2-3 Transport Alternative Scenarios

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Large Opportunity in APEC to Improve Efficiency, Especially in Transportation

Two alternative scenarios for improving energy efficiency in the transportation sector were developed for each APEC economy:

- **Virtual Clean Car Race Scenarios**
  - Hyper-car Transition
  - Electric Vehicle Transition
  - Hydrogen Vehicle Transition
  - Natural Gas Vehicle Transition

- **Alternative Urban Development Scenarios**
  - High Sprawl
  - Constant Density
  - Fixed Urban Land

For each alternative scenario, the impact on oil consumption and emissions reduction is assessed.
Virtual Clean Car Race
To promote energy efficient transport, priority will be given to developing and promoting fuel efficient transport practices, including the use of alternative fuels as well as the development of corresponding energy efficient transport infrastructure.

Ministerial Joint Statement
7th APEC Transportation Ministerial Meeting

The adoption of alternative vehicles and alternative fuels has obvious oil savings benefits.

But what about the impact on CO₂ emissions from fuel production?

For example, for hydrogen or electricity production
Four scenarios were modeled, alternative vehicles adopted are:

1. **Hyper-Cars**: An ultra-efficient conventional vehicle, achieved using ultra light composite materials, advanced power trains and state of the art aerodynamic design.
2. **Electric Vehicles**: Uses electricity as its energy source.
4. **Natural Gas Vehicle**: Combusts natural gas instead of oil as its energy source.

**Key Assumption**

Accelerated adoption of light vehicle alternative technologies where sales of alternative vehicles in each transition increase incrementally from the same as BAU in 2013 to 50% above BAU in 2020 and thereafter.
Hyper (passenger) Car – Super Efficient but uncompromised performance

- Light weight carbon composites (or polymer composites) substitute for traditional steel – resulting in a car which is **50% lighter** (a reduction of ~500-600 kg)

- An efficiency of **38 km per liter** (90 miles per gallon) or double that of new conventional non-hybrid gasoline vehicles (no assumed change in performance)

- 2/3 of efficiency gains are from weight reduction, 1/6 from hybridization and 1/6 from reduced drag, rolling resistance and accessory loads

- Safety maintained with the strength and energy absorption of carbon composites being higher than steel or aluminum

Increase in Retail Price from Standard vehicle

Estimates range from about USD 4,000-6,000 in today’s dollars


Relative Efficiency of Vehicles

Transition of an Industry

- Weight reduction is **essential** for US to achieve future CAFE targets
- Hyper-Car is a lighter version of the 2035 HEV
- Not all fuels created equal
  - Oil is a primary energy
  - Electricity & Hydrogen are energy carriers *(with an efficiency cost)*

Passenger Cars

- **ICE vehicles assumed** 20% lighter
- **No change in performance**
- **Reduced losses in transmission etc.**

Source: APERC Analysis & Bandivadekar et al

Capital Costs Considerations

- Hydrogen Fuel Cell and Electric Vehicle are expensive
- The Hyper Car is comparable in cost to a low range plug-in hybrid
- The Hyper Car is a feasible alternative for the rational consumer

- Price is important – An electric vehicle charged on renewable energy will lead to zero emissions but at what cost?

**Long Term 2035 (mass production) Estimates**

<table>
<thead>
<tr>
<th>Car Type</th>
<th>Added Capital Cost above Conventional Vehicles (standard gasoline vehicle)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric Car (200 mile)</td>
<td>$15,000 (High Estimate) $10,000 (Low Estimate)</td>
</tr>
<tr>
<td>H2 Fuel Cell</td>
<td>$10,000 (High Estimate) $5,000 (Low Estimate)</td>
</tr>
<tr>
<td>Plug in hybrid (60 mile)</td>
<td>$7,500 (High Estimate) $3,750 (Low Estimate)</td>
</tr>
<tr>
<td>Hyper Car</td>
<td>$6,250 (High Estimate) $3,125 (Low Estimate)</td>
</tr>
<tr>
<td>Plug in hybrid (30 mile)</td>
<td>$5,000 (High Estimate) $2,500 (Low Estimate)</td>
</tr>
<tr>
<td>Plug in hybrid (10 mile)</td>
<td>$3,750 (High Estimate) $1,875 (Low Estimate)</td>
</tr>
<tr>
<td>Hybrid Car</td>
<td>$3,125 (High Estimate) $1,562.50 (Low Estimate)</td>
</tr>
</tbody>
</table>

Source: APERC Analysis & Kromer and Heywood

The Hyper Car and Natural Gas Transitions use a primary fuel directly.

The Hydrogen Fuel Cell and Electric Vehicle Transitions use an energy carrier as a fuel which must be produced from a primary energy source, this has an efficiency cost.

Hydrogen production has an additional energy cost from the liquefaction process to enable distribution to refueling stations.

Urban Planning
Alternative Urban Development Scenario - Introduction

- There is a clear relationship between compact cities with low transport energy demand.

- Note that we are not claiming that population density alone is the cause of low-energy urban design.

- Is urban design the key to reducing oil dependency?

Source: Adapted from Kenworthy and Laube (2001), UITP Millennium Cities Database for Sustainable Transport
Urban design influences transport energy use in a number of ways... *the 5 D’s* –

- Mixed use development to reduce distances between housing, jobs, shopping and community services (*Density, Diversity*)
- Improve street connectedness to enhance use of walking and bicycles (*Density, Design*)
- High quality public transit services (*Density, Distance to transit*)
- De-emphasis of urban motorways and parking development which promotes vehicle use (*Density, Destination accessibility*)

**Low Transport Energy Demand**  
**Urban Density**

*Convenient measure of effectiveness*

*Causation for energy savings*

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Urban Density in APEC is Decreasing

Urban city density to income and population size between 1984-2002

Urban density has declined at an average rate of 1.7% each year in the past

Alternative Urban Development Scenario - Model

The interaction between urban planning and vehicle transportation was modeled to assess the potential energy savings:

- **Business as usual** - Urban density continues to decline at the historical world average of 1.7% per annum.
- **High Sprawl** - Urban density declines at 3.4% per annum (or twice the historical average), leading to rapid urban area expansion.
- **Constant Density** - Urban density is maintained at a constant level (2009) where city expansion is in line with population growth.
- **Fixed Urban Land** - Urban land area is fixed and population growth is contained inside existing urban boundaries.
Key Findings
Virtual Clean Car—
Overall Results for Oil Demand and CO\textsubscript{2} Emissions

Introduction

- How will the adoption of light vehicle alternative technologies impact the energy sector if we take into account fuel production?

![Light Vehicle Oil Consumption](chart1)

- Light Vehicle CO\textsubscript{2} Emissions

![Light Vehicle CO\textsubscript{2} Emissions](chart2)

- The results can vary dramatically by economy depending on the marginal source for electricity generation.

- APEC-wide, hyper-cars has the best emissions reduction benefits.

Source: APERC Analysis
Virtual Clean Car—
Results by Economy for CO₂ Emissions

Light Vehicle CO₂ Emissions

- Business as Usual 2035
- Hyper Car Transition 2035
- Electric Vehicle Transition 2035
- Hydrogen Vehicle Transition 2035
- Natural Gas Vehicle Transition 2035

Source: APERC Analysis

- Emission vary from differences in carbon intensity of electricity production
- Each economy has varying fuel efficiency assumptions under BAU
The rapid growth of APEC’s economies presents a unique opportunity to build cities in an energy efficient manner.

Compact cities tend to favor transport energy-saving features in greater abundance.

Results consistently show that cities with lower population densities has higher energy demand.

Source: APERC Analysis
Virtual Clean Car—
Results by Economy for CO₂ Emissions

<table>
<thead>
<tr>
<th>Country</th>
<th>Light Vehicle Oil Demand (toe/capita)</th>
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</thead>
<tbody>
<tr>
<td>Canada</td>
<td></td>
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<tr>
<td>United States</td>
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<tr>
<td>Australia</td>
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<td>New Zealand</td>
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<td>Philippines</td>
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<table>
<thead>
<tr>
<th>Scenario</th>
<th>Light Vehicle Oil Demand (toe/capita)</th>
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<tbody>
<tr>
<td>Historical 2010</td>
<td></td>
</tr>
<tr>
<td>Business as Usual 2035</td>
<td></td>
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<tr>
<td>High Sprawl 2035</td>
<td></td>
</tr>
<tr>
<td>Constant Density 2035</td>
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</tr>
<tr>
<td>Fixed Urban Land 2035</td>
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</table>

Source: APERC Analysis

Non-OECD economies still undergoing rapid growth in oil demand from rising income.
Pathways to low carbon transportation is more *complicated* than promoting alternative fuels and will require multiple solutions.

R&D has focused on battery and fuel cell technology but should lightweight composites be given greater priority?

The Hyper Car could be combined with alternative fuel vehicles with net benefits to sustainability and oil security.

The benefit of electric and hydrogen vehicles is their pathway to non-fossil transportation.

*One time opportunity* in developing cities to implement smart urban design before it's too late.

Once cities are developed it becomes very difficult to alter land use.

The oil saving benefits of smart compact urban design is *very* significant.