Scenario Analysis &
Peak Oil

How to Plan for an Uncertain Future

Keith Bartholomew
Department of City & Metropolitan Planning
University of Utah
Uncertainty – Part of the Human Condition
What is “Scenario Planning”?

Scenario:

“an internally consistent view of what the future might turn out to be – not a forecast, but one possible future outcome.”

Scenario Planning:

A process using a range of possible futures that:

Define outer bounds of impacts from external factors

Provide a laboratory for testing possible policy responses
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Famous Examples from Military & Business

RAND Corp’s nuclear war scenarios (1950s)
Famous Examples from Military & Business

Royal Dutch/Shell’s “Arab Oil Embargo” scenarios (1970s)
Land Use-Transportation Scenario Planning

Incorporating variable land use assumptions, but not broader economic and environmental considerations

Military/Business Scenario Planning

“3C” Transportation Planning NEPA Alt. Analyses
Four Scenarios for the Future
## Sacramento Region Blueprint

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>Single-Family: Multifamily Housing</th>
<th>% Housing Growth through Infill</th>
<th>% Trips by Auto</th>
<th>% Trips by Transit</th>
<th>% Trips by Walk/Bike</th>
<th>Daily VMT per Household</th>
</tr>
</thead>
<tbody>
<tr>
<td>A: Business as usual (trend)</td>
<td>75:25</td>
<td>27.0</td>
<td>93.7</td>
<td>0.8</td>
<td>5.5</td>
<td>47.2</td>
</tr>
<tr>
<td>B: Higher housing densities than A, with growth focused at the urban fringe</td>
<td>67:33</td>
<td>39.0</td>
<td>83.2</td>
<td>4.0</td>
<td>12.7</td>
<td>37.6</td>
</tr>
<tr>
<td>C: Higher housing densities than A, with growth focused on central infill sites</td>
<td>65:35</td>
<td>38.3</td>
<td>81.8</td>
<td>4.8</td>
<td>13.4</td>
<td>36.7</td>
</tr>
<tr>
<td>D: Higher housing and employment densities, with growth focused on central infill sites</td>
<td>64:36</td>
<td>44.0</td>
<td>79.9</td>
<td>4.8</td>
<td>15.3</td>
<td>35.7</td>
</tr>
<tr>
<td>Preferred Scenario</td>
<td>65:35</td>
<td>41.0</td>
<td>83.9</td>
<td>3.3</td>
<td>12.9</td>
<td>34.9</td>
</tr>
</tbody>
</table>
Sacramento Region Blueprint
Keith Bartholomew
Scenario Analysis & Peak Oil

U.S. Land Use-Transportation Scenario Planning Projects
Source: Bartholomew & Ewing 2010
Scenario Inputs

- Transportation system elements: \textit{variable}
- Land use/growth allocations (the D’s): \textit{variable}
- Growth levels: \textit{some variable/most constant}
- Economic conditions (real estate markets & fuel prices): \textit{constant}

Assessment Tools

- Land use allocation methods
- Travel demand modeling
- Other tools

Assessment Outputs

- Travel related
- Air quality & CO2
- Public costs
- Other
Scenario Inputs: Transportation System Elements

Road Lane Miles of Alternative Scenarios
percent difference compared to trend scenarios

-30.65% 18.18%
30%
20%
10%
0%
-10%
-20%
-30%
-40%

mean = -1.19%

n = 92
Scenario Inputs: Land Use Elements

Density of Alternative Scenarios
percent difference in persons per developed acre compared to trend scenarios

mean = 19.82%

n = 119
Scenario Inputs: Land Use Elements

Households Near Transit
percent difference in percentage of total households within 1/4 mile of transit vs. trend scenario

-58.71% 327.50% -100.00% -50.00% 0.00% 50.00% 100.00% 150.00% 200.00% 250.00% 300.00% 350.00%

n = 62
Assessment Outputs

Vehicle Miles Traveled of Alternative Scenarios
percent difference compared to trend scenarios

mean = −2.51%

n = 119

−30.27%
Assessment Outputs

Vehicle Hours of Delay of Alternative Scenarios
percent difference compared to trend scenarios

mean = 16.38%

n = 33

~49.13%
Agriculture Lands Consumed by Alternative Scenarios
percent difference compared to trend scenarios
Assessment Outputs

NO\textsubscript{x} Emissions of Alternative Scenarios
percent difference compared to trend scenarios

3.16%  

n = 25  

-11.41%
Assessment Outputs

Greenhouse Gas Emissions of Alternative Scenarios
percent difference compared to trend scenarios

n = 31

-30% -20% -10% 0% 10% 20% 30% 40% 50%

45.72% -23.16% -30% -20% -10% 0%
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Assessment Outputs

Road Costs per Person: Alternative vs. Trend Scenarios
M. King Hubbert
Hubbert's Peak
**Keith Bartholomew**
*Scenario Analysis & Peak Oil*

*Source: EIA, 2000*
Chart 79: UK Liquids Production 1970 - 2008

Source: ASPO Ireland & BP Statistical Review of World Energy
Chart 65: Saudi Arabia Liquids Production 1935 - 2008

Source: ASPO Ireland & BP Statistical Review of World Energy
Declining Country & Well Production
1997 - 2006

Yemen, Columbia, Netherlands, Argentina, Papua N. Turkey, United States, France, Serbia, Norway, Congo, Indonesia, Tunisia, Cameroon, Sharjah, Venezuela, Canada, Australia, Oman, Nigeria, Egypt, United States, Gabon

- Ave/Decline per Well (%)
- Ave/Daily Change in Production (%)

Source: Simmons, 2008
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OGJ, 9 Feb 2004 (Jan-Nov 2003)
Figure 5: Key Estimates of the Timing of Peak Oil

Source: GAO study.
### Table 1. WORLD OIL PRODUCTION FORECAST

<table>
<thead>
<tr>
<th>Probability Estimate</th>
<th>Ultimate Recovery BBbs</th>
<th>Annual Demand Growth, %</th>
<th>Peak Year</th>
<th>Peak Rate, MMBbls/yr</th>
<th>Peak Rate, MMBbls/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low (95%)</td>
<td>2,248</td>
<td>0.0</td>
<td>2045</td>
<td>24,580</td>
<td>67</td>
</tr>
<tr>
<td></td>
<td>2,248</td>
<td>1.0</td>
<td>2033</td>
<td>34,820</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td>2,248</td>
<td>2.0</td>
<td>2026</td>
<td>42,794</td>
<td>117</td>
</tr>
<tr>
<td></td>
<td>2,248</td>
<td>3.0</td>
<td>2021</td>
<td>48,511</td>
<td>133</td>
</tr>
<tr>
<td>Mean (expected value)</td>
<td>3,003</td>
<td>0.0</td>
<td>2075</td>
<td>24,580</td>
<td>67</td>
</tr>
<tr>
<td></td>
<td>3,003</td>
<td>1.0</td>
<td>2050</td>
<td>41,238</td>
<td>113</td>
</tr>
<tr>
<td></td>
<td>3,003</td>
<td>2.0</td>
<td>2037</td>
<td>53,209</td>
<td>146</td>
</tr>
<tr>
<td></td>
<td>3,003</td>
<td>3.0</td>
<td>2030</td>
<td>63,296</td>
<td>173</td>
</tr>
<tr>
<td>High (5%)</td>
<td>3,896</td>
<td>0.0</td>
<td>2112</td>
<td>24,580</td>
<td>67</td>
</tr>
<tr>
<td></td>
<td>3,896</td>
<td>1.0</td>
<td>2067</td>
<td>48,838</td>
<td>134</td>
</tr>
<tr>
<td></td>
<td>3,896</td>
<td>2.0</td>
<td>2047</td>
<td>64,862</td>
<td>178</td>
</tr>
<tr>
<td></td>
<td>3,896</td>
<td>3.0</td>
<td>2037</td>
<td>77,846</td>
<td>213</td>
</tr>
</tbody>
</table>

Source: Energy Information Administration

Figure 31. World oil prices in three cases, 1990-2035 (2009 dollars per barrel)

Source: EIA, 2011
Source: Stover & Bae, 2011
Source: Maley & Weinberger, 2009
Percent Change in House Prices: 4\textsuperscript{th} Quarter 2006 to 4\textsuperscript{th} Quarter 2007
Housing Prices Declines Greatest at the Suburban Fringe
Portland-Vancouver MSA

Percent Change in House Prices: 4th Quarter 2006 to 4th Quarter 2007

Source: Cortright, 2009
Source: Chakraborty, Kaza, Knaap & Deal, 2011
Synthesis

• Scenario analysis is an effective method for thinking about alternative futures, especially when there is significant uncertainty

• Regional transportation agencies are now well-practiced with the technique, but only with respect to internal variables

• Energy prices are volatile and the volatility is likely to increase, thereby increasing uncertainty

• It is now time to incorporate external variables into scenario analysis, especially those related to energy prices
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