Global Oil Demand Outlook

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About the Koch Companies

Koch companies are a diverse group of trading, investment and operating companies that identify, acquire and build businesses and assets in which their strengths may be leveraged to generate long term economic value through superior earnings.

- **Fuels & aromatics**
  - Olefins & polymers
  - Biofuels & ingredients

- **Mass transfer, mist elimination**
- **Low emission burners**
- **Membrane separation**
- **Heat exchangers**

- **Pet coke**
- **Coal, cement, sulfur**
- **Oil & natural gas properties**

- **Closely Held Private Company**
- **Annual Revenue ~$100 Billion**
- **Worldwide Employees ~120,000**
- **Presence in ~60 Countries**
- **Reinvests up to 90% of earnings**
- **Headquartered in Wichita, KS**

- **Fertilizer**
- **Natural gas**
- **Midstream power**
- **Methanol**

- **Nylon intermediaries & polymers**
- **Premium apparel & performance nylon fibers**

- **Consumer products**
  - Pulp, paper, packaging
  - Building products

- **Commercial & micro connectors**
- **Integrated electronic products**

- **Float & fabricated glass**
- **Chrome plated plastic parts**

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Global Oil Demand

- Oil demand is based on GDP growth, energy intensity, and the BTU of choice to provide that energy
- GDP growth has generally been the most significant driver
- Energy intensity and BTU of choice are slowing future demand growth and adding significant uncertainty for the future

EIA forecasts global demand of 121 million bpd by 2040
- OECD demand declines while non-OECD demand grows

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Global Oil Demand

- Energy intensity and BTU of choice have become more important factors in the demand equation
- Trends in government policy, technology and society could have profound impact to global demand and deserve additional focus

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- Efficiency standards and development of autonomous vehicles are the 2 primary disruptive factors to gasoline demand (and global oil demand)
U.S. Fuel Economy Standards

- Corporate Average Fuel Economy (CAFE) standards are the largest short term factor impacting gasoline demand in the U.S.
- The current standard raises fuel economy through 2025

![Graph showing the impact of hypothetical future standards on fuel economy](image_url)

![Graph showing US pump gasoline demand indexed to 2017](image_url)
Global Passenger Vehicle Standards

- Nine governments worldwide have established or proposed fuel economy or greenhouse-gas emission standards for passenger vehicles and light-commercial vehicles/light trucks, covering roughly 80% of global sales.

Historical fleet CO2 emissions performance and current standards (mpg normalized to U.S. CAFE test cycles) for passenger cars. Chart provided by icct with no changes (The International Council on Clean Transportation) at www.theicct.org. Made available under the Share Alike license of Creative Commons. https://creativecommons.org/licenses/by-sa/3.0/
Autonomous Vehicles

- Autonomous driving encompasses a wide range of technology from driver assist systems to fully driverless vehicle performance.
- Full self-driving automation occurs at Level 4 & Level 5.

1. **Driver Assistance**
   - Active cruise control, lane monitoring, etc.

2. **Partial Automation**
   - Requires continual human monitoring.

3. **Conditional Automation**
   - Human driver available when needed.

4. **High Automation**
   - Self-driving car within a geofenced area.

5. **Full Automation**
   - Self-driving car.

Level definitions from SAE International J3016 Automated Driving standard.

- By eliminating the need for a driver, a new mobility model could emerge.
- **Fully driverless vehicles have the potential to be highly disruptive.**

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Autonomous Vehicle Impact to Mobility

AV’s could change the way we travel

- Autonomous Vehicles (AV’s) could enable economically attractive autonomous mobility as a service (A-Maas)
- Passenger vehicle miles travelled (VMT) could be allocated to a smaller, more highly utilized pool of vehicles mostly owned by fleet operators

AV’s will increase demand for travel

- Autonomous vehicles are expected to increase demand (increase VMT) by providing mobility to the current underserved population (elderly, young, poor, those with medical conditions)
- A-MaaS decreases the cost of transportation, creating additional demand
Autonomous Vehicle Commercialization

- Technological, legal, and social barriers must be solved before AVs can be commercialized

**Technological**
- Effective & economic LiDAR *
- Improved algorithms
- Comprehensive high definition maps
- Computers fast enough to handle feedback between system with no delay

**Legal**
- Legislative changes for AV’s to be legal
- Laws to evolve to determine liability when AV causes harm to person or property

**Social Concerns**
- Vehicle safety
- Cyber security
- Labor disruption

**Typical Driverless AV Capability**

- **City centers:** Low speed driving and traffic density
- **Suburbs:** Higher speed capability
- **Rural:** Requires high speed capability and ability to manage more random events

*LiDAR: (light imaging, detection and ranging)
The powertrain of choice for autonomous vehicles will be the critical factor for gasoline demand.

AV technology is capable of operating on both internal combustion engine vehicles (ICEV) and battery electric vehicles (BEV).

AV technology (at least initially) may be better aligned with hybrid electric powertrains due to power demand (software is needed to manage high speed data without overheating computers).

**Impact of A-Maas**

A-Maas scenarios assume 1.5x additional vehicle miles travelled.
Conclusions

• U.S gasoline demand illustrations are directional to the potential impact to global oil demand

• The range of outcomes is wide and based on areas that are difficult to predict leading to uncertainty regarding future demand

• Government policies and their effectiveness are important to understand

• Autonomous vehicles will be disruptive, however the impact to gasoline demand is unclear