

# World Energy Resources | 2016

## EXECUTIVE SUMMARY

The past 15 years have seen unprecedented change in the consumption of energy resources. Unexpected high growth in the renewable energies market, in terms of investment, new capacity and high growth rates in developing countries have changed the landscape for the energy sector. We have seen the growth of unconventional resources and improvements in technology development for all forms of energy resources. This has contributed to falling prices and the increased decoupling of economic growth and GHG emissions. Most countries have achieved a more diversified energy mix with a growth in community ownerships and an evolution of micro grids.

To better understand these unprecedented changes the 2016 World Energy Resources report highlights the key trends and identifies the implications for the energy sector.

### KEY FINDINGS



#### SOLAR

Global installed capacity for solar-powered electricity has seen an exponential growth, reaching around 227 GW<sub>e</sub> at the end of 2015, producing 1% of all electricity used globally.

The total capacity for solar heating and cooling in operation in 2015 is estimated at 435 GW<sub>th</sub>.

As solar PV module prices have declined around 80% since 2007 (from ~ \$4/W in 2007 to ~ \$1.8/W in 2015), the cost associated with balancing the system represents the next great challenge for the Solar PV industry.



## E-STORAGE

E-storage has been characterised by rapid change, driven by reduced costs (especially batteries) and increased industry requirement to manage system volatility.

As of end-2015, the global installed storage capacity was 146 GW, consisting of 944 projects. There are already around 25 000 residential-scale units in Germany alone.

Bottom-up projections suggest a global storage market of 1.4 GW/y by 2020, with strong growth in electro-mechanical technologies in particular.



## MARINE ENERGY

0.5 GW of commercial marine energy generation capacity is in operation and another 1.7 GW under construction, with 99% of this accounted for by tidal range.

The total theoretical wave energy potential is said to be 32 PWh/y, but is heterogeneous and geographically distributed, technology costs for marine energy are still very high, hindering deployment.



## URANIUM AND NUCLEAR

Global uranium production increased by 40% between 2004 and 2013, mainly because of increased production by Kazakhstan, the world's leading producer.

As of December 2015, 65 nuclear reactors were under construction with a total capacity of 64 GW. Two-thirds (44) of the units under construction are located in three countries: China, India and Russia.

Currently there are more than 45 Small Modular Reactors designs under development and four reactors under construction.



## WASTE-TO-ENERGY

Despite Waste-to-Energy (WtE) occupying less than 6% of the total waste management market, the global WtE market was valued at approximately US\$ 25 billion in 2015 and is expected to reach US\$ 36 billion by 2020, growing at CAGR of around 7.5% between 2015 and 2020.



## HYDROPOWER

Hydropower is the leading renewable source for electricity generation globally, supplying 71% of all renewable electricity at the end of 2015. Undeveloped potential is approximately 10 000 TWh/y worldwide.

The global hydropower capacity increased by more than 30% between 2007 and 2015 accounting to a total of 1209 GW in 2015, of which 145 GW is pumped storage.



## OIL

Oil remained the world's leading fuel, accounting for 32.9% of global energy consumption. Crude oil prices recorded the largest percentage decline since 1986 (73%).

Roughly 63% of oil consumption comes from the transport sector. Oil substitution is not yet imminent and is not expected to reach more than 5% for the next five years.

Unconventional oil recovery accounts for 30% of the global recoverable oil reserves and oil shale contains at least three times as much oil as conventional crude oil reserves, which are projected at around 1.2 trillion barrels.



## NATURAL GAS

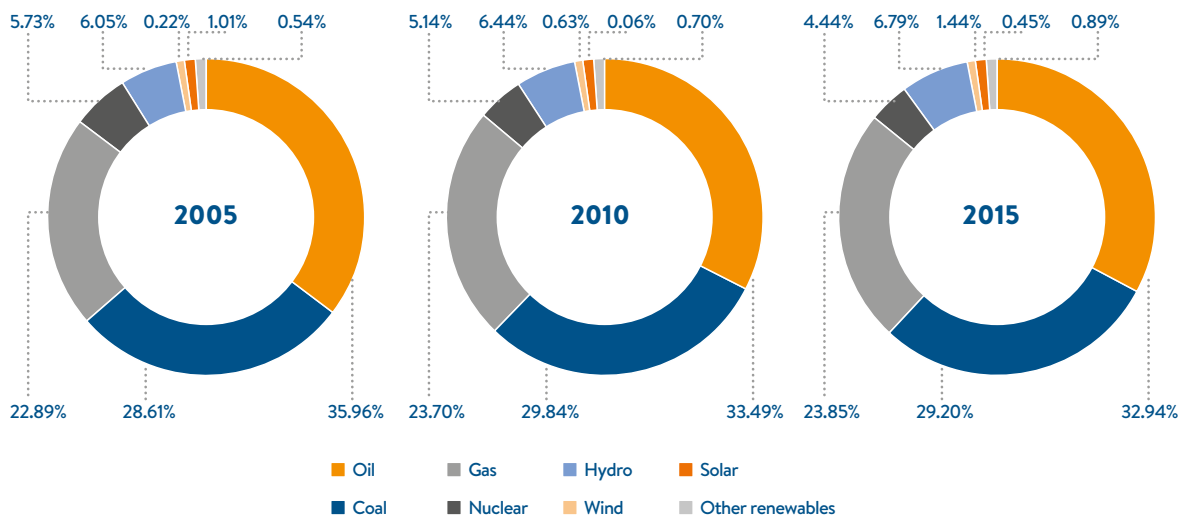
Natural gas is the second largest energy source in power generation, representing 22% of generated power globally and the only fossil fuel whose share of primary energy consumption is projected to grow.



## WIND

Global wind power generation capacity reached 432 GW in 2015, around 7% of total global power generation capacity (420 GW onshore, 12 GW offshore). A record of 63 GW was added in 2015 and total investment in the global wind sector was US\$ 109 billion in 2015.

## COMPARATIVE PRIMARY ENERGY CONSUMPTION OVER THE PAST 15 YEARS





## COAL

Coal production declined with 0.6% in 2014 and with a further 2.8% in 2015, the first decline in global coal production growth since the 1990s.

Coal still provides around 40% of the world's electricity. However, climate change mitigation demands, transition to cleaner energy forms and increased competition from other resources are presenting challenges for the sector.

Asia presents the biggest market for coal and currently accounts for 66% of global coal consumption.



## CCS

CCS is an essential element of any low carbon energy future, but policy is the main issue, not technology. The world's first large-scale application of CO<sub>2</sub> capture technology in the power sector commenced operation in October 2014 at the Boundary Dam power station in Saskatchewan, Canada.

There are 22 large-scale CCS projects currently in operation or under construction around the world, with the capacity to capture up to 40 million tonnes of CO<sub>2</sub> per year (Mtpa).



## GEOHERMAL

Geothermal global output is estimated to be 75 TWh for heat and 75 TWh for power, but is concentrated on geologic plate boundaries.



## BIOENERGY

Bioenergy is the largest renewable energy source with 14% out of 18% renewables in the energy mix and supplies 10% of global energy supply.

## IMPLICATIONS FOR THE ENERGY SECTOR

There is already significant transition in the sector, however some energy resources have challenges:

Despite some notable progress, the rate of improvements towards cleaner energy is far slower than required to meet emissions targets. Public acceptance remains a challenge, regardless of the energy source, with an increased ‘Not in my back yard’ (‘NIMBY’) attitude to the development of energy sources. Increased commodity and energy price uncertainty that results in higher risk, and larger investments with long lead times are less appealing.

Without diversification and review of business models, national and international oil and gas companies could struggle over the medium to long term. Incentive-assisted renewable energy companies have created a boom in certain countries and regions. However, as incentives are decreased, some companies might not be viable anymore.

Rare earth elements, metals used in especially renewable energies, create new dependencies in the value chain and could represent possible future barriers to growth. Change is at its slowest at the moment, but our research identifies that technologies will change a lot quicker and the regulatory system is not keeping up, which may also become a barrier.

Liberalised markets could reach their limit, as the lowest cost generation in the short term can be perceived to provide the highest value. There is a significant need to balance other aspects of the Energy Trilemma such as environmental considerations, including increased resilience and security of supply. This is particularly important for long-term planning in short-term power operations, with the lack and lag of new, expanded, upgraded and smart infrastructure offering the potential to hinder new energy developments.

Heat generation and cooling technologies are lagging behind in terms of innovation. Increased use of natural gas combined with decreased use of coal will see energy-associated carbon dioxide emissions from natural gas surpass those from coal. Failure to timeously plan for replacement of decommissioned baseload power plants might pose a risk to energy reliability in some countries.

All of this creates a highly dynamic context for the energy sector.

## ABOUT THIS REPORT

The World Energy Resources have been produced by the World Energy Council for over 80 years. The details and analysis provide a unique data set that allows governments, private sector and academia to better understand the reality of the energy sector and the resource developments.

The assessments are compiled with our network of member committees in over 90 countries along with a panel of experts who provide insights from across the globe. With information covering more than 180 countries this is the 24<sup>th</sup> edition of the World Energy Resources report.

## WORLD ENERGY COUNCIL

The World Energy Council is the principal impartial network of energy leaders and practitioners promoting an affordable, stable and environmentally sensitive energy system for the greatest benefit of all. Formed in 1923, the Council is the UN-accredited global energy body, representing the entire energy spectrum, with over 3,000 member organisations in over 90 countries, drawn from governments, private and state corporations, academia, NGOs and energy stakeholders. We inform global, regional and national energy strategies by hosting high-level events including the World Energy Congress and publishing authoritative studies, and work through our extensive member network to facilitate the world's energy policy dialogue.

Further details at [www.worldenergy.org](http://www.worldenergy.org) and [@WECouncil](https://twitter.com/WECouncil)

The full report can be found at [www.worldenergy.org/publications](http://www.worldenergy.org/publications)

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