PALMERSTON NORTH PEAK OIL VULNERABILITY STUDY

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ABSTRACT

This study is an evidence-based assessment, providing Palmerston North City Council and Council's stakeholders with information to better anticipate, plan and manage a transition to a less transport energy intensive city. A successful collaboration of three consultants and Council brings together expertise in transportation planning, traffic engineering, risk exposure to energy and resource issues, and ecological economics. Together these address the implications of peak oil and consequential increases in household costs.

Peak oil is a risk management issue for local councils affecting asset management, operations and provision of services. The current global energy trends and consumption are unsustainable as stated by the International Energy Agency (2008). The physical reality is that world oil supply from conventional sources will continuously decline over any conceivable planning horizon according to Deffeyes (2001). There are currently no practical alternative technologies or substitute resources that will fill the supply-demand gap left by declining oil supply according to Guseo, Dalla Valle and Guidolin (2006). This is because oil is very high in energy, and alternatives or substitutes pale in comparison.

The council, organisations, businesses and households in Palmerston North, and the rest of NZ and the world, should acknowledge potential high oil prices and promote appropriate contingency planning to adapt accordingly as reported by the UK Government (2010). This study shows it is possible to maintain a thriving economy and society during this adaptation period, and this paper presents a clear assessment of the scope and timeframe for the task of prosperous adaptation.

Note: The figures shown within this report have been produced in colour.

INTRODUCTION

In 2011, Palmerston North City Council (PNCC) commissioned Abley Transportation Consultants, EAST (Energy Activity Systems Transition) Research and Market Economics Limited to deliver the Palmerston North Peak Oil Vulnerability Study. This study is an evidence-based assessment, providing Palmerston North City Council and Council's stakeholders with information to better anticipate, plan and manage a transition to a less transport energy intensive city.

Peak oil is a risk management issue for local councils affecting asset management, operations and provision of services. The physical reality is that world oil supply will continuously decline over any conceivable planning horizon. There are currently no practical alternative technologies or substitute resources that will fill the supply-demand gap left by declining oil supply. This is because oil is very high in energy, and alternatives or substitutes pale in comparison.

The council, organizations, businesses and households in Palmerston North, and the rest of NZ and the world, will all inevitably adapt to using less petroleum. It is possible to maintain a prosperous economy and society during this adaptation. This prosperous adaptation will require solid understanding of current petroleum fuel use and the implications to the economy and activity systems if adaptation does not occur. Prosperous adaptation will further require new and innovative adaptive development in the urban form and transport networks.

WORLD OIL SUPPLY

The largest oil end-use by far is petrol and diesel fuel for private travel and freight movements. The elasticity of transportation uses depends largely on the adaptive capacity of each city and freight network. The adaptive capacity for personal transport is a function of geography and available options that use less fuel as reported in Watcharasukarn, Page and Krumdieck (2012),. The adaptive capacity for freight movement is a function of geography of primary production, logistics systems, and availability of modes that use less fuel such as rail and shipping. Wakeley (1980) states the long-run adaptive capacity of the whole transport sector is critically dependent on network, infrastructure, and land-use decisions made today.

The response of government, industry and business to peak oil has historically been denial. This is quite understandable. The implications of declining energy supply are nearly impossible to comprehend based on our past experience according to Dantas, Krumdieck and Page (2006).

Avoiding a situation is an understandable response when that situation is negative and where there are no immediate solutions. Another response is to fall back on shared beliefs; such as that technology will provide alternatives and the market will provide new resources. Whilst a range of alternative technologies and non-conventional fuel sources are emerging, they are constrained in terms of the energy efficiency, resource availability, market viability and/or ability to be integrated as a system solution as detailed in Abley Transportation Consultants, East Research and Market Economics (2008).

RISK MANAGEMENT

The key to moving forward from denial to productive risk management is to get a clear understanding of the most pertinent facts about oil supply and the timeframe for changes from historical trends. The key to effectively addressing the issue with appropriate decisions at critical times is to use the proven risk management approach.

By setting priorities, gathering information, assessing adaptive capacity, and planning development and re-development projects it is possible to increase adaptability. In the PNCC 10 Year (2012-22) Plan, the Council's success is judged by involvement of the residents, informed residents and financial responsibility. The PNCC strategy for peak oil risk management should be based on clear information not fear, and should be transparent, cooperative and participatory with the city residents. The opportunities to reduce fuel demand must be the result of thinking and analysis by each business and household.

Confidence in positive possibilities for managing activities to meet limits can be achieved if the processes involve public creativity and opportunities for new local businesses. Prosperous adaptation will involve technology, business, land use and infrastructure changes that provide for increased productivity while fossil fuel use declines. An important peak oil risk management goal is to avoid destructive change such as loss of productivity, loss of essential services, a reduced ability to travel, reduced demand for commodities, property devaluation and businesses contraction.

FORECASTING PEAK OIL PROBABILITIES

An oil supply probability distribution has been developed by analysing a wide range of expert estimates of future conventional oil supply and decline rate as presented in Krumdieck, Page and Dantas (2010). The distribution indicates the probability that a certain quantity of oil supply, or more, will be available in a given future year. There is a 97% probability that the amount of oil described by the blue line will be available, while there is a very small probability that an amount greater than that described by the pink line will be available. The probability distribution of future fuel supply including all published scientific expert analysis gives a new "risk attitude" approach to long term planning as shown in **Figure 1**.

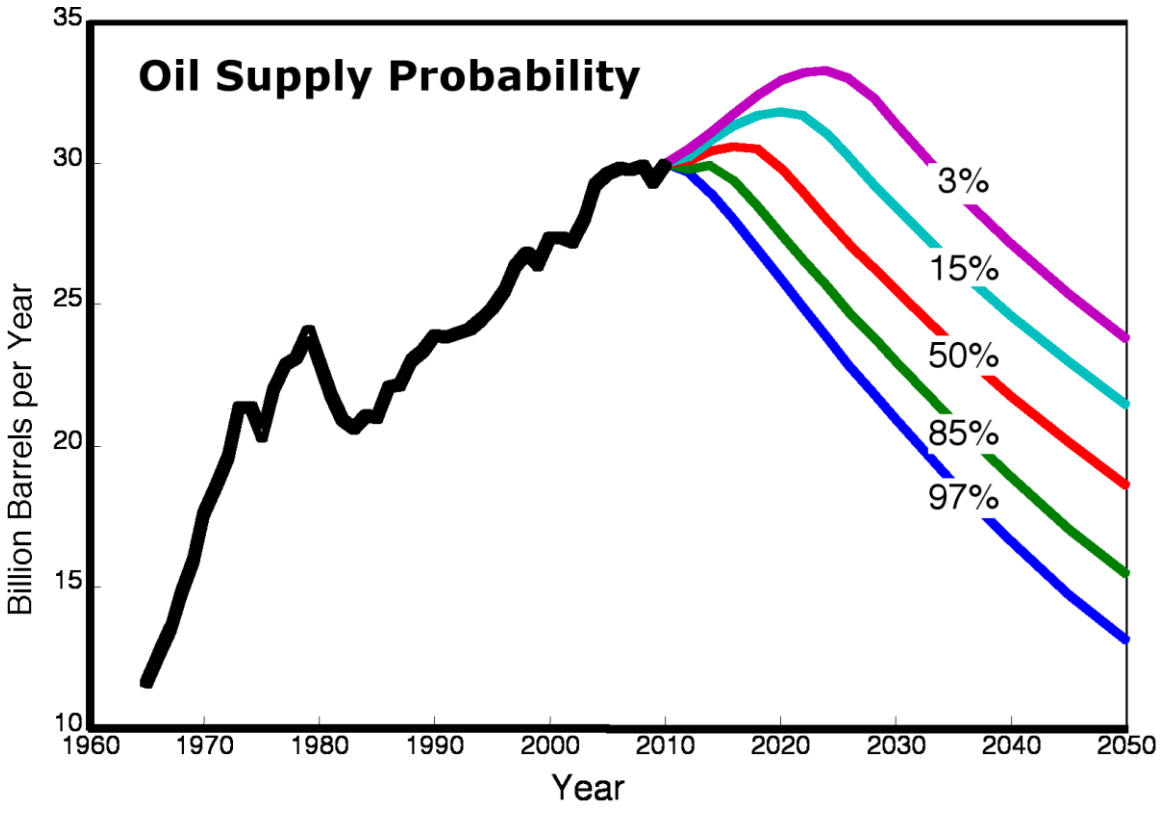

Figure 1: Conventional Peak Oil Supply Probability Curves (from Krumdieck, Page & Dantas, 2010)

The distribution indicates that it is almost completely certain that oil supply will begin to decline by 2025. Palmerston North City Council has decided to use a relatively conservative risk attitude for the forward planning analysis. The position is to have at least 85% probability of oil supply which equates to a 2-3% reduction in supply per annum for the foreseeable future. The resultant reductions to achieve these targets are presented in **Table 1**.

Table 1: Fuel Use Reductions to Match Palmerston North's 85% Risk Position

Year	Condition	Diesel (TJ)	Petrol (TJ)
2010	The 'current' fuel use level	2479	2131
2020	2.5% fuel reduction p.a.	1859	1598
2030	2.4% fuel reduction p.a.	1405	1208
2040	2.6% fuel reduction p.a.	1033	888
2050	2.8% fuel reduction p.a.	744	639

The 2050 level of transport fuel energy use target in Table 1 is in the range that was being used in the 1960-1970's in New Zealand. The population of Palmerston North has grown substantially since then, but the fuel efficiency of vehicles, trucks, buses, farm equipment, processes and homes has also improved.

MEASURING VULNERABILITY

Palmerston North has a well-defined central area with 90% of the households located within 5 kilometres from the Square in the heart of the CBD. The CBD, hospital, University and the science centres are key attractors for employment. The industrial and large format retail work places are located along Tremaine Road and follow the main trunk rail line and the Palmerston North – Gisborne Line. This layout of the industrial and large format retail workplaces is well suited to support the development or use of existing sidings, and facilitate a freight modal shift from road to rail. Prominent outlying areas include Ashhurst and Whakarongo villages to the east and the Linton Military camp located to the south west of the city, and are all disconnected from the compact Palmerston North urban area.

The Vulnerability Assessment for Mortgage, Petroleum and Inflation Risks and Expenses (VAMPIRE) is an econometric analysis methodology presented in Dodson and Sipe (2008). and developed at Griffin University in Australia. This straight-forward analysis has been adapted for New Zealand in this assessment, to use Census data and National Household Travel Survey data. A relative vulnerability score (called the VAMPIRE Index) is calculated for households by using four variables:

- Proportion of those working who undertook a journey to work (JTW) by car (either as a driver or passenger);
- Proportion of households with 2 or more cars;
- Median weekly household income; and
- Proportion of dwelling units that are being purchased (either through a mortgage or a rent/buy scheme).

The first two variables are measures of car dependence and the latter two indicate income and mortgage indices respectively. A relative vulnerability score of between 0 and 30 (called the VAMPIRE Index) is calculated for each meshblock, based on the degree of car

dependence, income level and mortgage index of the households situated within that meshblock.

The results for each Statistics New Zealand meshblock in Palmerston North are displayed in **Figure 2.** A low VAMPIRE index (indicated in green) signifies those areas that are less vulnerable to rising fuel prices, inflation rates and mortgage rates. The orange and red areas are more vulnerable to rising fuel prices, inflation rates and mortgage rates as generally they exhibit a higher degree of car dependence, relatively low-income levels, and higher levels of household ownership compared to the green areas.

It is evident that in Palmerston North the central city and southern suburbs are less vulnerable with outlying areas showing higher levels of vulnerability.

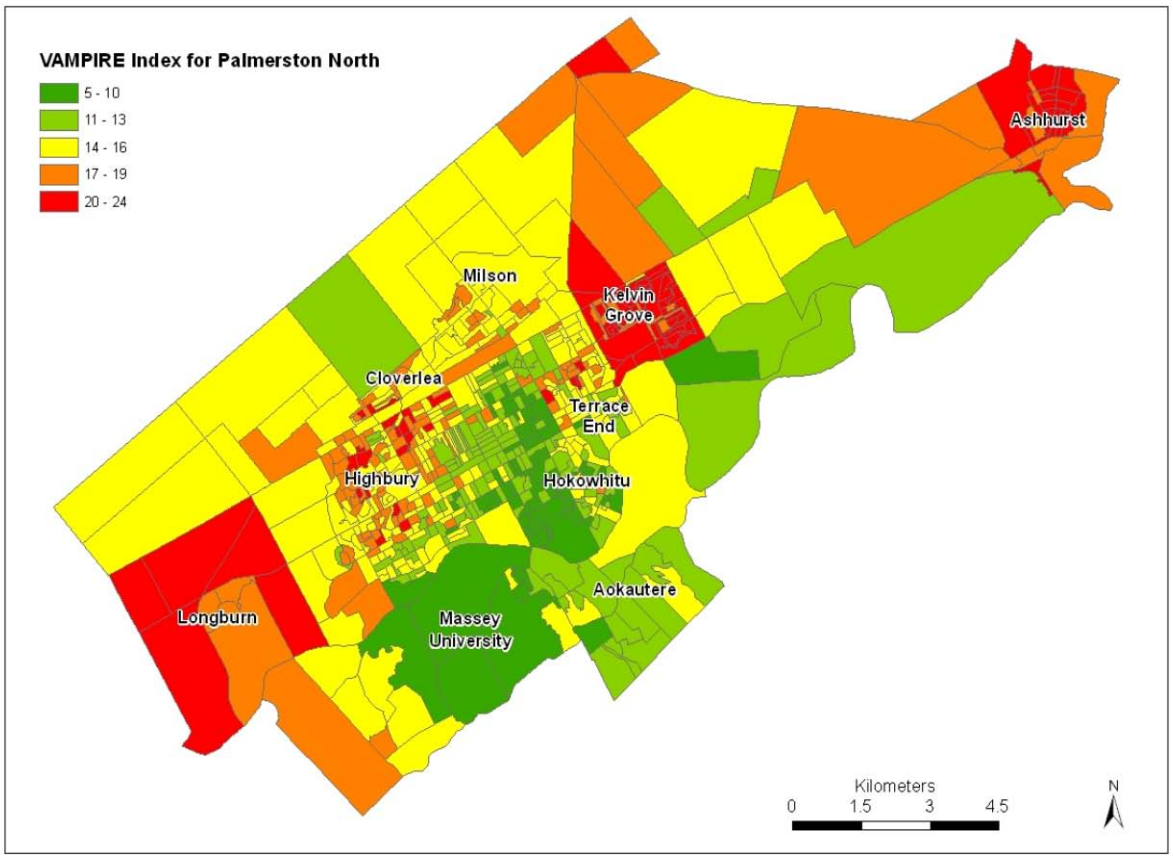

Figure 2: Mapping VAMPIRE vulnerability scores in Palmerston North

The VAMPIRE Index can also be calculated for cities as a whole such that Palmerston North can be compared to other regions throughout New Zealand and Australia. The VAMPIRE scores for a range of similar urban areas is compared in **Figure 3.** Palmerston North exhibits an average degree of vulnerability relative to other main urban areas and is similar to Dunedin in this regard. Based on the detailed breakdown presented in Abley Transportation Consultants, East Research and Market Economics (2008), of the main centres identified, Palmerston North has a lower than average rate of car travel to work, and higher than average incomes, vehicle ownership rates and home ownership.

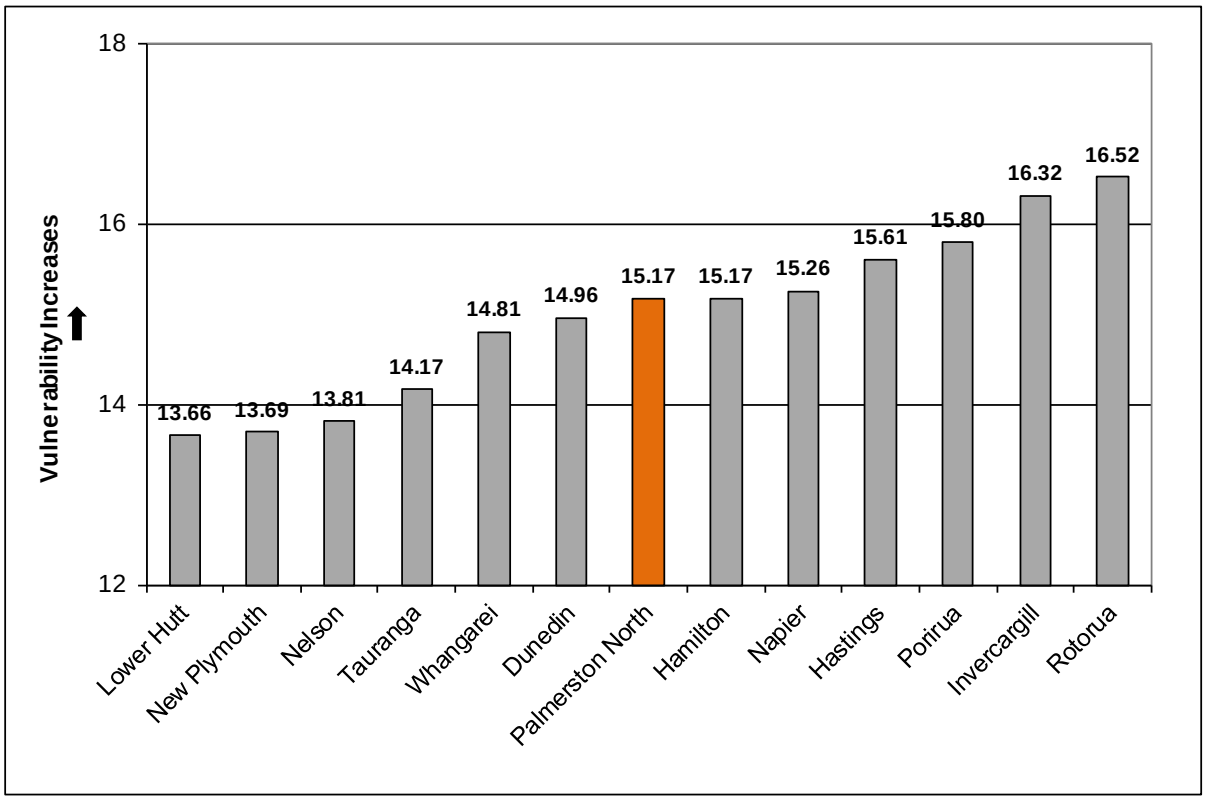

Figure 3: Comparison of average VAMPIRE scores for the Urban Areas

TRAVEL DEMAND IN PALMERSTON NORTH

The total vehicle kilometres travelled (VKT) per annum by private motor vehicle has been calculated from the Ministry of Transport's Warrant of Fitness records, and displayed in **Figure 4** as the average VKT per household for each Census Area Unit in Palmerston North. The VKT results link closely with the proximity of households to the core of the City where employment and retail opportunities are prevalent and the need to travel to reach key destinations diminishes. People who live in the CBD travel the least, while people in rural areas, like Turitea and Whakarongo, drive their private vehicles the most.

In terms of reducing peak oil vulnerability, the analysis highlights the importance of retaining a centred urban form, encouraging intensification within existing urban areas, and discouraging single-purpose development in disconnected outlying areas. A single-purpose development can be residential with no services or employment, or it could be an industrial facility with no residential and shopping facilities. Any new development should ideally have multiple uses or reasons why people would go to the development to provide more opportunities for combining trips. Single-use developments, particularly in outlying areas are 'locked-in' to high energy intensity.

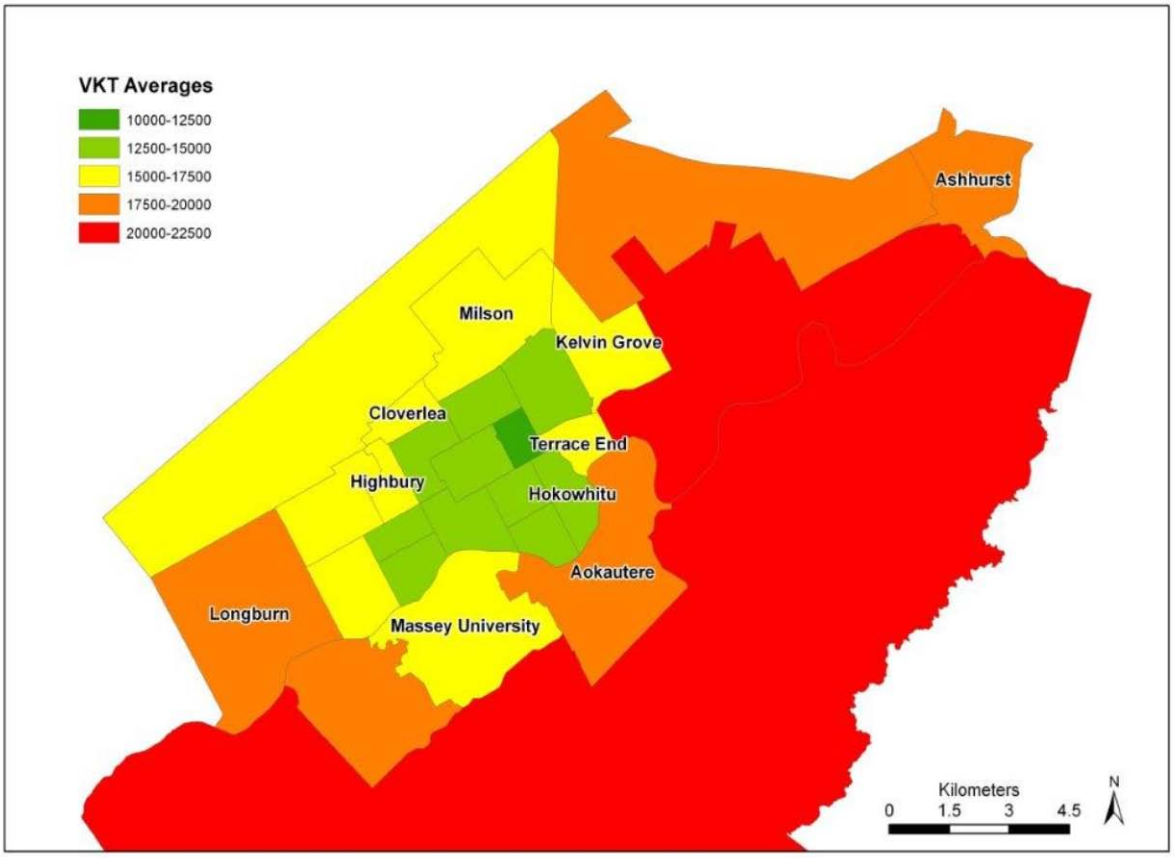

Figure 4: Palmerston North Average VKT per Annum by Census Area Unit

The Ministry of Transport coordinate the National Household Travel Survey (NHTS) which surveys households throughout the country to understand their travel patterns. Analysis of the NHTS indicates that Palmerston North has the highest incidence of cycling at 3.6% of all trips which is more than twice the national average. It also returns one of the lowest rates of walk trips at 13.6% which is 40% lower than the Christchurch and Dunedin results of 21.5%, and slightly below the national average of 16.1%.

There are opportunities to increase the quantity of walking, cycling and public transport use in the City by targeting short trips on 'more fuel intensive' modes of transport such as vehicle driver trips and shifting them across to 'less fuel intensive' modes such as walking, cycling and public transport. The NHTS survey data is presented here by trip length and mode in **Figure 5** to understand the current mode split in Palmerston North and the impact of distance on travel mode choice.

Approximately 17% of all trips in Palmerston North are vehicle driver trip legs of less than 2 km, which is a comfortable distance for walking or cycling. A further 23% of all trip legs in Palmerston North are vehicle driver trips of 2km to 5km, which is a comfortable distance for cycling and is further serviced by public transport routes. Most residential locations, workplaces and other activities are situated within 5kms from the Square, with 78% of all trip legs being under 5km in length.

A comprehensive and valued public transport network, and well promoted walking and cycling culture in Palmerston North, are fundamental to reducing the City's dependence on the private motor vehicle.

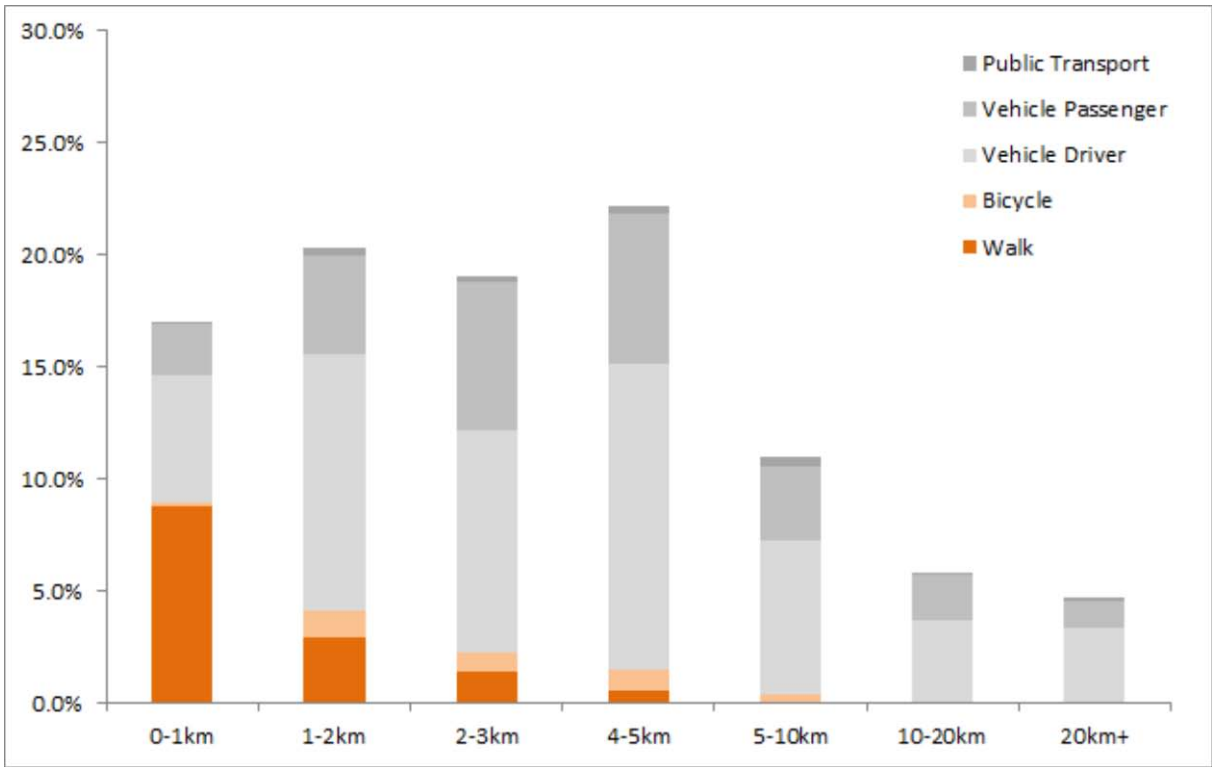

Figure 5: Mode Split by Trip Length in Palmerston North

ECONOMIC IMPACTS OF PEAK OIL

Economic analysis produced using the Economic Futures Model describes the ramifications of failing to plan for reduced oil use for the local and regional economy. The outcomes of not planning for adaption are stark.

Through economic modelling, a number of alternative futures for Palmerston North are considered. Among these, a scenario referred to 'Business As Usual' (BAU) models a future in which there are no constraints on the supply of fuel and therefore no acknowledgement of peak oil. There is also a 'No Intervention' scenario acknowledges peak oil in the form of global fuel supply constraints and assumes PNCC's 85% risk profile from Figure 1. In this scenario, without intervention to adapt to peak oil or significant changes in production methods, economic output is severely curtailed by the future limits on fuel supply.

By contrast a 'With Intervention' scenario utilizes the same 85% peak oil risk profile as the 'No Intervention' scenario, but additionally assumes that a number of management interventions, designed to reduce the economy's reliance on fuel, are implemented. The management interventions are successful in creating a decoupling of the trends in economic output growth and fuel consumption.

If we don't adapt to peak oil the economic modelling concludes that the economy will go into shock and the number of employed people will fall sharply as shown in **Figure 6**. It also indicates that through intervention employment rates can be maintained to BAU levels despite the modelled global constraints on fuel supply in line with Palmerston North's risk profile.

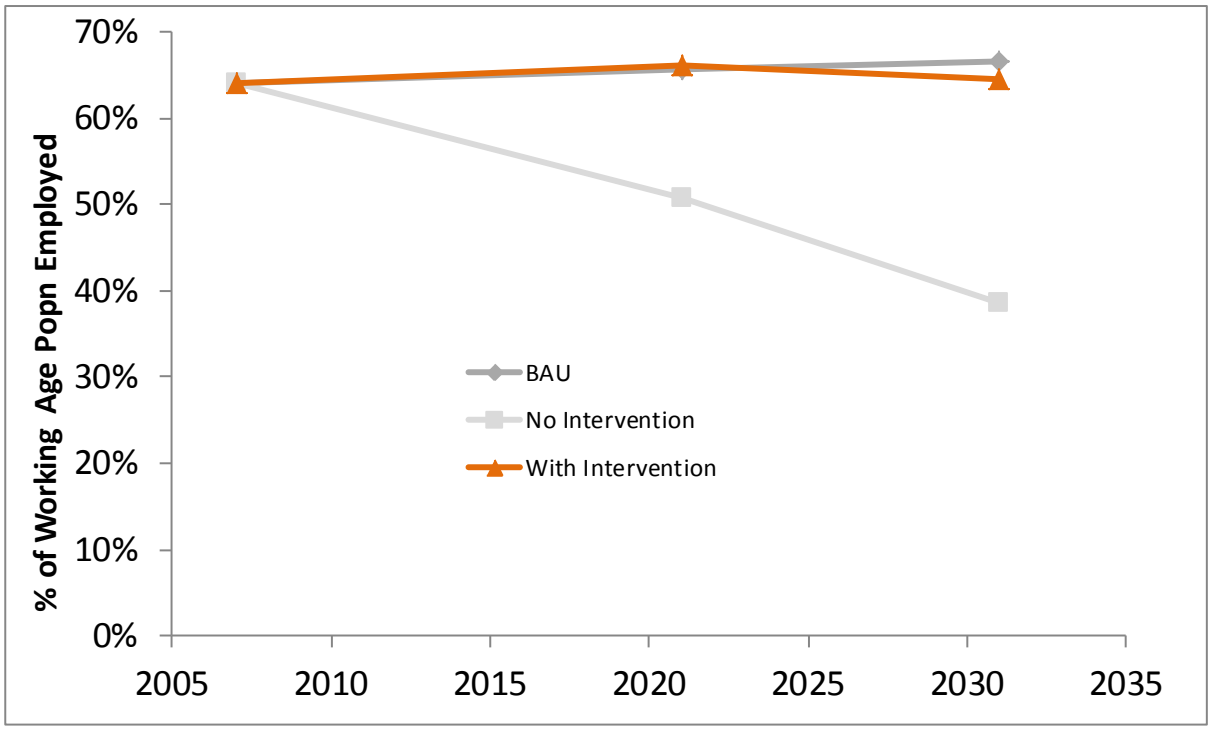

Figure 6: Forecast Employment Rates for Manawatu-Wanganui Region

Another key economic indicator is the change in per capita income, in the form of wages and salaries paid by firms, under the three different scenarios as shown in **Figure 7**. For Palmerston North it is projected that per capita real incomes will increase at a rate of 0.7% per annum under the BAU, while under the 'With Intervention' peak oil scenario, growth rates are more modest at 0.2% per annum.

The 'No Intervention' scenario demonstrates that if economic output drops due to an inability of the economy to adapt to lower fuel supplies, and create output with proportionally less inputs of fuel, the outcome is that there will be substantially less income paid by businesses to households based on Palmerston North's risk profile.

In terms of household expenditures, if the price of fuel were to increase by $1 per litre, this factor alone will cause a net loss in local and regional value-added of nearly 1%. There is a clear need to provide, in the future, means for households to travel that do not involve significant increase in costs.

The creation of a successful adaptive economy is also likely to entail some major changes in economic structures, so that road transportation becomes significantly less important. Although this is clearly a threat to the local logistics sector, it can also be seen as an opportunity. Firms that are agile and able to pursue opportunities in providing ways to achieve levels of service with fewer resources will perform well under changing market conditions.

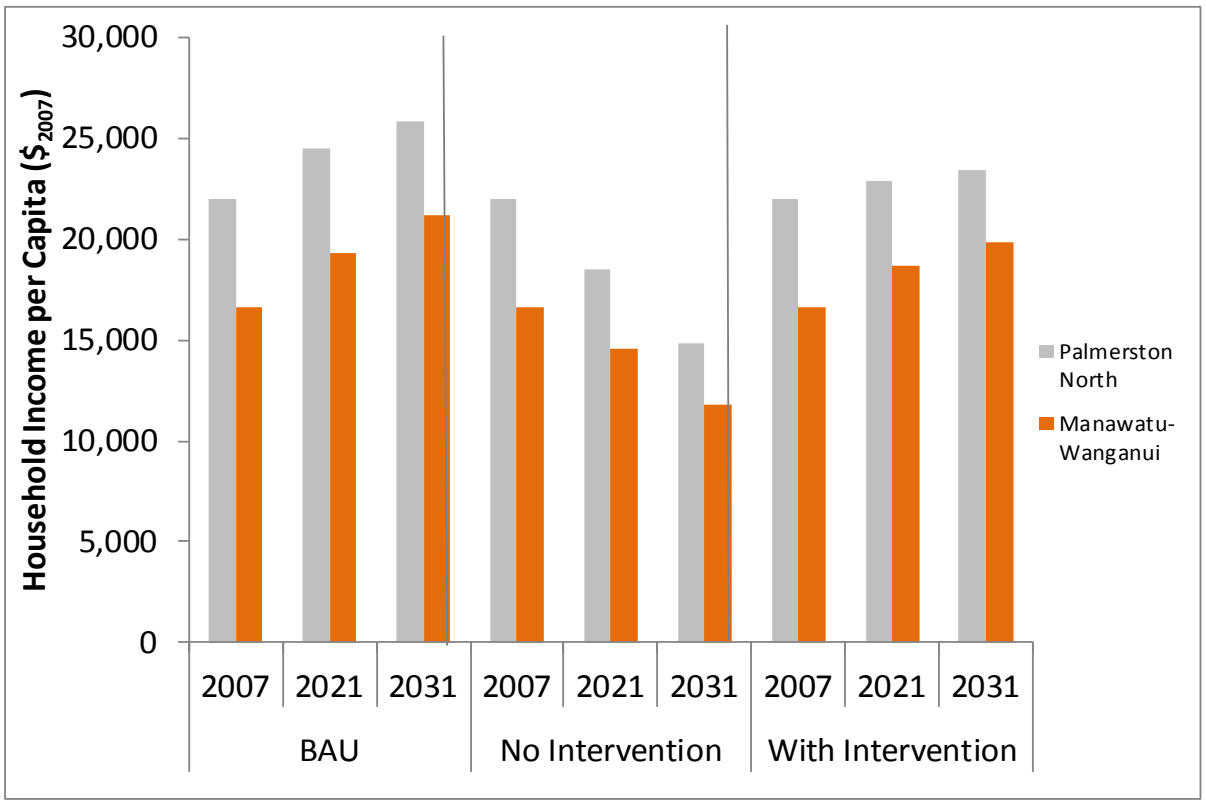

Figure 7: Palmerston North and Manawatu-Wanganui Household Income per Capita

CONCLUSIONS

The Palmerston North City Council must manage the city services in a way that continuously reduces transport fuel demand at a rate of 2-5% per year. The council must also facilitate local communities, businesses and organizations to manage their fuel use adaptation. The measure of success for any council action is the provision of adaptive capacity that also provides ancillary social and economic benefits.

A number of specific management strategies are recommended that fall into five broad categories as follows:

a. Land Use and Urban Form – Adaptive urban development in the CBD, developing several high intensity (but not necessarily high density), multi-destination satellite centres and stimulating growth in adaptive areas accessible by low-energy modes of transport.

b. Capital Spend Strategy – Restructure funding and planning requirements in transport energy inefficient areas. For example, funding set aside for the development of roading and parking infrastructure may be re-directed into infrastructure for less fuel-dependent modes of transport such as walking and cycling, or as incentives for centred urban development zones.

c. Ability to Choose – Increase the accessibility of public transport, cycling and walking infrastructure. Shift implicit priority in traffic engineering from private vehicles to less oil dependent modes. Provide community active mode activities and travel assessments. Place the top priority on safety of people walking or cycling.

d. Embracing Technology – Engage with central government, encouraging the implementation of policy to improve the efficiency of the private, commercial and Public Transport vehicle fleets. Develop low-energy high-efficiency infrastructure to link key destination zones in the City, and support the electrification of regional rail transport where practical.

e. Support Business – Work with industry to facilitate a freight mode shift from road to rail. Provide support for supply chain risk assessments for businesses and organizations. Encourage further development of sectors with lower fuel intensity. Advocate to National Government for support of research to develop a New Zealand freight inter-modal matrix and innovations which enhance logistic efficiency and integration.

The path forwards for Palmerston North is to facilitate 'Adaptive Design', focusing on fiscal planning, traffic engineering, transport planning, urban design and land use planning. These five facets of Council have a common mission in the face of peak oil – to manage risk and to achieve prosperous adaptation.

It is recommended that the City actively promotes the outcomes of this study both locally and nationally to create awareness of peak oil as a problem affecting us all. This will serve a dual function of also raising Palmerston North's profile in New Zealand and overseas.

Palmerston North has already started a journey towards peak oil adaptability and resilience by acknowledging and reacting to peak oil as depicted in Abley Transportation Consultants, East Research and Market Economics (2008) and included here as **Figure 8**. The City has the opportunity to lead the way for other New Zealand cities, and in doing so can gain a competitive edge in attracting top-quality people and a strong international reputation.

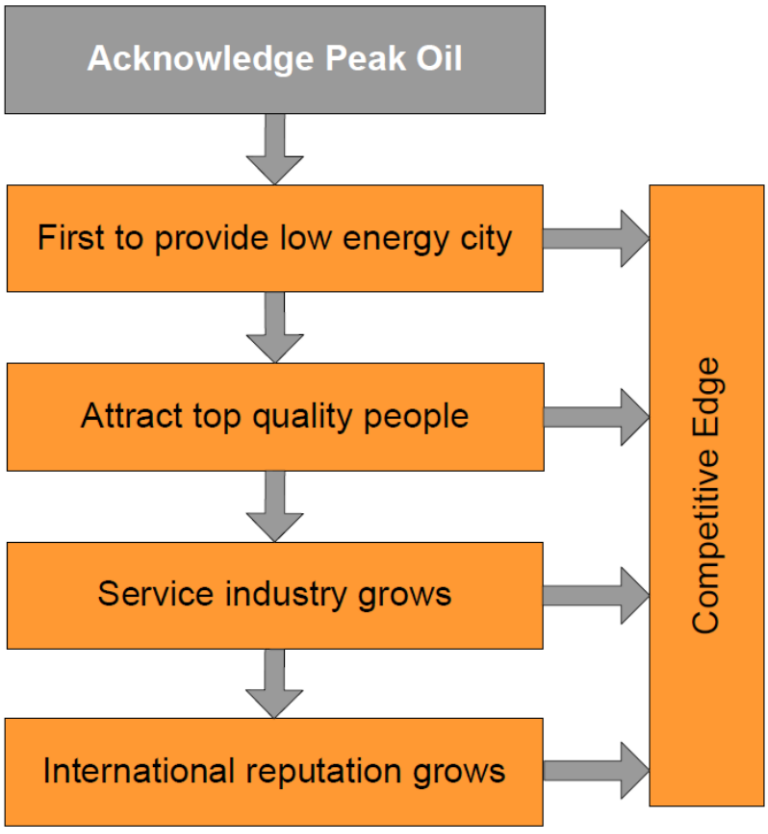

Figure 8: Pathway towards Palmerston North gaining a competitive edge

ACKNOWLEDGMENTS

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