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ENERGY CONSUMPTION AND PRODUCTION

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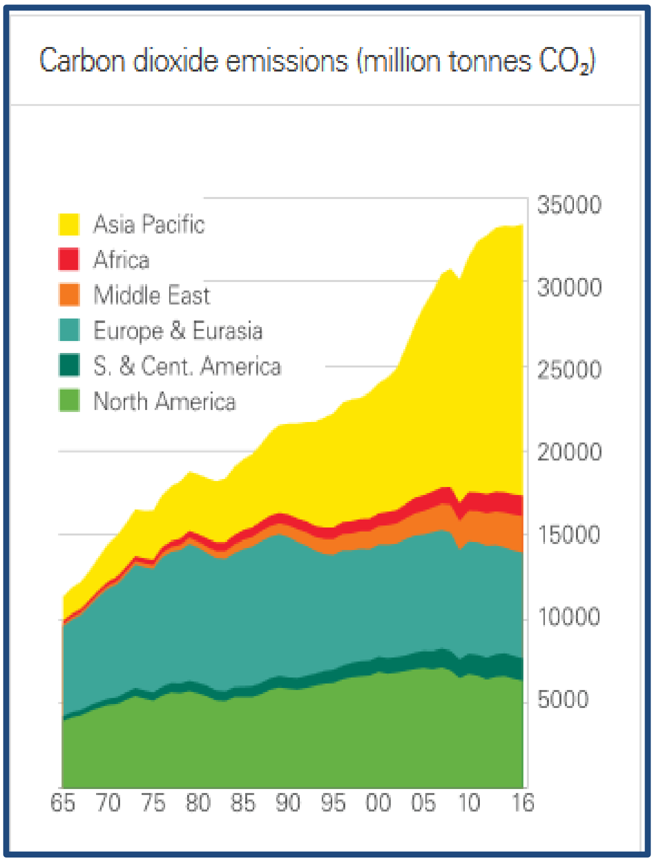
In my presentation I will try to answer to the questions: Are energy consumption & producing patterns changing fast enough to save the Planet? Are renewables and non-pollutant technologies winning the cost-effectiveness competition against fossil fuels? How effective and influential are the players and interests that deny human responsibility on climate change accelerations? We all agree that we have to go to a decarbonated economy. But things don't happen from one day to the other, and the big question is how fast we can go in this transition.

When there was COP 15 in Copenhagen, the goal was to limit the increase of temperature to 2°C in 2050 and 2.5° C in 2100. This was not a very successful agreement. The Paris agreement, signed at COP21, sets out a global action plan to put the world on track to avoid dangerous climate change by limiting global warming to well below 2°C and make efforts to limit the increase to 1.5°C by 2100. This is much tougher.

What is the current situation? CO_2 emissions in 2016 were 33.4 Gigatons (or billion tons, if you use the UK unity). A cumulative total of 1 962 Gt of CO_2 was emitted by the end of 2013. The Asia-Pacific region contributes much to the increase.

The Fifth Assessment Report (2014) of the International Panel on Climate Change (IPCC) quantifies the global maximum CO_2 the world can still emit and also have a likely chance of keeping global average temperature rise below 2°C above pre-industrial temperatures. This goal is likely to be met if cumulative emissions do not exceed 3 670 Gigatons of CO_2. That's a big challenge, if we consider the current levels and also the fact that we are not going to achieve zero emissions from one year to the other.

CO_2 emissions can be estimated using the Kaya identity [Kaya, Yoichi; Yokoburi, Keiichi (1997). *Environment, energy, and economy: strategies for sustainability.* Tokyo: United Nations Univ. Press]. The Kaya identity states that the total emission level of the greenhouse gas Carbon Dioxide (per year) can be expressed as the product of four factors. The first is carbon intensity (CO_2 emissions per unit of energy consumed). We all need energy and it does not happen in nature naturally, so we need to generate this electricity. We can therefore estimate how many tons of CO_2 are sent to the air to produce 1 MWh. For example, if I use coal to generate MWh, It's certainly much less environmentally friendly than if I use renewable energy that has no CO_2. Carbon intensity depends on the source type (coal, oil, gas, nuclear, non-fossils, etc.) reflected on the Primary Energy Mix. The second factor is energy intensity (energy consumed per unit of GDP), the third is gross domestic product (GDP) per capita (probably not a very reasonable or sustainable concept) and the forth factor is human population. Of course, the more people we have, the more energy we need and the more we need to produce MWh and, therefore, we will send more CO^2 in the atmosphere.



2018 BP Energy Outlook
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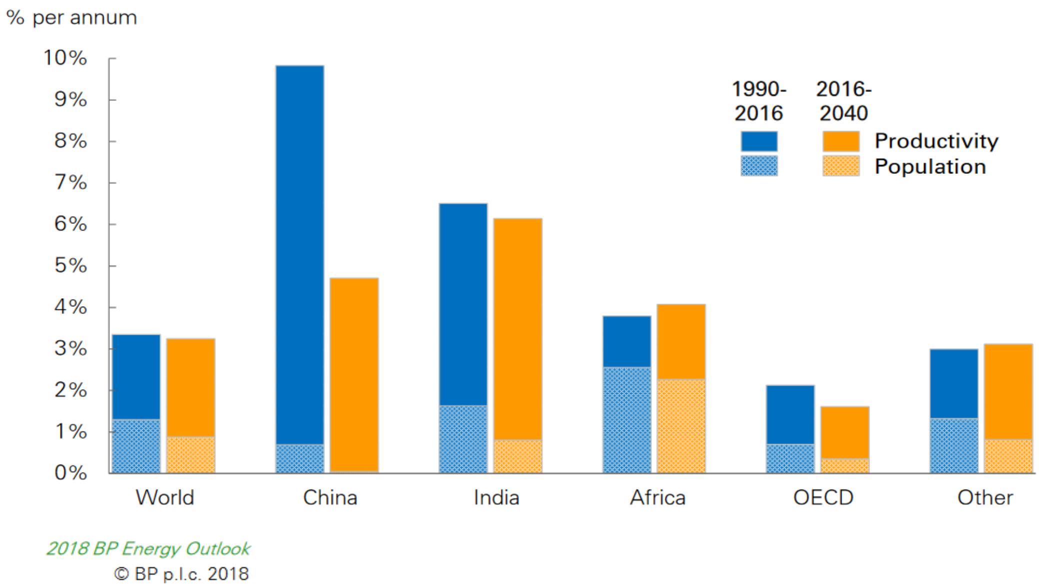
Growth rates 1990-2016 and projections 2016-2040



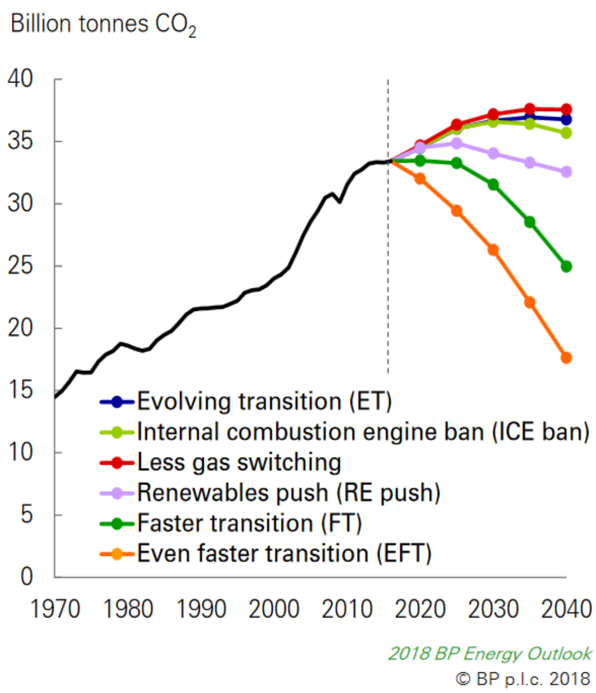
Energy transition has to look at these 4 factors, and I will start with the last ones. Everyone loves economic growth and every government these days wants at least a 3% growth rate per year. With a 3% growth rate, there is no deficit, social security has enough money to pay for the elderly people, to pay for the hospitals, etc. According to BP, the world GDP per capita will increase by 3.25% a year between 2016 and 2040, which would represent an increase of 122% in 25 years. In the Kaya equation, if I double the GDP and we do not change any of the other factors, I double the amount of CO_2.

Regarding population, and accordingly with the United Nations, the world population is currently 7.6 billion, and will be 9.2 billion (+21%) in 2040 and approximately 10 billion (+32%) in 2055. If things remained unchanged the CO_2 emissions for the combination of population and economic growths, we will be emitting 98 gigatons in 2040, which is three times as much as of today. And there are currently no actions are in place to reduce economic or population growths.

Therefore, there are only two factors that we can work on: carbon intensity (how many tons of CO_2 do I need to produce 1 MWh), and energy intensity (how many MWh do I need to produce 1 KEUR of wealth). Energy transition can only be achieved through reducing these two factors.

The Energy Information Agency (EIA) projected that worldwide emissions of carbon dioxide from the burning of fossil fuels would grow 16 percent by the year 2040 from the levels of 2015, the year of the landmark Paris Agreement on climate change that is intended to reverse the trend. BP has a scenario that is rather pessimistic.

Scenarios in Energy Transition



Carbon Intensity depends on the source used to generate Energy. In the case of Fossil Fuels, Coal emits 70% more CO_2/MWh than Gas. If I burn coal, then for every MWh I would need 0.345 tons of CO_2 emitted in the atmosphere; if I use gas it's 0.2 t_{CO2}/MWh. If we could eliminate the use of coal or oil from day to night, the estimate is that the emissions would go from 33 to 15 gigatons. We need some CO_2 in the atmosphere, we should not forget that, and 15 gigatons is a number that the earth can cope with.

The current situation of the Primary Energy Mix is not a nice picture. There are five major industrial and human activities:

- Electricity generation (represents 37% of the total Mix) – main sources: Coal (47%), Non-fossils (26%) & Gas (22%). Almost half of the electricity in the world is generated by coal. This also raises other questions. For instance, electric cars can be good solution, but don't forget that if I have an electric car that uses electricity generated by coal it is not good. We need to go to non-fossil energies, which also includes nuclear energy (the main source of electricity generation in France, and very important in some other countries as Japan) These are very good in terms of CO_2 emissions, but they have other problems like how to recycle the by-products.

- Industry (22% of the Mix) - main sources: Coal (43%), Gas (31%), Oil (19%) & Non-fossils (7%). The weight of coal is again very high, and we can act upon that.

- Transportation (19% of the Mix) - main sources: Oil (92%) & Non-fossils (6%). We use mainly oil, and this is probably the major challenge, because personally I don't see that today we can have electric airplanes or even big ships. This is one of the major difficulties in this sector.

- Buildings (15% of the Mix) - main sources: Non-fossils (45%), Gas (32%) & Oil (16%). It is good news today that 45% of the buildings use energy from non-fossil energy and 32% from gas.

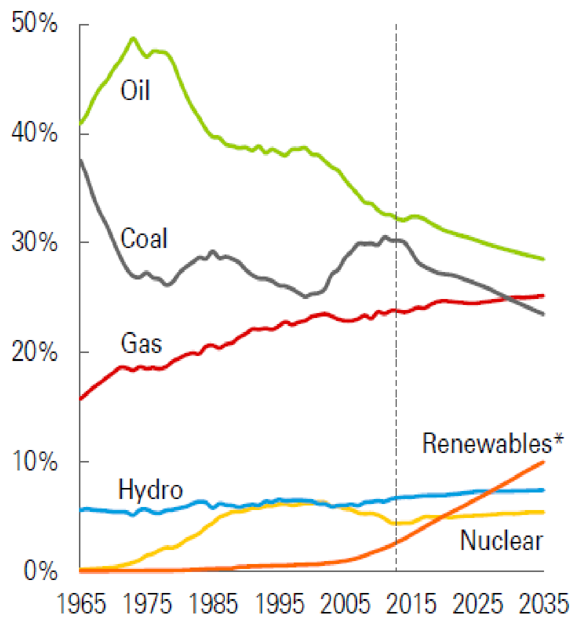
- Transformation (7% of the Mix) - main sources: Oil (74%), Gas (17%) & Coal (9%). Oil is dominant in this sector. Our life is invaded by plastic - and I'm not discussing the interest of having or not having plastic, but we need plastic for our life - and plastic comes from oil.

Reducing CO_2 emissions is largely dependent on the modification of the Primary Energy Mix by using less CO_2 intensive energy sources, and I think gas is certainly the best option for energy transition. Maybe I can shock some of you with this opinion, but if we replace coal and oil by gas we will reduce the emissions of CO_2 in the atmosphere significantly.

The expected trends reveal some good news: oil will decrease in the energy mix, gas and renewables proportion will increase. Nevertheless, coal volumes consumed slightly increased before 2015, because the Americans did the shale gas revolution, and coal from the US became very cheap. The Americans replaced coal by gas – and therefore reduced the emissions of CO_2 - and the coal was exported to other countries, particularly in Europe. The major difficulty I see is that, although the proportion of coal in the mix will decrease in the future, unfortunately some predict that this will stable the consumption. It's good that it's not going up, but I think there should be an effort to reduce the volumes of coal consumed in the planet.

Regarding energy intensity (how many MWh of energy do I need to produce wealth for our economy), the numbers vary a lot across the world.

Primary Energy Mix trends



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It is very high in some countries like Russia, India or China (Russia = 4.7, India = 4, China = 3.7), but the European Union countries have some positive results (France = 1.1, Germany = 1.0, U.K. = 0.8). This is what I call sometimes “the poor’s dilemma” – most of the effort about energy intensity has to be done by poor countries, because Europe somehow has done its job (in terms of energy intensity, I’m not talking about carbon intensity). Even the US is worth almost the double as Europe (USA = 1.7) but it is better than the world average that is 2.3.

Regarding the trends for CO_2 emissions, they rose by 2% per year between 1995 and 2015, but CO_2 should rise by 0.5% per year between 2015 & 2035, due to lower GDP growth, Energy Intensity reduction and Energy Mix shift. However, we don’t need a 0.5% growth, we need a decrease; current amounts of CO_2 emissions should be significantly reduced to fulfil the Paris agreement pledge. These are the current trends, and they are important because they let us know where we should act. They also point out that we are not going fast enough.

Many uncertainties exist concerning the future of energy demand and supply, including potential actions that societies may take to address the risks of climate change. For instance, I think a carbon tax is probably a good thing, but it should be worldwide and not country by country or the EU on its own.

In conclusion, we need to reduce carbon intensity and this can mainly be achieved through :
(i) reducing the carbon intensity by replacing coal and oil by gas and renewables sources; (ii) reducing the energy intensity by Improving the efficiency to generate electricity (cogeneration, combined gas-steam cycle, improve renewables, etc.); (iii) reduce consumption in transports (electric cars in the cities) and buildings (better isolation); and (iv) optimize the use of energy in the industry.

For instance, when I come to Portugal, I’m always really shocked that the buildings are all very bad from an isolation point of view; and this is good for the local economy as you cannot delocalize this in China: the buildings are here, so the work has to be done here.

In this context, gas is certainly the “best friend” of renewable sources for the energy transition, because we can’t go to a zero carbon situation in one day, and we have to use the fossil fuel that has less impact in the environment.

Of course, there are 3 pillars for the governments to at upon: Environment (climate), Society (energy security) & Economy (competitiveness). The policies have to be articulated around those three axes.

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More information at www.clubelisboa.com

Victor Alcobia is a Project Director & Senior Petroleum Engineer; he joined Beicip-Franlab as Senior Consultant in 2002. He gained a broad expertise in petroleum engineering since graduation in 1976 and benefits from a strong experience of assessing a wide variety of oil, gas and condensate fields, from those of the North Sea to those of Angola, Mexico, Russia, Venezuela, Far East and Middle East. He started his career as a professor of Mining Engineer at the University of Luanda. He also worked for Elf Aquitane in Angola and France (1983-90), for Scientific Software Intercomp in the UK (1990-95), Parexpro and CGG (*Companhia de Geologia e Geofísica Portuguesa)* in Lisbon (1995-2002). Victor Alcobia holds two MSc degrees, one in Mining (Angola, 1976) and another in Petroleum Engineering (France, 1984), and one MBA (France, 1989). He is a member of the SPE, the SPEE and the Portuguese Order of Engineers.

SOBRE O INSTITUTO MARQUÊS DE VALLE FLOR

Criado em 1951 como instituição privada de utilidade pública, o IMVF é uma Fundação para o desenvolvimento e a cooperação, tendo iniciado atividade como ONGD em 1988 em São Tomé e Príncipe. A partir dos anos 90 expandiu a sua ação a outros países, com predominância aos de língua oficial portuguesa e aumentou as áreas de atividade. Já em 2017 voltou a alargar a sua ação a novas geografias em África e na América Latina. O trabalho feito e os resultados alcançados tornaram o IMVF numa entidade de referência nos domínios da cooperação e do desenvolvimento.

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Created in 1951 as a private institution of public utility, IMVF is a foundation for development and cooperation, having started its activity as a NGDO in 1988, in Sao Tome and Principe. From the 90s onward, the Institute have expanded its actions to other countries, mainly Portuguese Speaking Countries and broaden its scope of intervention. In 2017 it widened again its sphere of activities to new geographies in Africa and Latin America as well. The work done and the results obtained have turned IMVF into a key stakeholder in different areas of expertise and intervention such as Cooperation and Development.

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