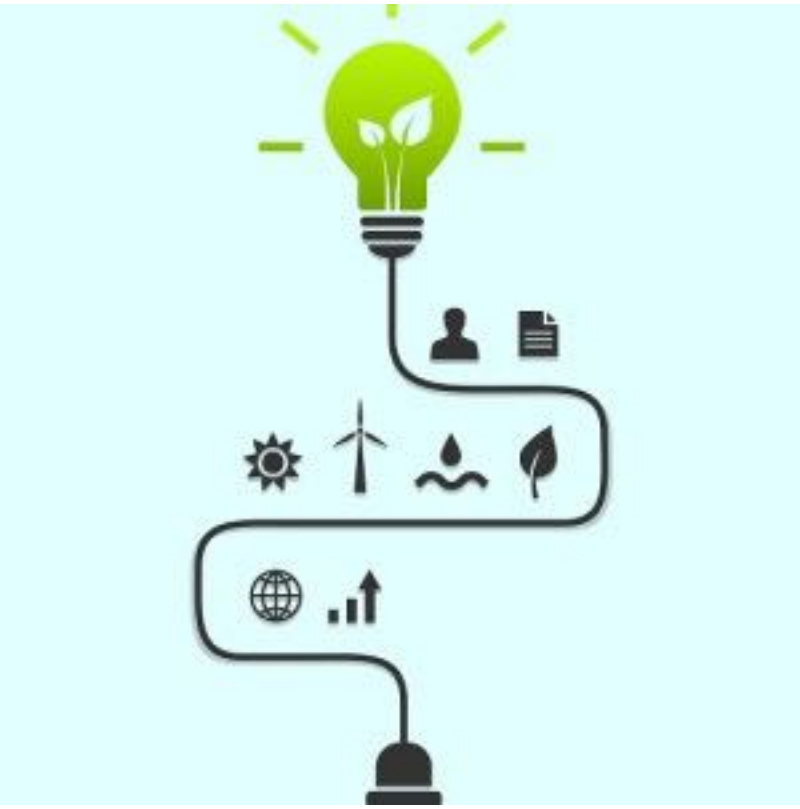
Renewable Energy: All You Need to Know



What is “Renewable Energy” and where does it come from? We all think we know and some of us may even be able to name some of the most prominent sources of renewable energy, but do we really understand the purpose of each type (such as how and

where it is used), how much energy it can generate or its wider economic or benefits? Here, we attempt to cut through the fog and give a clear and decisive summary of the information presently available on renewable energy and associated technologies. Put simply, renewable energies are those generated from sources that do not have a finite end, or those that can be recycled **(1)**, typically from natural sources - like solar power, wind power and water power. These are the examples that we think about most when we hear the term “renewable energy” but they are not the only sources.

We use energy every day of our lives - our electronic devices require electricity for power, our streetlights need the same for lighting, our vehicles require gasoline and diesel. We fuel our homes with domestic oil, propane or electricity from a national or local grid for lighting, heating and for powering our devices. You're reading this article on a website that is hosted on a server that needs power, as does the computer with which you are viewing the site. The places we work use computers, phone networks, security systems and servers, as do our shopping malls, parking lots, sports stadiums, cars, airplanes and so on. All of these things require power from fuel.

The world is doing what it can to reduce carbon emissions and limit the global average temperature change with a new agreement decided in 2015 at the Paris Climate Summit (or COP21) **(2).** To move forward, we also need to realize that there is only so much that can possibly be done in limiting GHG output as the human population only increases and puts more demands on our energy infrastructure **(3)**. To further help the environment and secure the future of the planet for our children and their children, we need to move to renewable sources for our energy generation.

A History of Renewable Energy

It may or may not come as a surprise to learn that before the discovery of coal deposits around the time of the Industrial Revolution, most of the energy we used for lighting and heating was from renewable sources - with one or two exceptions. Then we discovered coal, which fueled the industrial revolution in the western world, and later still learnt to tap oil in greater quantities leading to an acceleration of technologies that would take us into the 20th century. Throughout most of human history and pre-history, we burned what would today be known as “bio mass”: plant material such as wood, grass, mosses and so on, to fuel our hearths and later, homesteads. It became an important fuel source, hence why the hearth and the fireplace was central to homes until relatively recently.

From one perspective, the discovery and utilization of fire is a history of civilization, and a history of the use of renewable energy **(4).** Humanity continued in that fashion for many thousands of years before the discovery of oils (though obviously in smaller quantities than later) in antiquity and the mass drilling of oil during the industrial age. Other uses of renewables in antiquity include animal power (using cattle to drive ploughs or turn millstones) and wind for the sail that has driven trade for some 8,000 years of human history. The use of water sources, such as creating dams to harness the power of the fluid motion of water, is not a new idea either.

It was in the 1970s that we began to look back towards some of these ancient methods and technologies to provide the power sources of tomorrow. Peak oil and peak coal was theorized as far

back as the 1870s. Remarkably, even during the Industrial Revolution, some thinkers were theorizing on and developing concepts of solar technology **(5)** to prepare for a post coal world. The reason may have changed, but the thinking has not as many of the modern developments are for a post oil world. We have known since early in the process of mass mining of coal and oil, that there would be a peak and a time when these resources ran out. Theories and investment in solar technology lasted until the outbreak of WWI. Even in 1912, a paper in Scientific American hypothesized that soon, fossil fuels would run out leaving solar power our only option **(6)**.

The concept of peak oil in the 1950s began a new drive towards renewables. Solar, hydro and others were seized upon by both environmentalists and industrialists. They were both equally concerned about the exponential growth in human population, in oil consumption, and realized that it is a finite resource and will run out **(7)** regardless of the size of the supply today. A growing environmental movement, the development of environmental sciences and a push against pollution (such as the Clean Air Act in the US and equivalents in other countries most of which passed in the 1960s-1970s) meant that more than ever before, renewable energy became not just a scientific innovation for the future, but a necessity.

Since then, there have been successive debates about whether we have reached peak oil. Many experts agree that it happened around 2008 **(8)**. New pockets are getting fewer and fewer and smaller and smaller. Shockingly, demand has outstripped supply since 1986, spurring on economists, scientific researchers and environmental campaigners to hasten its demise by campaigning that what is in the ground to remain in the ground. Instability in oil-producing countries has led to fluctuations, particularly since the

1990s, and that has brought another issue to the world's attention - energy security.

Energy security has been a major concern to world leaders since the end of the 20th century, but even more so since the beginning of the 21st century. The term refers to the link between each country's national security, and the availability of that country to resources for energy production and consumption. If a country loses, or finds it has restricted access, to oil and other resources, instability is likely as energy is rationed. Energy security can be the result of armed conflict or political instability in gas or oil-producing countries, or a buying country having access restricted when a producing country deliberately cuts a supply.

Renewable Energy: The Figures

According to a report by the International Energy Agency, the increase of amount of electricity produced from renewable sources increased from just over 13% in 2012 to 22% the following year. They also predict that that figure should hit 26% by 2020 **(9)**. In terms of total generation, renewables accounts for 19% of our present usage. More clearly needs to be done though for the reasons stated below, but these figures are encouraging from the perspective of the use of renewables on its own. Most long-term forecast models predict that use will triple between 2012 and 2040, with a greater amount should the planet hit 2^0 of warming.

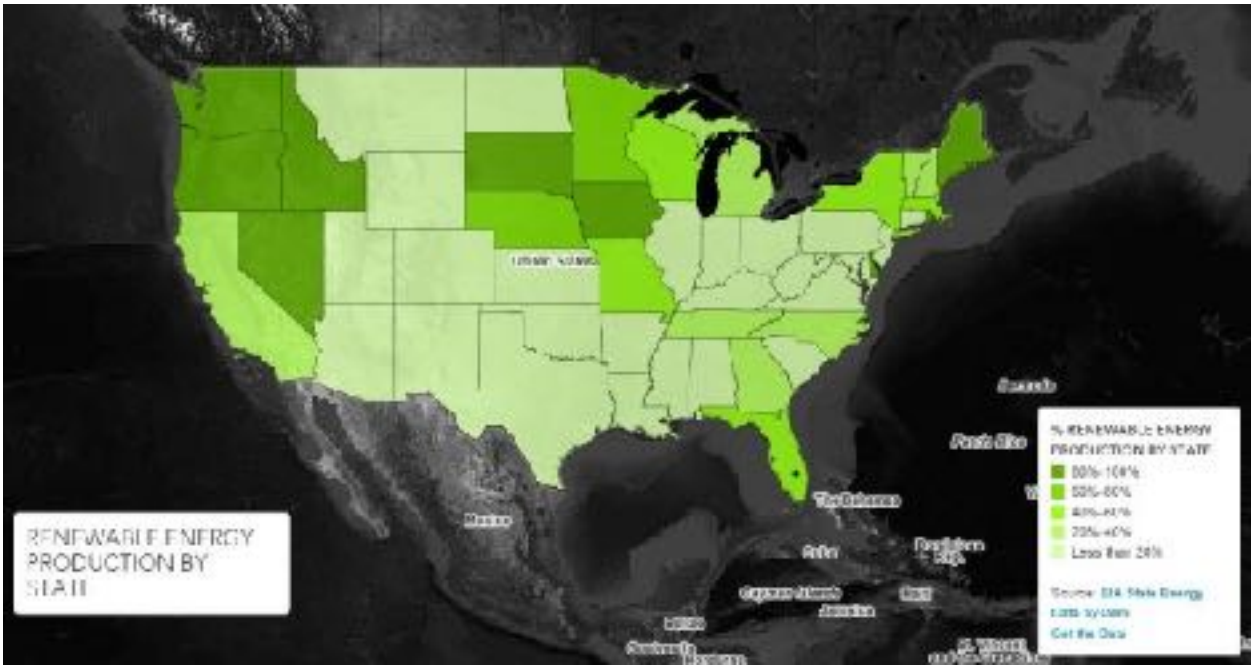
We can break these figures down even further and look at the divide between renewable energy types. These are:

- 9% from biomass
- 2% as non-biomass heat energy
- 8% from hydro electricity generation
- 2% of electricity generated from geothermal, biomass, wind and solar power

There is still much to do though; between 2000 and 2012, the largest growth area in terms of resources was coal - easily the dirtiest form of fossil fuel. The most used resource amid fluctuating price coupled with what we now understand to have been over-production for several years, was oil.

Domestically, the US produces just over 13% of its electricity from renewable sources **(10)**. As one of the world's largest consumers of energy (at 11.4kw per person per year) and consuming around 25% of the world's production every year, the situation in the US is immediate. Exponential growth of production in China, and equal exponential growth in coal mining there, should not be permitted to outstrip renewable use and it seems we are winning that particular battle; a UN report concluded in 2015 that renewable technology is now being produced on an industrial scale **(11)**.

There is a large disparity of energy production by state in the US with some producing a lot more than others. If we look at the map of energy production below (https://www.energy.gov/) we can see just how much variation there is between the 50 states.



Idaho came out on top as it produces most of its electricity from geothermal sources thanks to the volcanic activity of its topography **(12)**. Idaho is a success story of a renewable future and it reports some of the lowest energy prices (to the customer) of any state. Delaware is a net consumer of energy supplied by other states. However, a wind farm grant in 2012 now means that all of its domestic production comes from renewable sources.

Wyoming was reported as the lowest producer / user of renewable resources. The state has a long history of coal production and some 33% of the country's coal supply comes from this single state. It also produces around 6% of the country's natural gas supply. 0.34% of its total energy supply came from renewable sources, but also 11% of its electricity generation **(13)**. Wyoming's source of renewables is wind power. The story is similar for Alaska where the oil rich areas means a large supply of diesel to fuel the generators on which many state residents reply, though geothermal energy supply is also a boon for the state.

Why Do We Need Renewable Energy?

Fossil Fuels Are Limited

The first and main reason for why governments and businesses are keen to move to renewable energies as soon as possible is that fossil fuels are a finite resource. We may or may not have reached peak oil - the point at which demand outstrips supply -and by current figures, many experts seem to agree we did so around 2008 with only external factors creating fluctuations in demand making it difficult to predict precisely when it will run out. That is another debate entirely that our politicians and economists have argued for decades, and will continue to argue **(14)** for many years to come. Whichever way we look at it, fossil fuels will run out eventually and it will take some 10,000,000 years to replenish what we have used in around 150 years.

As the human population increases, our rate of consumption of these fossil fuels also increases. Geologists and others whose job it is to locate and access these pockets of crude oil are finding it increasingly difficult to locate and extract new sources. Whether we have 1 year or 100 years left of oil, many argue that what is left should remain in the ground because it is not sustainable - it will run out eventually and so we should prepare for a post-fossil fuel world now.

Carbon Emissions & Climate Change

The most immediate problem, particularly in light of the COP21 agreement of 2016, and the changes we have seen to the climate in the last 150 years, is climate change and the carbon emissions

that are forcing it **(19)**. In the last few years especially, no part of the world has been untouched by freak weather conditions. Most continents have recorded record high temperatures in summer, record lows in winter and increased frequency of typhoons and hurricanes, record dry spells, drought and flooding. There is no doubt that these freak weather conditions are affecting every country **(15)**.

Most renewable energy sources, and the technology used to harness them, are low carbon emission. In most cases, once installed they have minimal or no carbon output and can still provide our energy needs. We can never go fully carbon neutral as it takes resources to make a solar panel, build a dam and so on, but it is a critical and significant reduction of our carbon output. What we do need to do, is to take the steps we can to reduce our carbon footprint for international regulations, to help those in the developing world, and to protect ourselves against the freak weather. We also know that the ice caps are melting and the sea levels are rising which creates food shortages and national instability as well as being an expensive situation for our insurance.

Energy Security

Energy security is a relative newcomer to public perception when we consider the greater need for renewable energy **(19)**. The beginning of this decade has seen instability in the Middle East. The Arab Spring swept across Algeria, Tunisia, Libya, Egypt and Syria leading to pro-democracy demonstrations. There are ongoing problems in Syria with the rise and spread of ISIS. Why have these political issues in other parts of the world encouraged the rest of the world to think about its energy plan?

The Middle East is one of the biggest suppliers of oil to the world. South America also produced oil, North America and South America supplies coal and the UK, Russia and other European Atlantic powers mine for gas. New tension between Russia and the west, firstly over Ukraine and secondly over Syria, has led to increased distrust between world powers. Being dependent on other countries for our energy supply is problematic in itself, but when international relations between supplier and supplied sour, increased wholesale prices threatening to destabilize the economy is the least that could happen **(16, p5)**. If a supply is cut off, then disaster could strike. For this reason alone, we need spare capacity and multiple avenues of energy acquisition.

Energy security will become a much greater factor as fossil fuels begin to dwindle. More than ever before, demands on energy supply often outstrip supply of conventional production forcing prices up **(3)**. It is expected that increased tension over acquisition and protection of resources could lead to global conflict. Some are already arguing that the crisis in Syria is less about campaign for democracy reform in a major Middle Eastern power, and more a result of ongoing regional climate crisis. Former farmers who have fled to Europe and beyond have cited drought as the major catalyst for the civil war in the country **(17)**.

The price of oil has fluctuated greatly in the last 10-15 years - from an all-time high in 2012 to 2013 to record lows in 2015 to 2016. Oil prices have a knock on effect for the economy when they are at the extreme and lead to protests **(18)**. We must remember that oil is a commodity and when prices are erratic, it affects jobs all over the world.

Economic Stability

Related to some of the issues mentioned above, where renewable energy offers a constant and sustained supply (such as hydroelectric, wave power, solar and biofuels), energy prices are likely to remain stable and in turn, keep the economy stable **(20)**. In many cases, energy produced from renewable sources is already cheaper than that produced by non-renewable means. Mentioned above, Idaho produces a large amount of energy from geothermal sources. Another example is Texas where energy produced from wind power is noticeably cheaper for the state's citizens.

Environmental Damage

As fossil fuel supply gets harder to acquire, and prospectors search for new pockets of oil and have to drill longer and deeper to acquire it, there has been conflict between environmental groups and industry **(21)** and between governments and both groups **(22)** when local wildlife and environmentally sensitive areas are threatened. Here in the US, public consciousness and the need to protect our wildlife and natural landscapes means that many new developments are protested with concerns of environmental damage. Ongoing protests against fracking and new drilling in Europe and North America and recent examples. Though some renewables will have an environmental impact, many do not and when built, have no further impact - unlike ongoing drilling.

Public Health

Oil, gas and coal drilling and mining have high levels of pollution that are pumped into local environments and the wider atmosphere, so while protestors attempt to prevent the building of

pipelines or new prospecting in virgin areas and wilderness, it is as much about public health as it is about conservation. We have known for decades about the knock on effect of industrial processes for public health **(20)**. Few renewables are entirely emission-free, but their output is much lower than conventional fossil fuel acquisition and processing.