaptations that reduce demand. The range of adaptations possible depend on the urban form, e.g. land use and transport infrastructure, and by development of new supplies and technologies, e.g. biofuels or electric cars, which have long development time requirements (Krumdieck, 2007). Adaptability is less severely limited by choice of destination, occupancy, mode or living arrangements, which can be rapidly adjusted. However, the flexibility for adaptation may depend on urban form, infrastructure and built environment (Nix and Mayes, 1983).

Over the past 30 years, Europe, the Americas and Australasia have experienced growth in all aspects of personal transport; cars per capita, passenger kilometers per person, urban population, length of freeway per capita, and of course transport energy use per person (Lim, 1997; Chatterjee and Gordon, 2006). A survey of current literature indicates continued growth in demand for transport fuels over the next 30 years is expected, with significant up-take of personal passenger vehicles in Asia as a major contributor (IEA, 2007).

The oil price spike of 2007–2008 brought a new realization of how high fuel prices can go, and that the price rise can be on a much shorter time scale than the response of the market with alternative fuels and vehicles. Many policy makers assume mobility growth will continue even as the oil supply decreases via alternative vehicles and fuels becoming economic (Cervero, 1985; Bester, 2000). This assumption would require continued growth of household income, ahead of the increased cost of transport fuel in addition to numerous breakthrough technologies. The continued demand growth assumption would also require substantial investment in research, development and manufacturing. The unprecedented growth in resource development and manufacturing that has led to the current dominant position of petroleum fuels and private automobiles was produced by exploitation of oil fields with highly positive return on investment. None of the alternatives conceived to date have return on investment as high as oil. Thus, planning on the assumption of continued demand growth facilitated by technology change puts access to transport activities at risk.

There is an urgent need for a risk assessment approach for future transport and urban form planning. Risk is assessed by basic analytical characterization of the probability that an issue will arise, and modelling of the impact associated with the issue occurring. The main issue is the supply of transport fuel. The probability to be analysed is that the long range transport energy supply will be lower than the projected demand. The impact on transport activities of this shortfall in expectations should be specific to particular urban forms and relevant to current planning decisions. Risk assessment can effectively communicate complex technical issues to policy makers, urban planners, transport planners, businesses and the public. Risk assessment is a key to delivering more resilient and adaptable urban developments.

Transport energy use and energy intensity has been correlated with urban form, e.g. the spatial land use and transport system (Kenworthy and Laube 1999). Analysis of transport energy intensity of cities illustrates how urban density may be directly correlated with per capita fuel use (Cooper et al., 2002; Mindali et al., 2004). For example, Hong Kong with its constrained geographical boundary, has an urban density of 32,035 persons/km² and annual fuel energy use of around 5000 MJ per person. Sprawling Houston has an urban density of less than 1000 persons/km² while consuming more than 60,000 MJ per person per year for transport.

Cameron et al. (2004) model mobility as the vehicle kilometers traveled (VKT) which is a strong function of vehicle ownership, number of passengers per vehicle, and a weaker function of population and land area. Interestingly, Cameron's mobility model fits reasonably well to past trends for many cities, but does not include fuel price as a variable as it was relatively stable over the model period. The analysis shows that urban density alone does not fully explain energy intensity of transport or adaptability of trips to non-automobile modes.

Motorized travel is dominant in cities despite many initiatives to encourage and enhance public transport, walking and cycling as alternative and sustainable transport modes (Da Silva et al., 2001). Growth tendencies that create additional and complex travel patterns have been shown to require substantially more energy (Transport Canada, 1982; Danieri, 2000). Policy involving the range of factors that affect energy use must be developed in order to provide the resilience to reduced fuel use that will be needed in the long term.

Urban planners currently focus on managing growth under the assumptions of increasing population, expanding urban land area and growing mobility, but have historically ignored future fuel supply considerations (Nicholson and Dantas, 2004). Transport planners currently focus on delivering the infrastructure required for continued growth. State-of-the-art transport models and methods rarely consider energy as an integral part of the transport and activity systems, let alone as a development constraint or an investment risk (Greiving and Wegener, 2001; Ortuzar and Willumsen, 1994). Public and private investments in technology, infrastructure, and land use have historically been made under conditions of low cost, abundant oil. A portion of the growing demand for transport energy may be supplied by alternative fuels as conventional oil supplies decrease, but there is no analysis that indicates these alternatives will guarantee low fuel prices in the future. Future investments under outdated assumptions may be at long term risk (Dantas et al., 2006; Dodson and Sipe, 2006). For example, a new green field residential or retail development, could lose value in the future as people choose to reduce their travel distances, and live in the higher density areas with lower-cost access to more amenities and activities. It may be that the high fuel prices in the USA in 2007–2008 contributed to the loss of market value for out-lying suburban homes as people in the market to buy a home looked closer to their destinations and amenities.

Assessment of the risks to transport activities in a given urban form over the planning horizon will be an important component of policy development and investment planning. Connectivity, integration and non-automobile options will be important factors in resilient and adaptable urban forms. A new analysis tool that considers the travel demand pattern and the adaptability of transport options to preserve participation in activities is needed to optimize current development and re-development investments. The risk assessment method presented in this paper may seem to simply verify what we

Download English Version:

<https://daneshyari.com/en/article/310511>

Download Persian Version:

<https://daneshyari.com/article/310511>

[Daneshyari.com](https://daneshyari.com)