The Outlook for Energy: A View to 2040

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Global Progress Drives Demand

Population
- Billion
  - Average Growth / Yr.
    - 2010 – 2040
      - OECD
        - 0.8%
      - Non OECD
        - 2.8%

GDP
- Trillion 2005$
  - Average Growth / Yr.
    - 2010 – 2040
      - OECD
        - 2.8%
      - Non OECD
        - 0.8%

Energy Demand
- Quadrillion BTUs
  - Average Growth / Yr.
    - 2010 – 2040
      - OECD
        - 1.0%
      - Non OECD
        - 1.0%

Energy Saved
- ~500
Electricity Generation Leads Growth

Energy Demand by Sector

Quadrillion BTUs

- Electricity Generation
- Industrial
- Transportation
- Res/Comm

Electricity Demand

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Transportation

65%

Heavy duty transportation demand grows 65 percent by 2040.
Light Duty Vehicle Fleet Grows, Mix Changes

Powertrain Technology
Millions of Vehicles

2020

- PHV/EV
- Advanced*
- Full Hybrid
- CNG
- LPG
- Long Diesel
- Conventional Diesel
- Conventional Gasoline

North America
Europe OECD
Other OECD
China
India
Middle East
Latin America
Other Non OECD

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*Full Hybrid, Plug-in Hybrid, Electric Vehicles
Europe Transportation Demand

- MBDOE
- Million Cars

Transportation:
- Rail
- Marine
- Aviation
- Heavy Duty
- Light Duty

Light Duty Vehicle Fleet:
- Conv. Diesel
- CNG/LPG
- Hybrid
- PHV/EV
- Conv. Gasoline

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Electricity generation

85%

Global electricity demand will grow by 85 percent over the Outlook period.
Electricity Demand by Region

Non OECD
- Thousand TWh

- China
- India
- Africa
- Middle East
- Russia/Caspian
- Southeast Asia
- Other Non OECD

OECD
- Thousand TWh

- North America
- Europe OECD
- Other OECD

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Fueling Electricity Generation Varies by Region

Electricity Generation
Quadrillion BTUs

<table>
<thead>
<tr>
<th>Year</th>
<th>OECD</th>
<th>Non OECD</th>
</tr>
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<tbody>
<tr>
<td>2000</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>2020</td>
<td>100</td>
<td>200</td>
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<tr>
<td>2040</td>
<td>150</td>
<td>250</td>
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Growth in Fuels from 2010 to 2040
Quadrillion BTUs

- **Renewables**: Increase of 90 quadrillion BTUs
- **Nuclear**: Increase of 60 quadrillion BTUs
- **Gas**: Increase of 30 quadrillion BTUs
- **Coal**: Increase of 0 quadrillion BTUs
- **Oil**: Increase of -30 quadrillion BTUs

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Economic Choices for Europe Electricity

**Baseload, Startup 2030**

2012 Eurocents/kWh

- **Coal**: $12/ton of CO₂
- **Gas**: $0/ton
- **Nuclear**: $60/ton of CO₂
- **Onshore Wind**: Reliability Cost
- **Solar PV Utility**: Reliability Cost

*Wind and solar exclude costs for integration, backup capacity and additional transmission*
Renewables Gain Share

United States
Percent of TWh

Europe
Percent of TWh

Asia Pacific
Percent of TWh

* Biomass includes Municipal Solid Waste

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Energy Mix Continues to Evolve

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CO₂ Emissions Plateau

By Region
Billion Tons

OECD

Rest of Non OECD

India

China

Emissions Per Capita
Tons per Person

China

India

U.S.

Europe

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Supply

60% Oil and gas will supply about 60 percent of global energy demand in 2040, up from 55 percent in 2010.
Liquids Supply

Supply by Type

MBDOE

Conventional Crude & Condensate

Biofuels

Other Liquids

NGLs

Oil Sands

Tight Oil

Deepwater

Resource*

TBO

Remaining Resource

Cumulative Production

* Source: IEA

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Natural Gas Supply and Demand Shifts

North America Gas Supply

- Local Unconventional
- Local Conventional
- LNG

Global Gas Supply

- Rest of World Unconventional
- North America Unconventional
- Rest of World Conventional
- North America Conventional

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Global Gas Resource

Over 200 years coverage at current demand

North America: 4.3 TCF
Europe OECD: 1.6 TCF
Middle East: 4.9 TCF
Russia/Caspian*: 6.2 TCF
Asia Pacific: 4.5 TCF

World: 1000 TCF

Source: IEA; *Includes Europe Non OECD
Gas Demand Grows and Supply Diversifies

North America
- Local Production
- Conventional
- Unconventional
- LNG

Europe
- Pipeline

Asia Pacific

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Hydraulic Fracturing
Shale Gas: Demonstrate Responsibility

- Protect during Drill, Frac & Production
- Minimize Usage
- Demonstrate Responsibility
- Aquifers
- Water
- Local Area
- Minimize Industrial Impact
- Ground
- Open & Continual Communication
Shale Gas Production Process

- Uses two established technologies: horizontal drilling (1960s+) and hydraulic fracturing (1950s+)
  - Both widely used in Europe for decades
- Shale reservoirs are generally 2,000m to 4,000m below surface
- Water, sand and additives are pumped at pressure into the shale, opening up hairline fractures that allow gas to flow
- Thousands of meters of impermeable rock separate fractures from drinking water aquifers
- Fractures cannot propagate to the surface

Source: Total
Aquifer Protection

- Aquifers protected by several layers of steel and impermeable cement
- No different from a conventional oil or gas well, or geothermal well

Source: Total

Source: OGP
Opportunities: Economic Benefits

**Historic Henry Hub, NBP and JLNG Prices**

- **Henry Hub (€ct/kWh)**
- **NBP (€ct/kWh)**
- **JLNG (€ct/kWh)**

**Sources:** Platts, ICIS ESGM Heren Report and Waterbourne
Liquefied Natural Gas

Adriatic LNG Terminal
LNG Supply

Source: IHS CERA
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Europe LNG Supply Potential

- Significant volumes of LNG available to Europe 2015 – 2030
- 50 BCM 2015 (~10% Demand) to 170 BCM in 2030 (~ 25% Demand)

Source: WoodMackenzie Research (1H 2012 – Gas & Power Tool)