



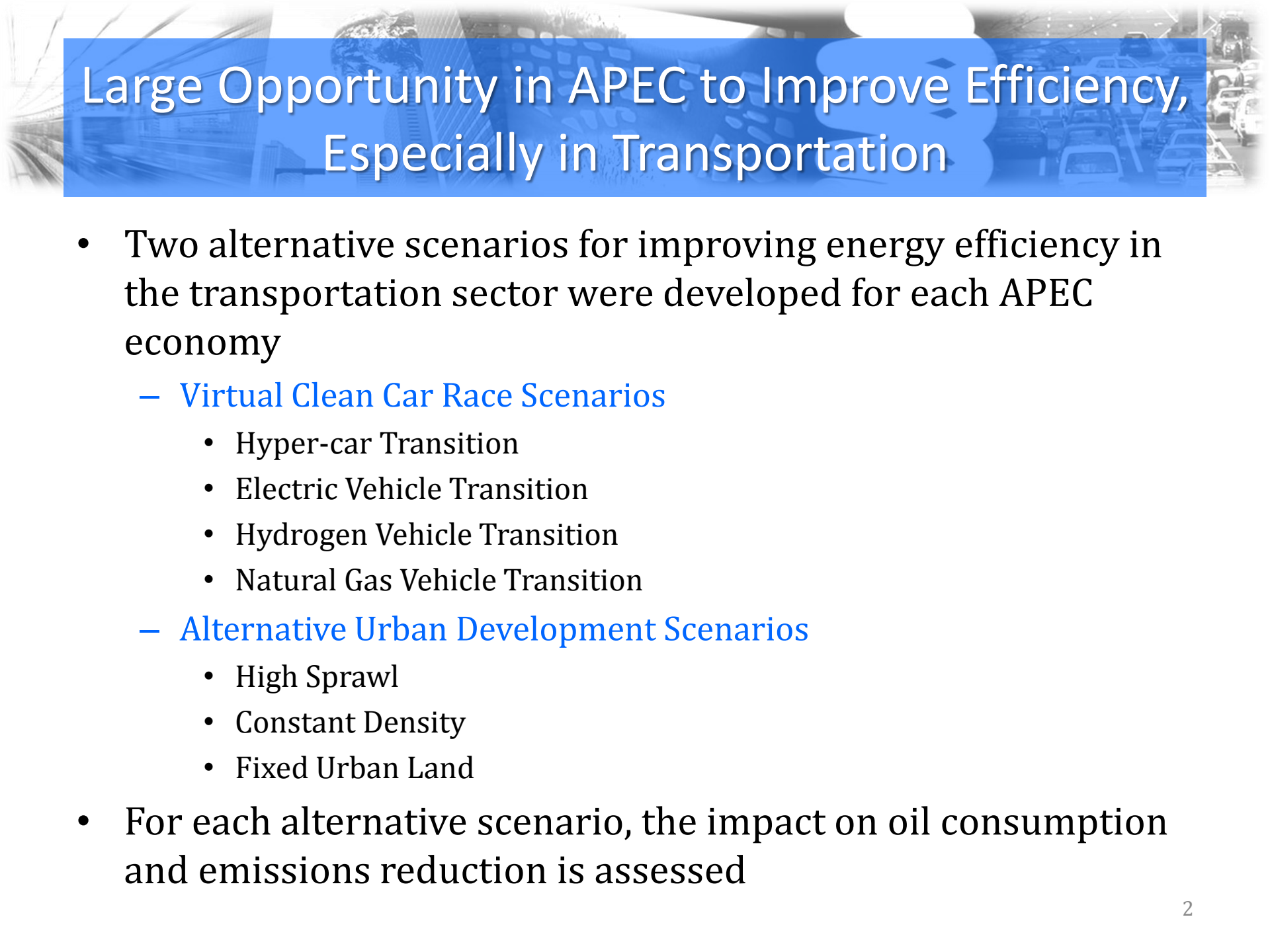
APERC Workshop, Washington,. D.C
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2-3 Transport Alternative Scenarios

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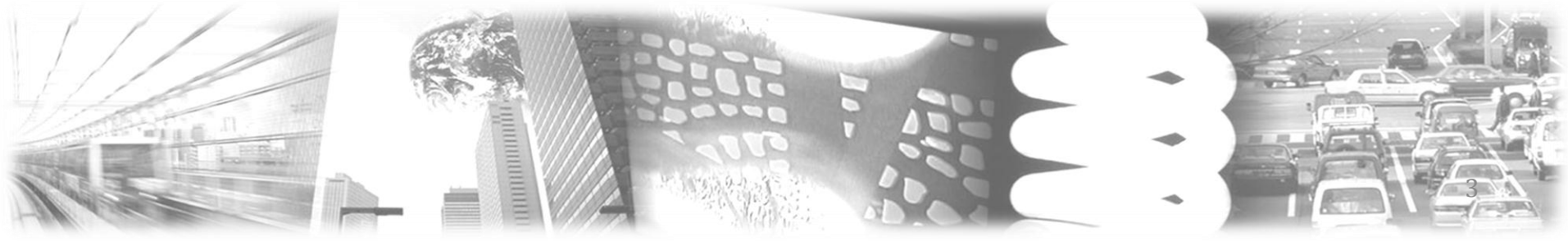
Asia-Pacific
Economic Cooperation



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



Virtual Clean Car Race - Introduction



Ministerial Joint Statement
7th APEC Transportation Ministerial Meeting

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**.

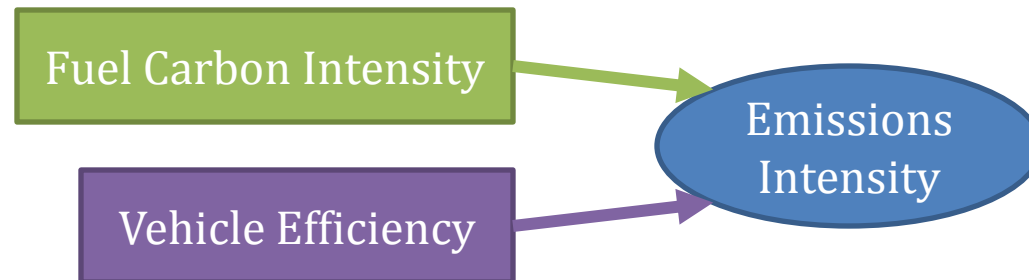
Background

- 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

Virtual Clean Car Race - Model

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.



- 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
 3. **Hydrogen Fuel Cell Vehicle:** Uses hydrogen fuel cells as its energy source
 4. **Natural Gas Vehicle:** Combusts natural gas instead of oil as its energy source

Hyper Car Concept

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

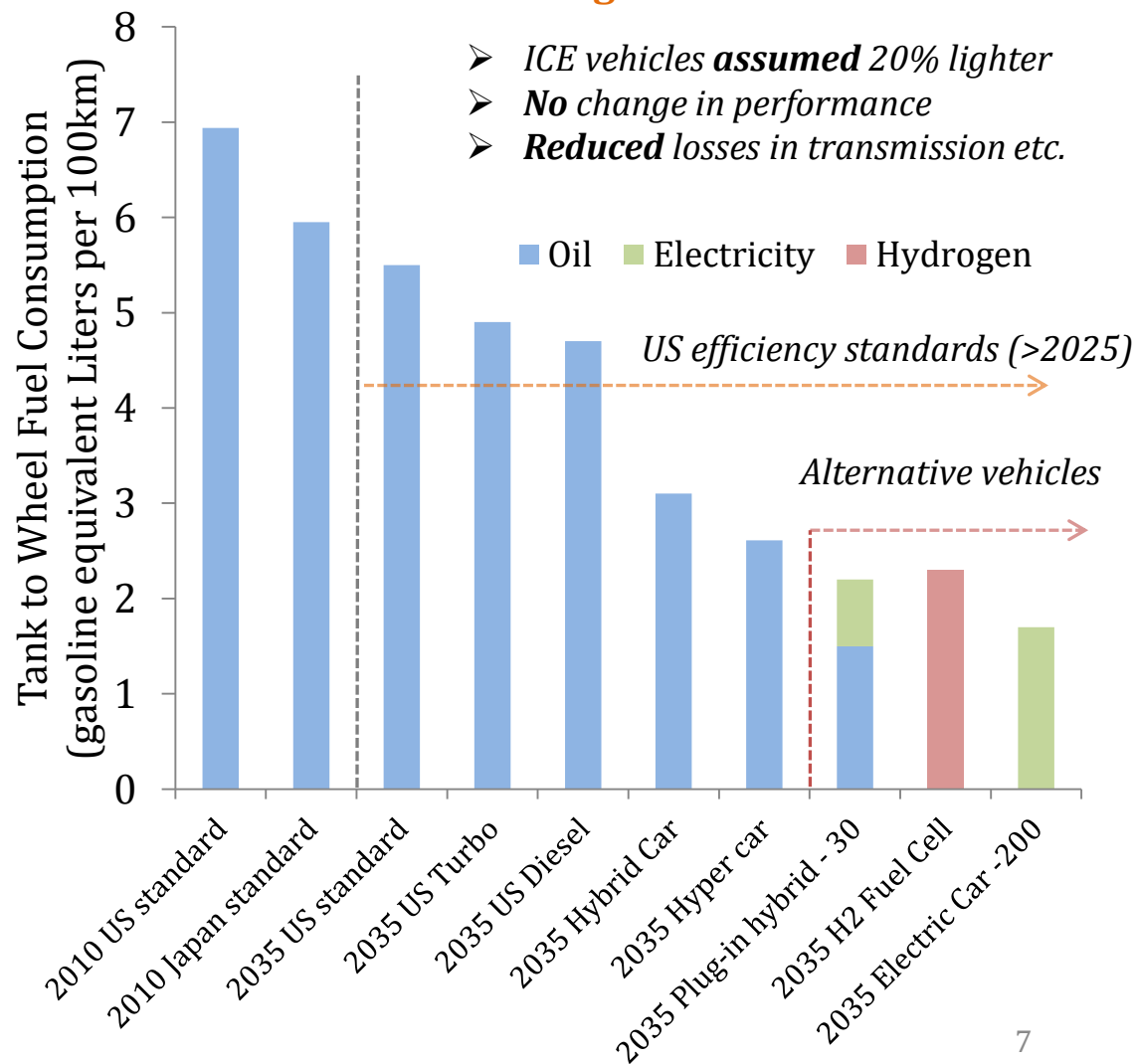
Estimates range from about USD 4,000-6,000 in today's dollars

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



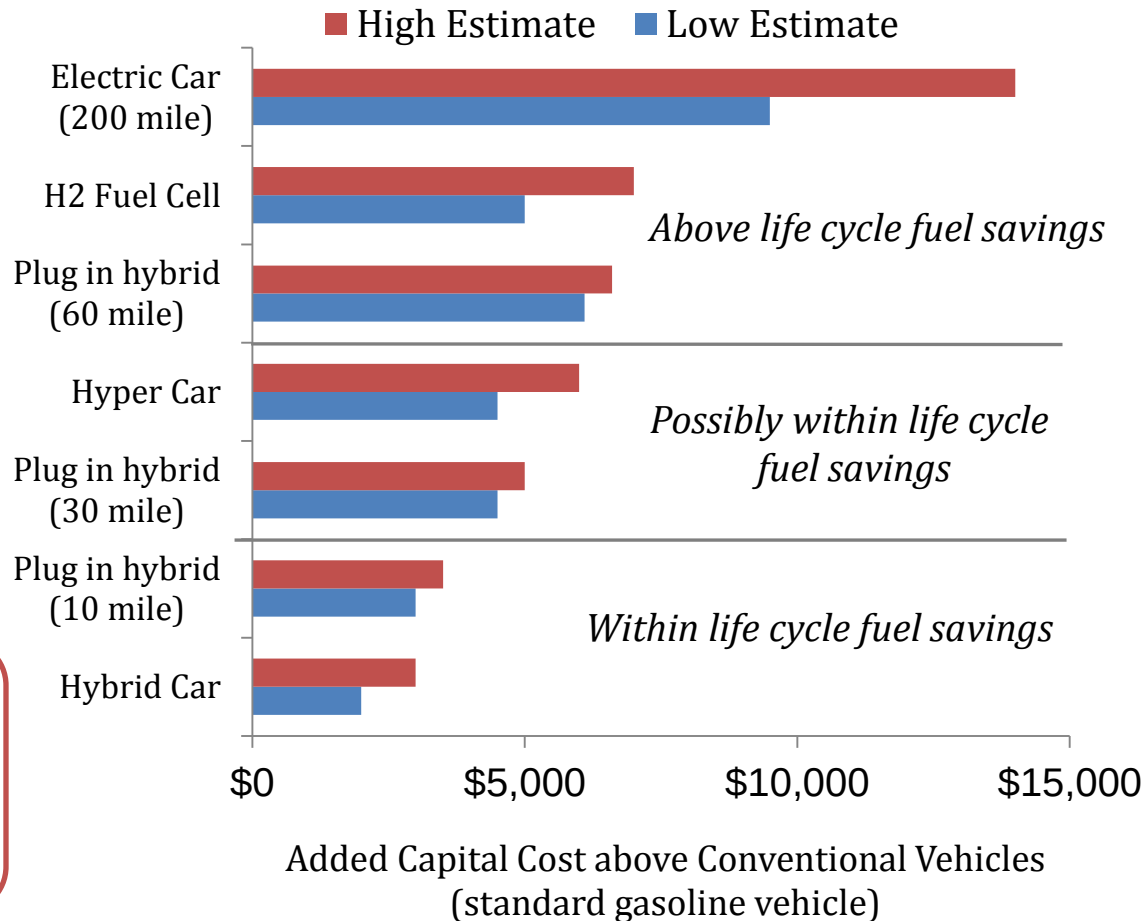
Capital Costs Considerations

Long Term 2035 (mass production) Estimates

- 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

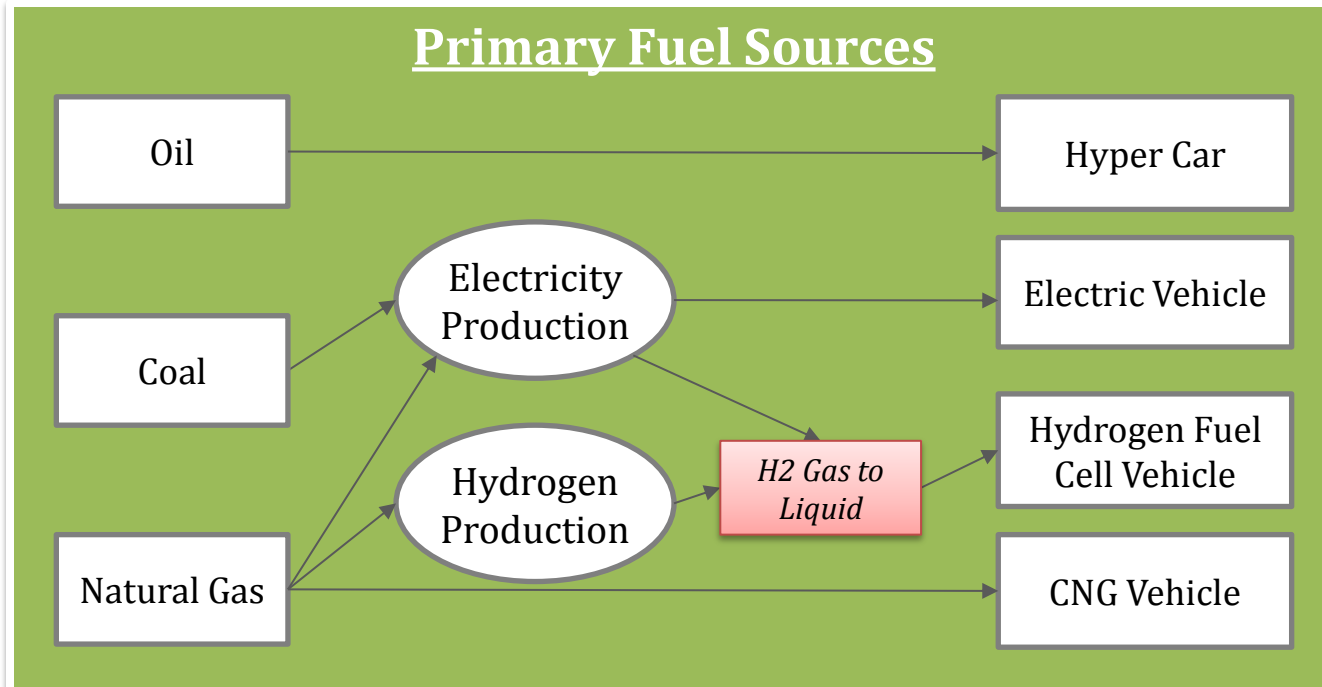


- *Price is important* – An electric vehicle charged on renewable energy will lead to zero emissions but at what cost?



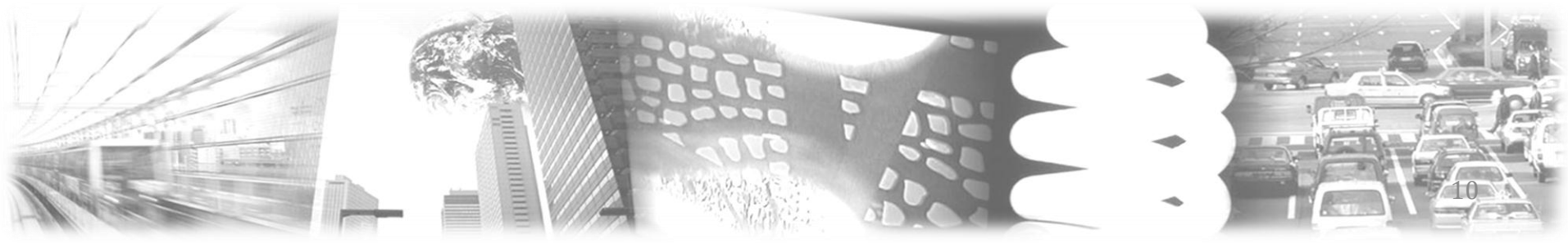
Source: APERC Analysis & Kromer and Heywood

Primary Fuel Sources



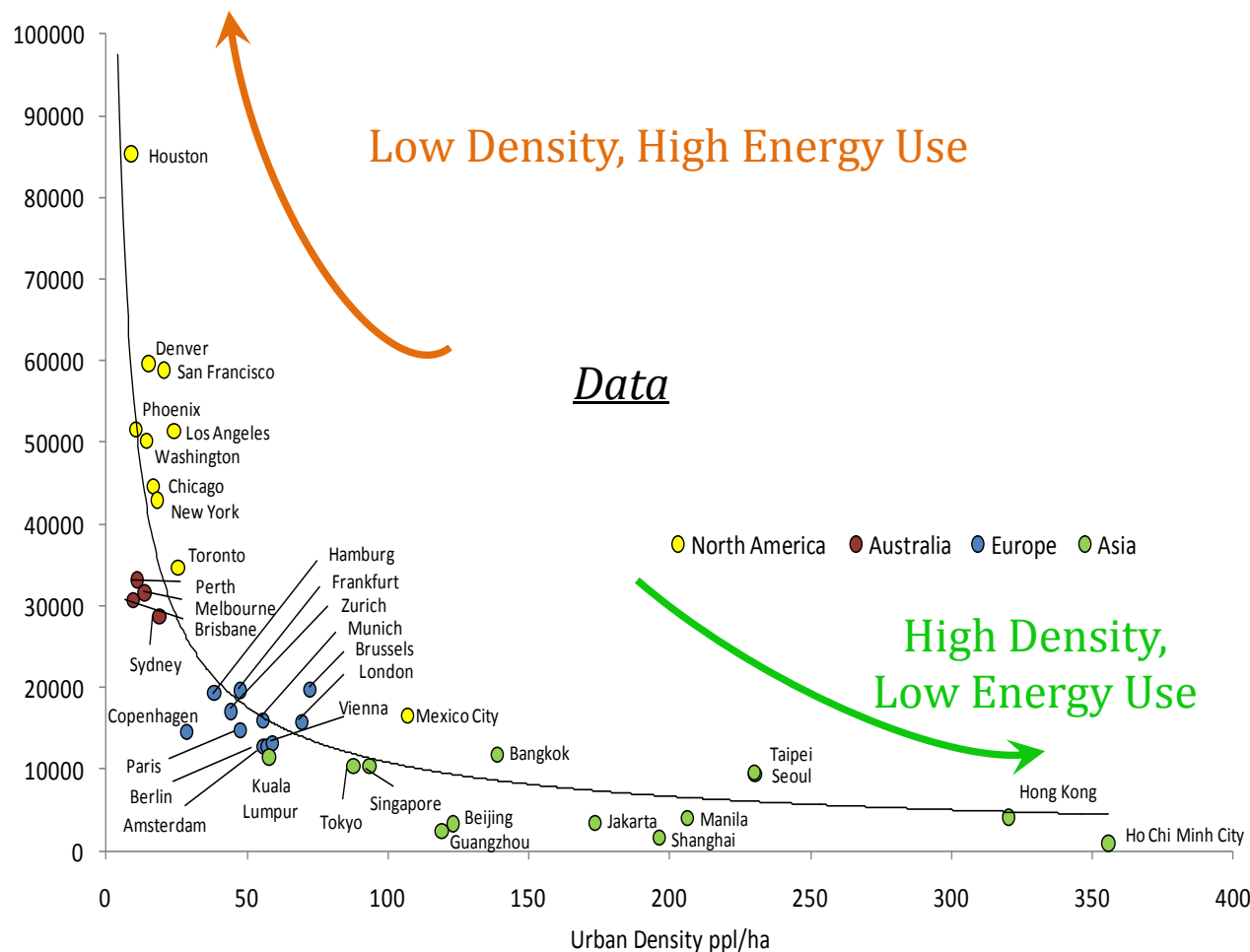
- The *Hyper Car* and *Natural Gas Transitions* use a primary fuel directly
- The *Hydrogen Fuel Cell* and *Electric Vehicle Transitions* use an energy carrier as a fuel which must be produced from a primary energy source, this has an efficiency cost
- Hydrogen production has an additional energy cost from the liquefaction process to enable distribution to refueling stations

Urban Planning



Alternative Urban Development Scenario - Introduction

Megajoules per capita

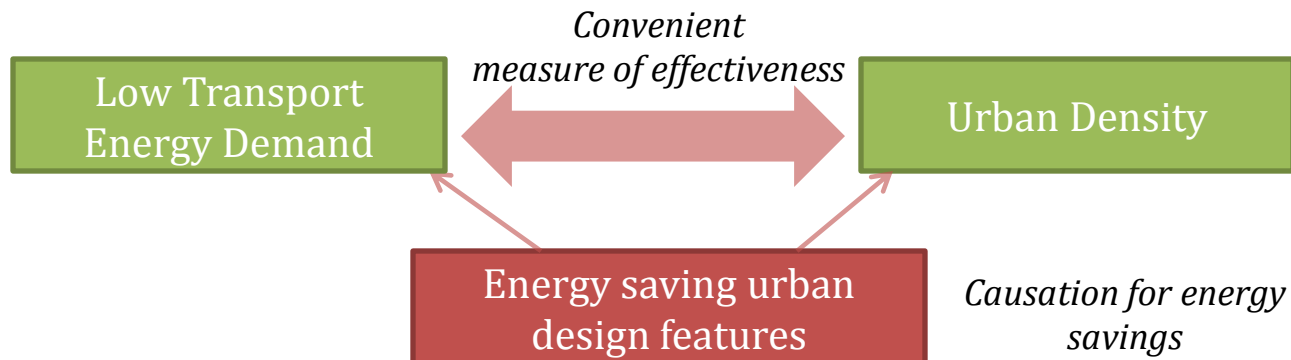


- There is a clear relationship between compact cities with low transport energy demand
- Note that we are **not** claiming that population density alone is the *cause* of low-energy urban design
- Is urban design the key to reducing oil dependency?

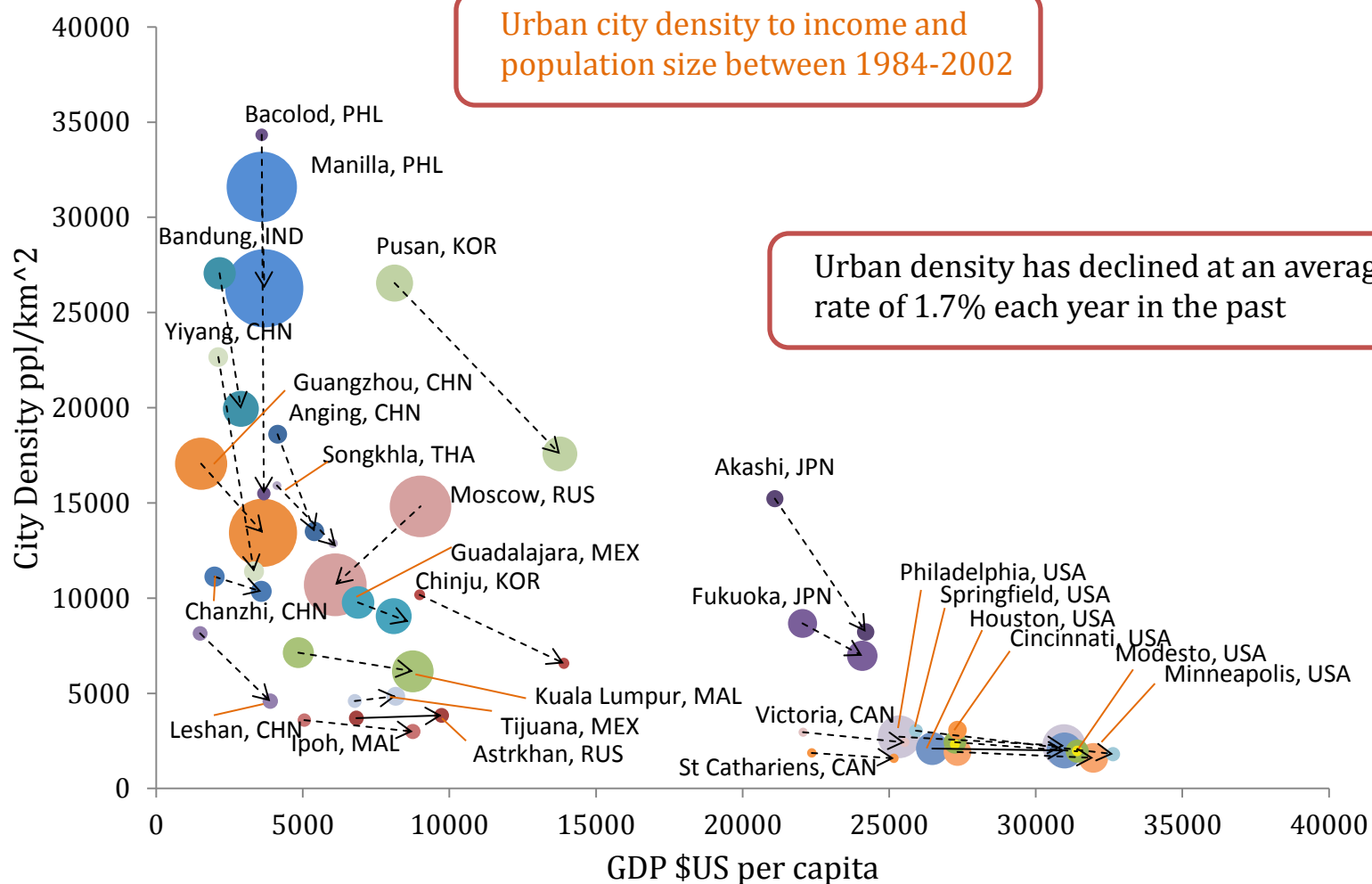
Smart Growth Urban Design

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*)

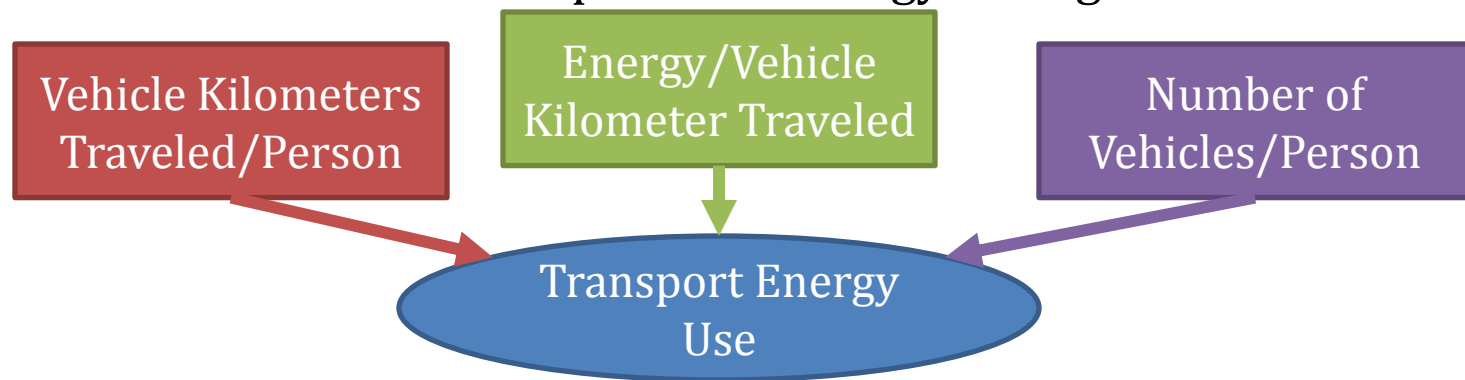


Urban Density in APEC is Decreasing



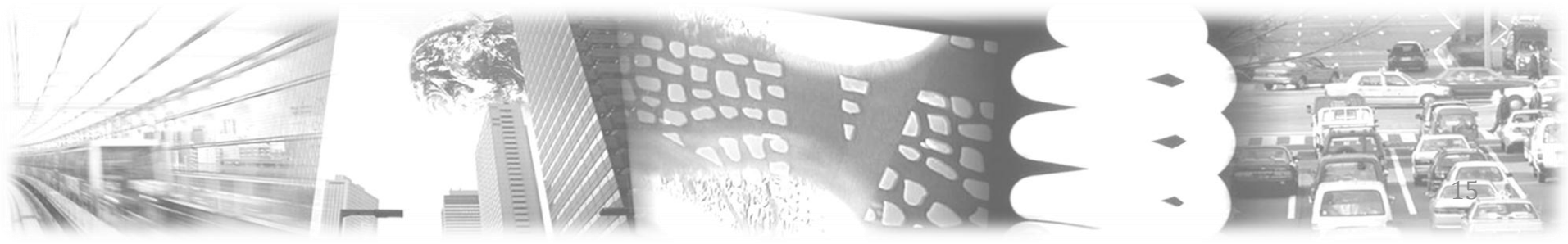
Alternative Urban Development Scenario - Model

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



- Three scenarios (and one business as usual case) were modeled:
 - **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

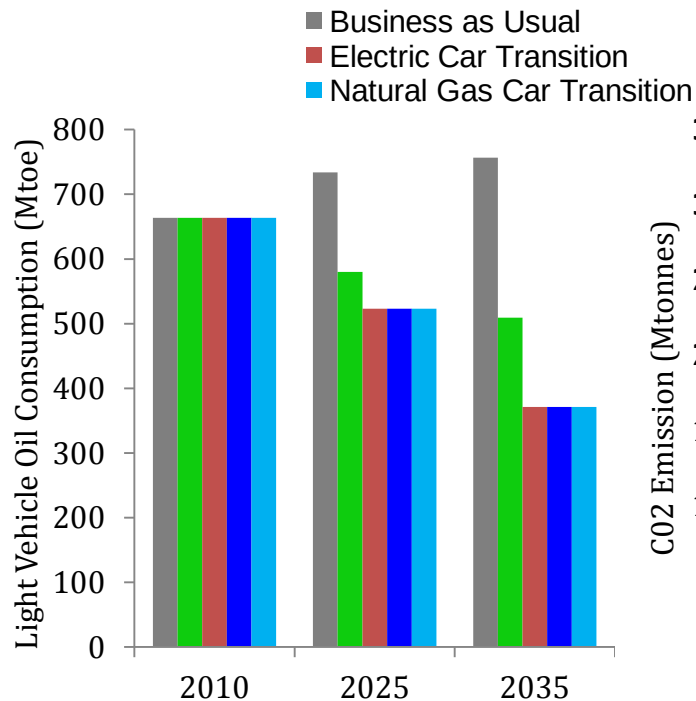


Virtual Clean Car— Overall Results for Oil Demand and CO₂ Emissions

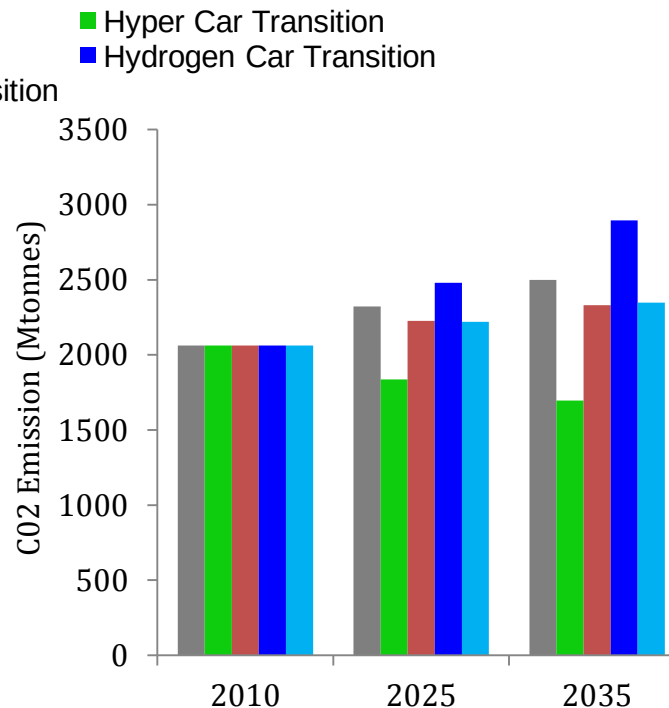
Introduction

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

Light Vehicle Oil Consumption



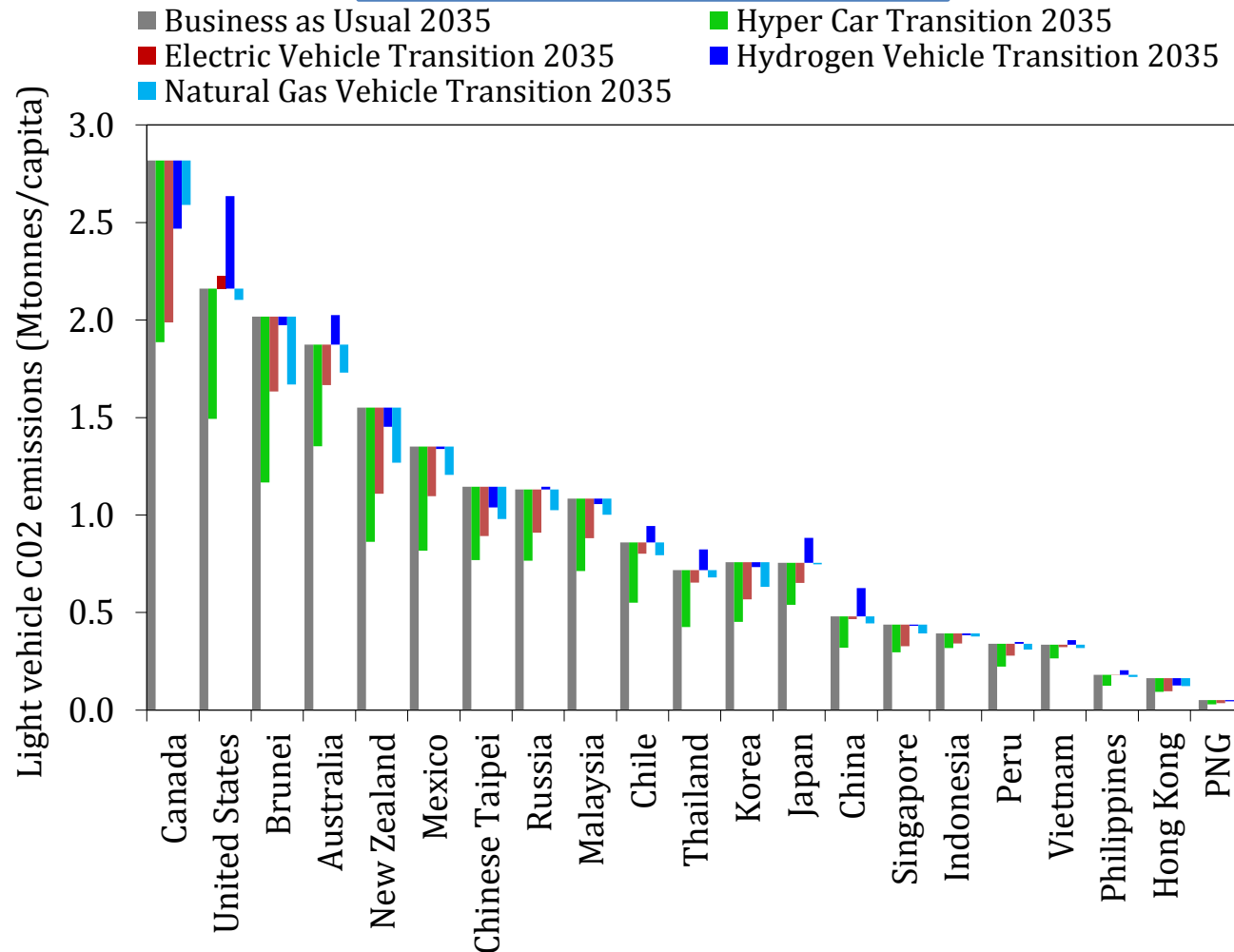
Light Vehicle CO₂ Emissions



- 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.

Virtual Clean Car— Results by Economy for CO₂ Emissions

Light Vehicle CO₂ Emissions



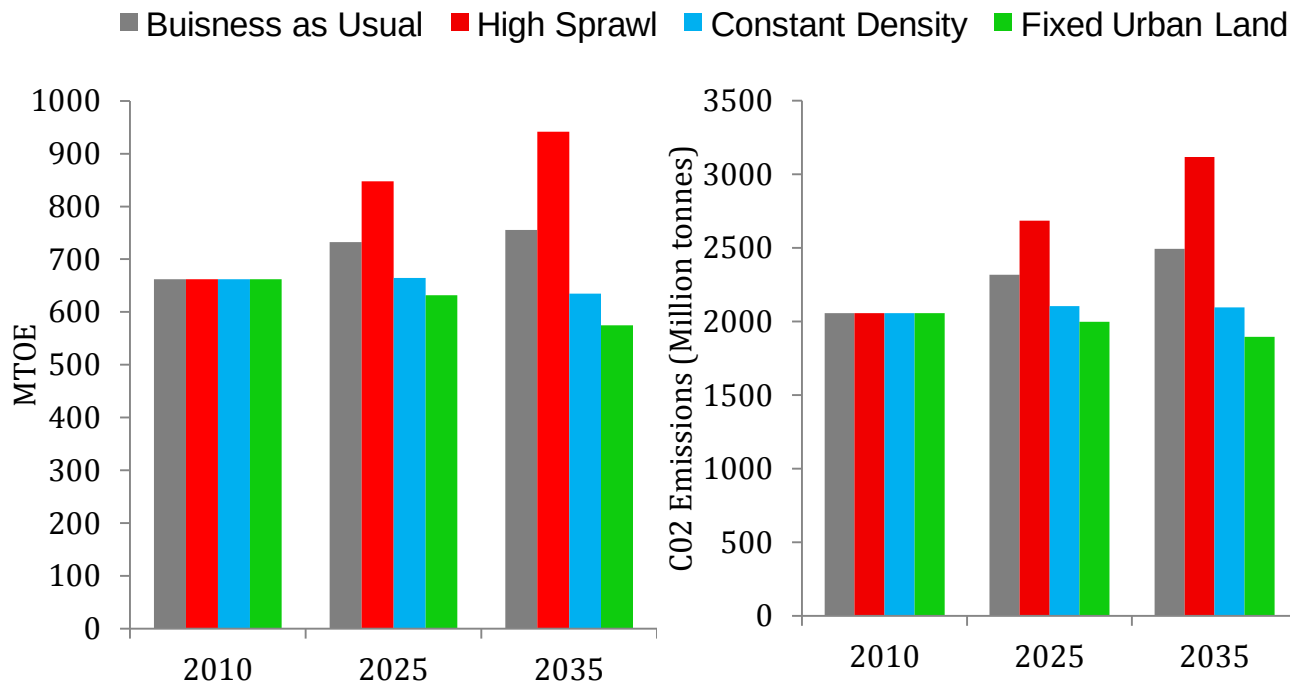
- Emission vary from differences in carbon intensity of electricity production
- Each economy has varying fuel efficiency assumptions under BAU

Alternative Urban Development Scenario – Overall Results for Oil Demand and CO₂ Emissions

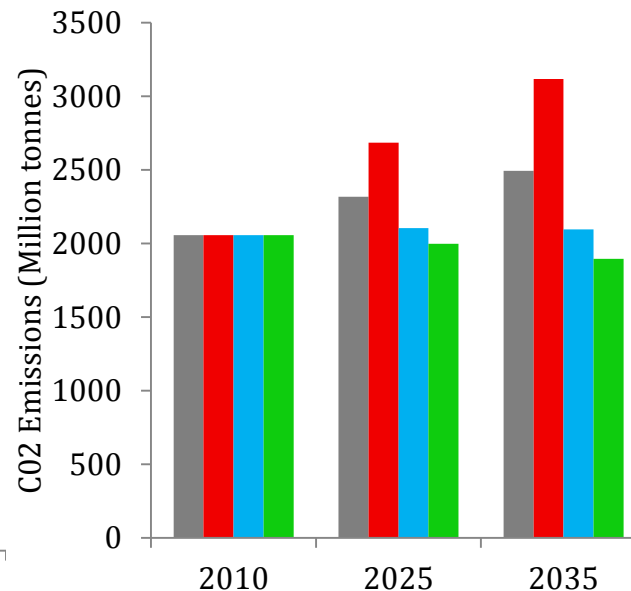
Introduction

- The rapid growth of APEC's economies presents a unique opportunity to build cities in an energy efficient manner.

Light Vehicle Oil Consumption



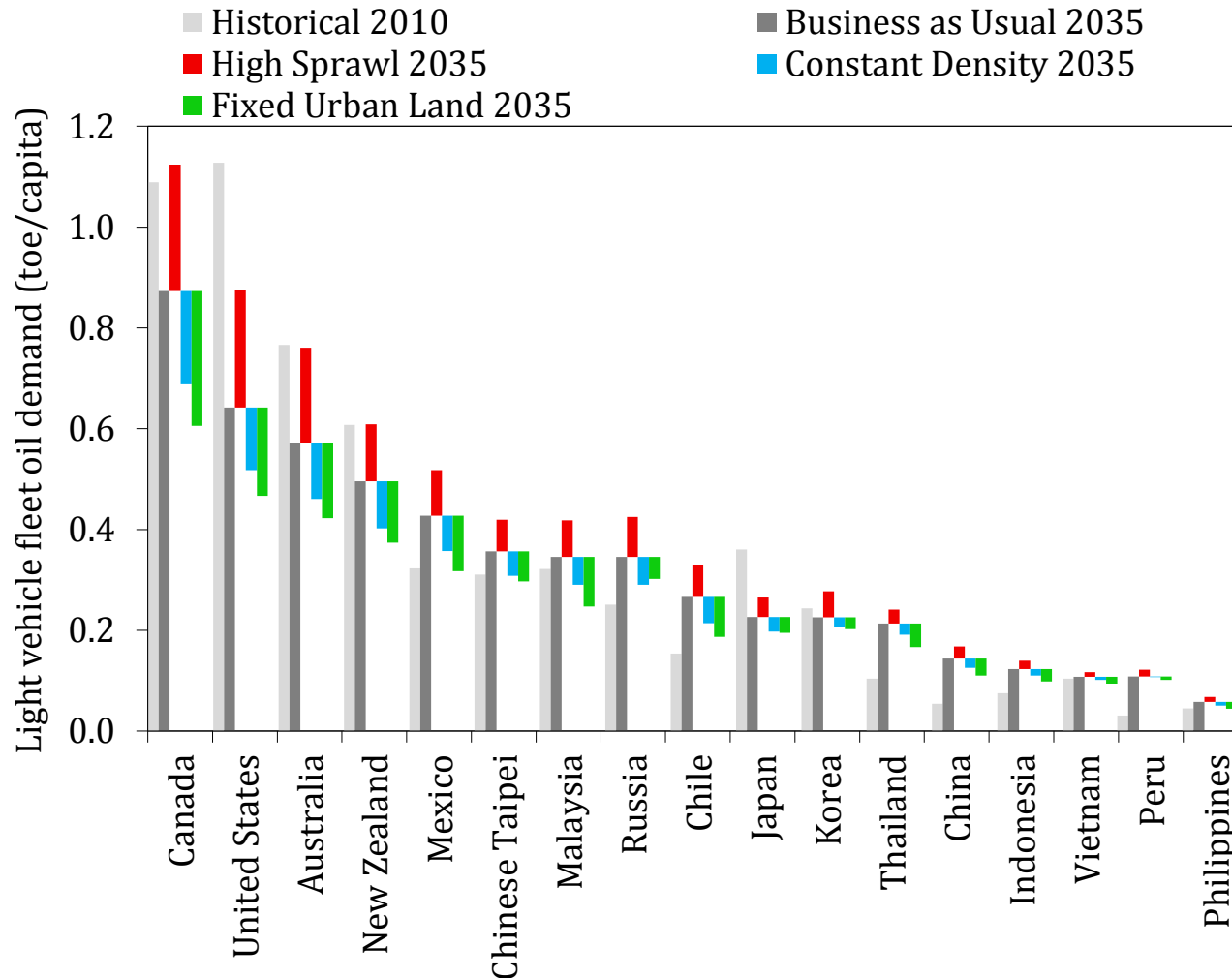
Light Vehicle CO₂ Emissions



- 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

Virtual Clean Car— Results by Economy for CO₂ Emissions

Light Vehicle Oil Demand



- Non-OECD economies still undergoing rapid growth in oil demand from rising income

Points to Ponder

Virtual Clean Car Race

- 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 light weight 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

Urban Planning

- One time opportunity in developing cities to implement smart urban design before its 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