Energy Independence for North America and the Impacts on National Security Planning

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The Outlook for Energy: A View to 2040

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Society of American Military Engineers
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Global Progress Drives Demand

Population
Billion

GDP
Trillion 2010$

Energy Demand
Quadrillion BTUs

Rest of World
Key Growth
India
China
OECD*

OECD*
Mexico and Turkey included in Key Growth countries

Energy Savings

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Key Growth Countries

Leading Economic Growth 2010 to 2040
Percent Share

- China
- India
- Key Growth
- Other
- 60+ Countries
- 10 Countries

2040 Energy Demand
QUADS

- China
- India
- Key Growth

Countries:
- Brazil
- Saudi Arabia
- Indonesia
- Iran
- Mexico
- Nigeria
- South Africa
- Thailand
- Turkey
- Egypt
- Iran
- Saudi Arabia
- Indonesia
- Brazil
Standards of Living Increase

2040 GDP per Capita
PPP 2005$k

OECD* | China | India | Key Growth | ROW

*Mexico and Turkey included in Key Growth countries

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The Middle Class Continues to Grow

Middle Class per The Brookings Institution
Billion People

*Mexico and Turkey included in Key Growth countries

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Global Demand

2040 By Fuel
Quadrillion BTUs

- Oil: 0.8% growth
- Gas: 1.6% growth
- Coal: 0.1% growth
- Biomass: 0.5% growth
- Nuclear: 2.3% growth
- Solar / Wind / Biofuels: 5.8% growth
- Hydro / Geo: 1.8% growth

Average Growth / Yr. 2010 - 2040: 1.0%
**Energy-related CO2**

**CO2 Proxy Costs**
Dollars per tonne CO2 (2014$)

- 2020
- 2030
- 2040

**CO2 Emissions**
Billion tonnes CO2

- Non OECD
- OECD

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Electricity Generation
Electricity Generation Leads Growth

Primary Energy Demand by Sector
Quadrillion BTUs

- Electricity Generation
- Industrial
- Transportation
- Res/Comm

Non OECD vs. OECD

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Electricity Demand

**Electricity Demand**

- Improved Standard of Living
- Population Growth
- Industrial Growth
- Base Demand

**Electricity Demand by Region**

- China
- United States
- Key Growth
- Europe
- India

- Thousand TWh

- 1980 to 2040

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Electricity Generation Fuel by Region

*Mexico and Turkey included in Key Growth countries
Transportation
Transportation Fuel Mix by Region

- **Asia Pacific**
  - MBDOE
  - **Natural Gas**
  - **Fuel Oil**
  - **Biodiesel**
  - **Diesel**
  - **Ethanol**
  - **Gasoline**
  - **Other**

- **North America**
  - MBDOE

- **Europe**
  - MBDOE

Data Source: ExxonMobil
Light Duty Vehicles

Global Annual Sales by Type

- Million

- Electrified/Plug-in/Fuel Cell
- Full Hybrid
- Natural Gas & LPG
- Diesel
- Gasoline

U.S. New Vehicles

- Percent

- Boosted
- Hybrid
- Diesel
- Electrified/PHEV
Heavy Duty Transportation

Heavy Duty Demand by Fuel
MBDOE

Gasoline
Diesel
Other

Gas Share of Heavy Duty Demand
Percent

China
India
U. S.
World

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Supply
Liquids Trade Balance by Region
Liquids Trade Balance by Region

MBDOE

- North America
- Latin America
- Africa
- Europe
- Russia/Caspian
- Middle East
- Asia Pacific

- Biofuels
- Other
- Natural Gas Liquids
- Tight Oil
- Oil Sands
- Deepwater
- Conventional C&C Development
- Conventional Crude & Condensate
- Demand

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North America Liquids Supply Grows

North America Liquids Supply and Demand

Net Imports

Liquids Demand

Canadian Oil Sands

Biofuels

Other Petroleum

Crude & Condensate
Unconventional Supplies Expand

Heavy Oil by Region
MBDOE

North America
Latin America
Russia/Caspian

Tight Oil by Region
MBDOE

North America
Latin America
Russia/Caspian
Other
Gas Demand

By Region and Supply Type

BCFD

- LNG Imports
- Pipeline Imports
- Local Unconventional Production
- Local Conventional Production

North America
- '10
- '25
- '40

Latin America
- '10

Africa
- '10

Europe
- '10

Russia/Caspian
- '10

Middle East
- '10

Asia Pacific
- '10

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Gas Trade Balance by Region

BCFD

North America

Latin America

Africa

Europe

Russia/Caspian

Middle East

Asia Pacific

Unconventional Production
Conventional Production
Demand
China’s Demand Peaks as Economy Matures and Intensity Improves

**Energy Demand**
Quadrillion BTUs

- China
- Key Growth
- U.S.
- India
- E.U.

**Energy Intensity**
Thousand BTUs per Dollar of GDP

OECD*
'95
'10
'25
'40

China
Rest of World

*Mexico and Turkey included in Rest of World
China’s Import Dependence Grows

**China Net Oil and Gas Imports**

- MBDOE

**Liquids Net Imports**

- Percent of Demand

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China’s Electric Generation Mix Diversifies

**Installed Capacity and Utilization**

- **Gigawatts**
  - Nuclear
  - Wind
  - Solar

**Electricity by Fuel**

- Thousand TWh
  - 1990
  - 2015
  - 2040

**Fuel Inputs to Electricity**

- Quadrillion BTUs
  - 2010
  - 2025
  - 2040

- Gas
- Coal
- Nuclear
- Solar
- Wind
- Other Renewables
China’s Transportation Demand Grows

Transportation by Sector
MBDOE

Transportation by Fuel
MBDOE

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China’s Industrial Demand Peaks

By Sector
Quadrillion BTUs

By Fuel
Quadrillion BTUs

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China’s Urban Households Have Modernized Rapidly

China’s Urban Appliance Ownership
Appliances per 100 Households

- Color TV
- Air Conditioner
- Washing Machine
- Refrigerator
- Water Heater
- Computer

Demand By Fuel
Quadrillion BTUs

- Electricity
- Other Renewables
- Biomass
- Coal
- Gas
- Oil

Source: China Statistical Yearbook
Energy Use Evolves Over Time

Global Mix of Fuels
Quadrillion BTUs

Source: Smil, Energy Transitions (1800-1960)
For a more information, visit exxonmobil.com/energyoutlook

or download the ExxonMobil app
Energy Trade

Indicative trade flows
Increasing Focus on Addressing Climate Risk

CO₂ “Proxy” Cost 2040

- > $40/ton
- $20-$40/ton
- < $20/ton
Remaining Oil Resource

Crude and Condensate (GBO)

- **Global** ~4,500
- **North America** ~1,100
- **Europe** ~100
- **Latin America** ~800
- **Middle East** ~1,000
- **Africa** ~300
- **Russia/Caspian** ~1,000
- **Asia Pacific** ~200

Source: IEA
Remaining Global Gas Resource

Over 200 years coverage at current demand

- North America: 3.9 TCF
- Latin America: 3.0 TCF
- Europe OECD: 1.6 TCF
- Middle East: 4.8 TCF
- Africa: 3.6 TCF
- Asia Pacific: 4.9 TCF
- Russia/Caspian*: 6.7 TCF

Source: IEA; *Includes Europe Non OECD