IESE Business School
University of Navarra

Executive Education

Energy

Industry Trends - 2015

SOME DRIVERS OF CHANGE TO GENERATE ALTERNATIVES
IN THE CURRENT ENERGY ORDER

Industry Meetings

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TABLE OF CONTENTS

INTRODUCTION

Who will dictate the rules of the game in the energy industry? The economy, technology or geopolitics? Companies, consumers, financiers, regulators, NGOs or opinion leaders? Saudi Arabia, the United States, Europe, China, Russia, Iran...? OPEC or the OECD? Oil, non-conventional fossil fuels or methane gas hydrates? The fight against climate change, perhaps renewable energies?

"An energy system under stress." Thus begins the executive summary of the International Energy Agency's annual report for 2014 (*World Energy Outlook 2014*, henceforth, *WEO-2014*).[1] The title illustrates to what extent the list of questions still to be addressed on the international agenda affects the global, national and regional architecture of energy.

The energy industry is facing many challenges, and stress is a word that aptly defines its current situation. This stress encompasses a variety of viewpoints and allows for making gradual progress; it is an impetus to act, and this is how we need to view the industry: as facing challenges, facing difficulties, but also offering solutions. Energy is the cause and, at the same time, the solution to some of the main challenges on an international level; i.e., it is both part of the solution and the problem when it comes to the environment, human welfare and poverty, geopolitical challenges, questions of peace and global security, economic growth and the competitiveness of industries.

In recent decades, there has been unprecedented economic growth stemming from humans' efforts toward achieving higher standards of living. This growth has helped put four billion people on the path to the type of wellbeing characteristic of the middle class. This improvement in living conditions could not happen without the discovery of the different sources and uses of energy, which have gradually evolved to meet the needs and demands of society. The graph below illustrates the proportion and energy transition over the past two centuries: from biomass, to coal, to oil, to natural gas, to hydropower and other renewable energies, as well as nuclear energy... These transformation processes have been slow and they combine a variety of models and technologies, which leads to significant immobility with regard to new energy options.

Today, the debate on energy revolves around the energy transition. A transition, on the one hand, toward a more diversified and sustainable model, which can respond to the future demographic challenges and allow for the entry of new resources. On the other hand, this process is not being approached solely from the standpoint of resources but also in geopolitical terms: from OPEC to the OECD and the emerging powers (United States, Europe, China, etc.).

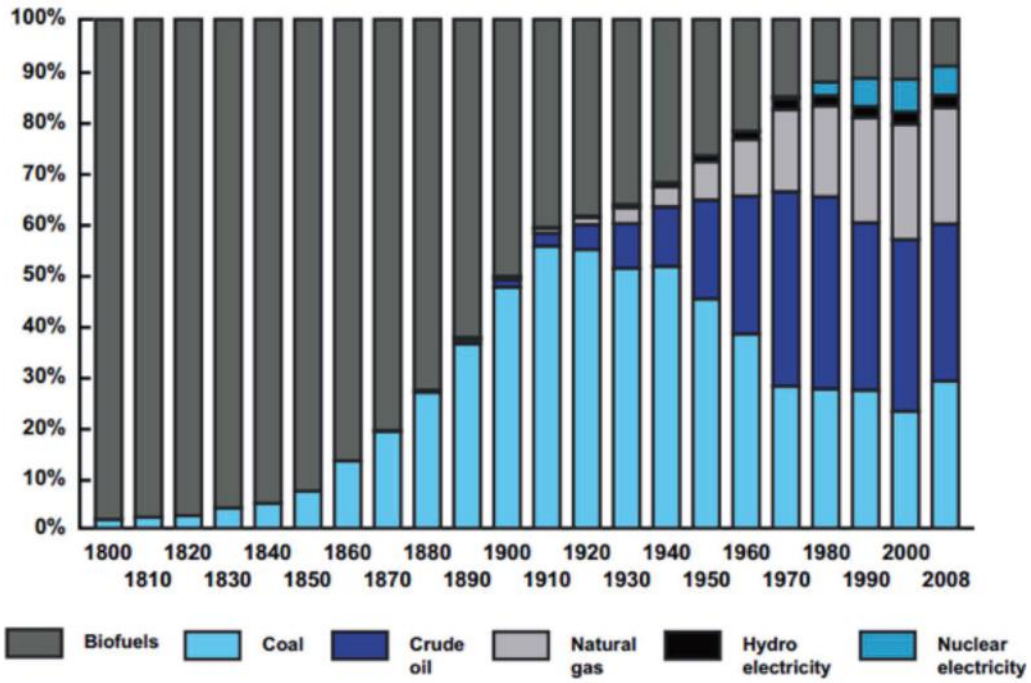
Today, this transition uses drivers of change that are already determining the current energy agenda – and will only become more relevant – along with the evolution of the industry (where it is and where it is going).

We have identified the following drivers of change, among others:

1. Geopolitics
2. Demographics
3. The Environment
4. Technology
5. The Role of Consumers

1 International Energy Agency (2014), *World Energy Outlook 2014*, pp. 1–711.

SHARE OF FUELS IN ENERGY MIX, 1800-2008



Source: World Economic Forum[2]

The purpose of our annual report on industry trends is to provide a summary of the issues that are part of the current dialogue/discourse on energy, from a global perspective. The goal of our study is not to engage in an in-depth analysis of each of them; for that, we refer to the prestigious institutions, think tanks, universities and other organizations that engage in research and offer ideas on the countless issues related to the industry, and which we have used as references for this summary. Instead, this report aims to organize and highlight the most important reflections and considerations that we believe will determine the evolution of the industry in the forthcoming years, a goal we strive to reach, year after year, during IESE's annual Energy Industry Meetings. The authors[3] of this article would like to express their thanks for the invaluable observations and contributions made by Estrella Jara, head of Strategy and Planning, Oil&Gas, Indra, and Jesús Navarro, co-organizer of the Energy Industry Meeting and partner at Deloitte.

2 World Economic Forum (2013), *Energy Vision 2013*: Energy Transitions: Past and Future, pp. 1–48.

3 Gifra, Júlia & López Cardenete, Juan Luís, "Some Drivers of Change to Generate Alternatives in the Current Energy Order", IESE Business School, OP-273-E, 2015.

1. THE GEOPOLITICS OF OIL

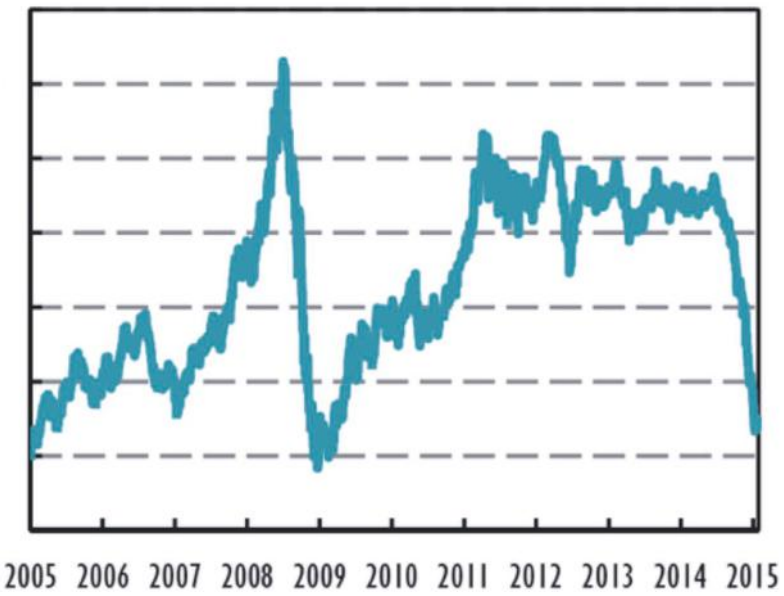
Oil has been one of the decisive elements in contemporary world geopolitics; as such, the recent drop in oil prices has geopolitical consequences. Obviously, the fall in the price of a barrel of Brent oil has caused major repercussions in the global economy and in geopolitical questions of energy. The issue lies in knowing whether these changes will be circumstantial or temporary, or if, on the contrary, they will last and become cemented.

After a three-year period with the lowest price volatility since 1970, and with 2013 being the third year in a row with Brent prices higher than $100/barrel, the current scenario has changed completely. In just eight months, the benchmark crude for Europe (the Brent) dropped from trading at $110/barrel to around $60 and had even fallen as far as $40.

The following graph illustrates the fluctuations in oil prices in the past decade, the relative stability in recent years and the plummet in recent months.

The explanation of the current situation can be expressed through two concepts: first, based on market components (supply and demand); and, second, based on the strategic component of "why right now?"

HISTORICAL BRENT CRUDE OIL PRICE



Source: International Energy Agency.[4]

4 International Energy Agency (2015), *Medium-Term Oil Market Report, Executive Summary*, pp. 1–7.

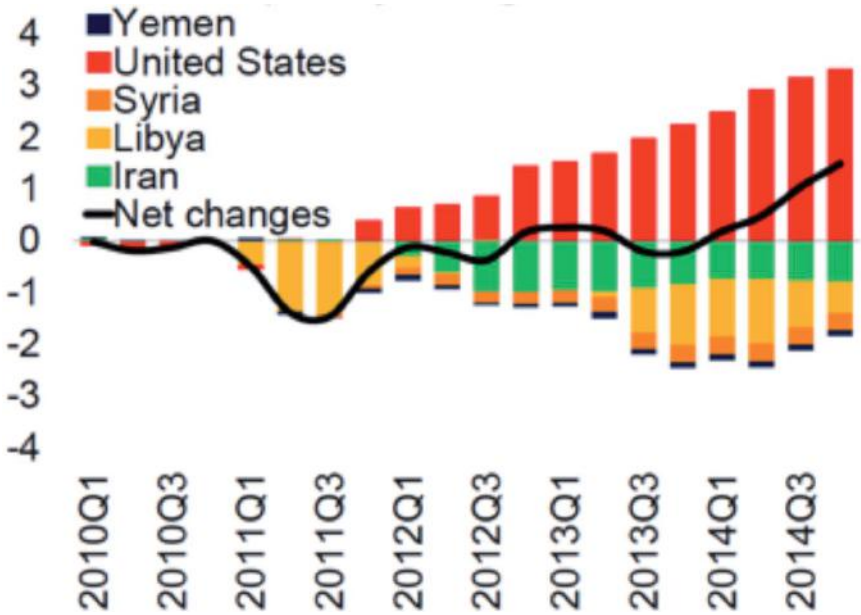
1.1 The Price of Oil. Market Reasons: Excess Supply at a Time of Waning Demand

There are two parameters that particularly determine the price of oil: variations in "non-OPEC" production and "non-OECD" consumption. Let us look at some specific information.

Oil production exceeded consumption throughout all of 2014. This over-production can primarily be identified in the non-OPEC countries, where the increase totaled 1.7 million barrels per day.

In turn, the oil obtained through fracking in the United States led to a significant rise in the production of crude. However, not only the United States and Canada are involved, since Russia also reached historic highs in 2014, and Iran and Iraq were in the spotlight because of the potential growth in their production. Nonetheless, this is also cause for concern because of the tensions caused by the advance of the Islamic State and its potential ability to control some of the main oilfields. The following graphs and tables reflect these trends:

MILLION BARRELS PER DAY, CHANGES SINCE 2010Q4



Source: World Bank[5]

5 Baffes, M.J. & Kose, A., & Ohnsorge, F. & Stocker, M., *The Great Plunge in Oil Prices: Causes, Consequences, and Policy Responses*, Policy Research Note, World Bank, 2015.

NON-OPEC OIL SUPPLY IN 2014, MB/D

	2013	1Q14	2Q14	3Q14	4Q14	2014	Change 14/13
Americas	18.16	19.12	19.77	20.08	20.46	19.86	1.70
of which US	*11.22*	*11.95*	*12.79*	*13.12*	*13.45*	*12.83*	*1.61*
Europe	3.58	3.75	3.51	3.40	3.72	3.59	0.02
Asia Pacific	0.49	0.51	0.52	0.54	0.50	0.52	0.03
Total OECD	**22.22**	**23.38**	**23.80**	**24.01**	**24.68**	**23.97**	**1.75**
Other Asia	3.61	3.56	3.55	3.50	3.64	3.56	-0.05
Latin America	4.78	4.86	4.92	5.10	5.23	5.03	0.25
Middle East	1.36	1.34	1.34	1.36	1.33	1.34	-0.02
Africa	2.40	2.44	2.41	2.40	2.41	2.42	0.02
Total DCs	**12.15**	**12.21**	**12.22**	**12.35**	**12.61**	**12.35**	**0.20**
FSU	13.41	13.48	13.36	13.39	13.48	13.43	0.02
of which Russia	*10.51*	*10.59*	*10.55*	*10.52*	*10.65*	*10.58*	*0.07*
Other Europe	0.14	0.14	0.14	0.14	0.14	0.14	0.00
China	4.24	4.24	4.27	4.20	4.34	4.26	0.02
Total "Other regions"	**17.78**	**17.86**	**17.76**	**17.73**	**17.96**	**17.83**	**0.04**
Total non-OPEC production	**52.16**	**53.45**	**53.78**	**54.10**	**55.25**	**54.15**	**2.00**
Processing gains	2.13	2.16	2.16	2.16	2.16	2.16	0.03
Total non-OPEC supply	**54.29**	**55.62**	**55.95**	**56.26**	**57.42**	**56.33**	**2.04**
Previous estimate	54.24	55.62	55.93	56.24	57.13	56.23	1.99
Revision	0.04	0.00	0.02	0.02	0.28	0.10	0.05

Source: OPEC, *Monthly Oil Market Report, March 16*, 2015

On the other hand, the following table shows the current status of oil reserves. The regional geopolitical balance is clear both in terms of traditional sources (Middle East) and non-traditional sources (United States).[6]

6 The latter does not include the potential reserves of shale gas because of the lack of an exhaustive assessment.

REMAINING RECOVERABLE OIL RESOURCES AND PROVEN RESERVES, END-2013 (BILLION BARRELS)

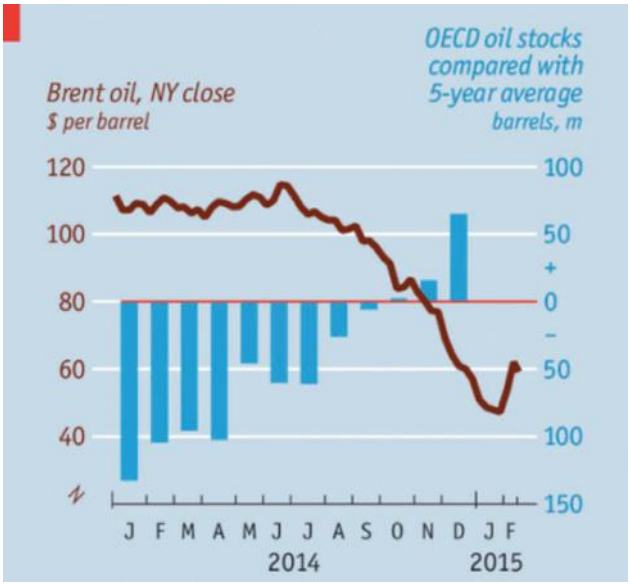
	Conventional resources		Unconventional resources			Total	
	Crude oil	NGLs	EHOB	Kerogen oil	Tight oil	Resources	Proven reserves
OECD	**316**	**99**	**810**	**1 016**	**114**	**2 355**	**250**
Americas	247	54	807	1 000	80	2 187	230
Europe	63	34	3	4	17	121	15
Asia Oceania	6	11	-	12	18	47	4
Non-OECD	**1 923**	**377**	**1 068**	**57**	**230**	**3 655**	**1 449**
E.Europe/Eurasia	342	83	552	20	78	1 074	136
Asia	110	29	3	4	56	202	45
Middle East	968	179	14	30	0	1 190	814
Africa	284	55	2	-	38	379	131
Latin America	219	32	497	3	57	809	323
World	**2 239**	**476**	**1 879**	**1 073**	**344**	**6 010**	**1 699**

Source: *WEO-2014*, p. 111

An added consequence of the current oversupply is an accumulation in the form of inventories and the storage of stocks (which also pushes prices down). The latest monthly report from the International Energy Agency[7] warns that we are reaching the ceiling in storage capacity (the oil storage complexes in the United States, Europe and Asia are already at 80%–85% of their capacity, as are oil tankers at sea), and this surplus storage may have further significant effects on the decline in prices.

The increase in production is combined with a less obvious decline in demand. Markets react slowly, and prices only began to fall in June 2014, as graph in the following page reflect.

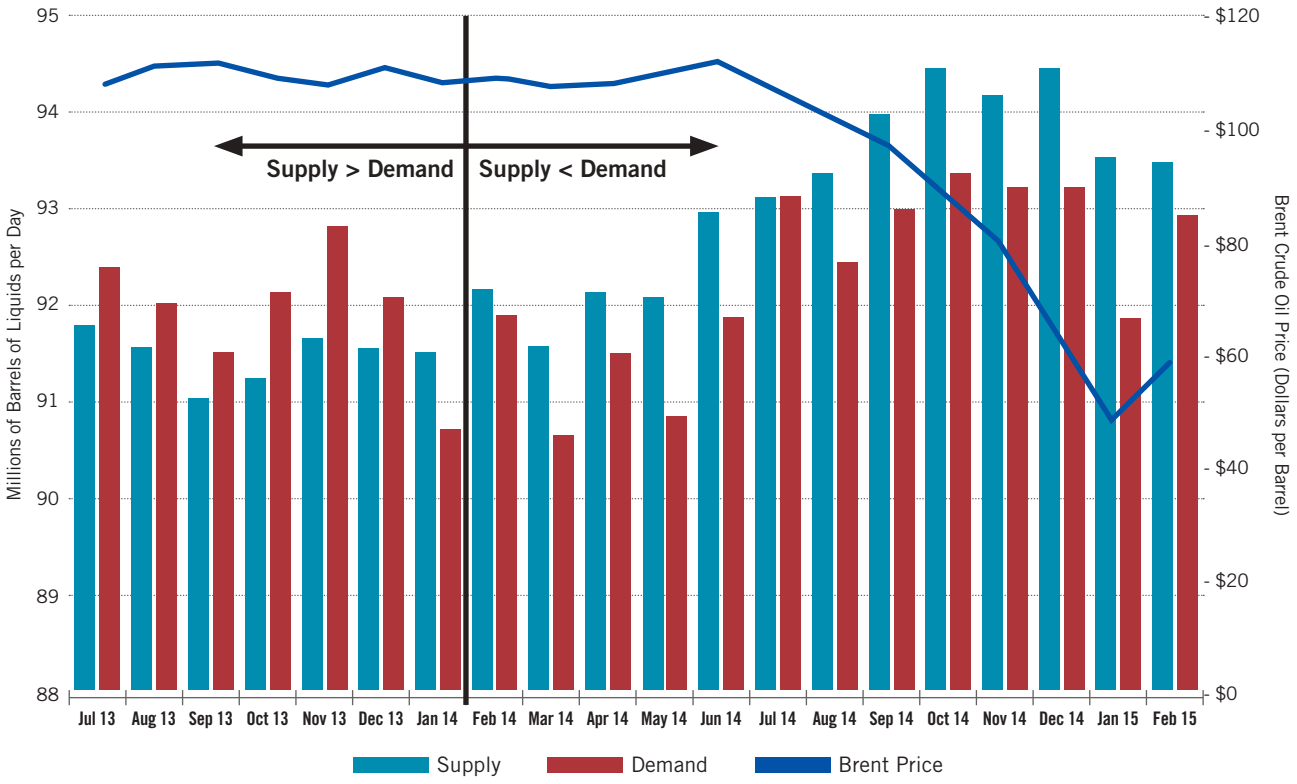
STORING UP TROUBLE



Source: *The Economist*[8]

7 International Energy Agency (2015), *Medium-Term Oil Market Report, Executive Summary*, pp. 1–7.
8 *The Economist* (February 21, 2015), "The Saudi Project, part two," pp. 1–3.

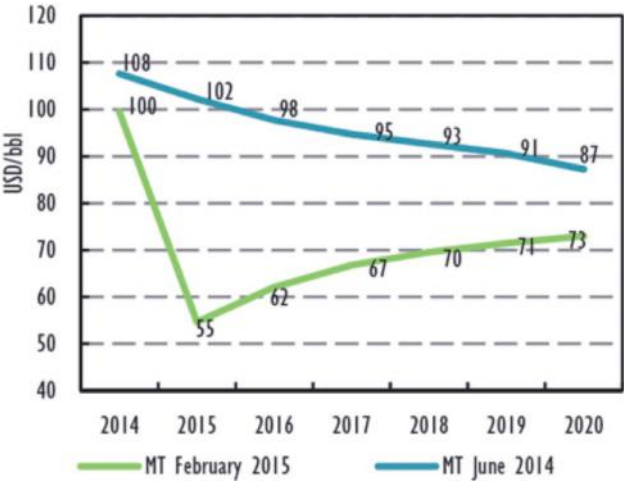
WORLD LIQUIDS SUPPLY AND DEMAND JULY 2013-FEBRUARY 2015



Source: EIA (Energy Information Administration) and Labyrinth Consulting Services

Forecasts for the evolution of oil prices and demand[9] depend on different variables which are always difficult to maintain, since the weight of intangible factors and expectations is high. Nonetheless, there seems to be a widespread consensus that the low price of Brent will continue to drop until it stabilizes at around $73/barrel. The majority of analysts believe that an equilibrium price of between $65–$75/barrel is good for the world as a whole. However, it seems sensible to recall that, in the past, the forecasted price expectations have rarely materialized.

IEA IMPORT PRICE ASSUMPTIONS



Source: International Energy Agency[10]

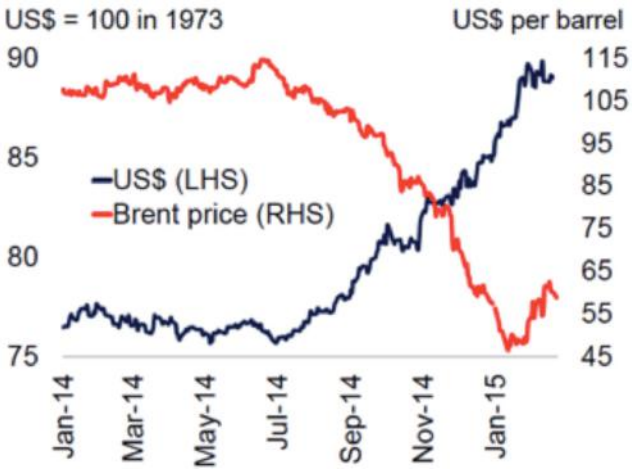
9 For a more detailed analysis of the future projections on oil production and demand, see: International Energy Agency (2014), "Oil Market Outlook," in *World Energy Outlook 2014*, pp. 95–134.
10 International Energy Agency (2015), *Medium-Term Oil Market Report, Executive Summary*, pp. 1–7.

1.2 Oil as a Financial Asset

In this economic analysis, we should not forget that oil is regarded as a financial asset in a context of extreme liquidity as a result of the U.S. Federal Reserve's monetary policy, the end of which might have a significant impact on the value of the dollar compared with other currencies, and ultimately on the price of crude oil.

The correlation between the value of the dollar and the price of oil can be clearly seen in the graph below:

OIL PRICES AND U.S. DOLLAR



Source: World Bank, IEA, Bloomberg, FRED, and Google Trends

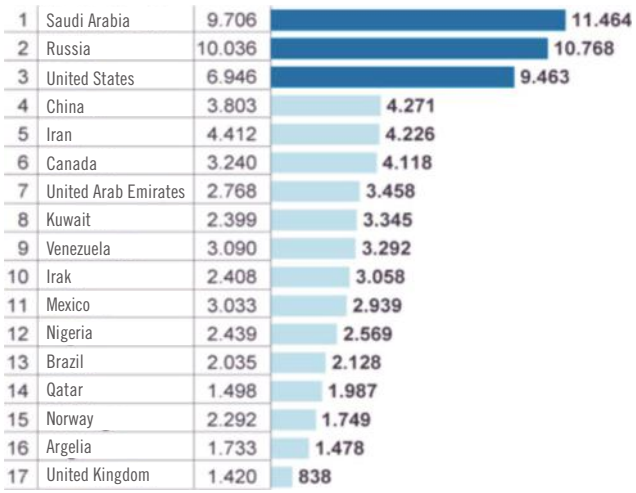
In the opinion of experts like Pedro Antonio Merino,[11] "Trading of investment assets referenced on the price of a barrel of oil has risen considerably in recent years. The daily trading volume on futures over the WTI (West Texas Intermediate, a benchmark crude) and the Brent is 50 times higher than the daily global demand for barrels of oil. The increase in activity has been reflected in greater market depth and has allowed both producers and speculators to meet their needs in terms of coverage and profitability. On the other hand, the entry of these assets into investment portfolios has led them to become a barometer of investors' appetite for risk. This is clear when we examine the inverse correlation between the price of oil and the profitability of the 10-year sovereign U.S. bond, as a security that is regarded as risk-free. However, the unbridled rise in the participation of financial agents in the oil markets in the years after the Lehman Brothers bankruptcy has led the G-20 to suggest specific measures to regulate this participation. Today, there are clear directives to discourage activity in OTC (over-the-counter) markets, as well as regulatory requirements for the financial agents to participate, which is changing the kind of agents who are acting in oil derivatives markets. This, in turn, translates into a reduced presence of banks and a greater presence of investment funds and trading houses."

11 Antonio Merino, chief economist at REPSOL.

1.3 Changes in OPEC's Strategic Objectives

The economic reasons are also compounded by geopolitical considerations. The main oil producers in the past year are well known, as illustrated in the graph below:

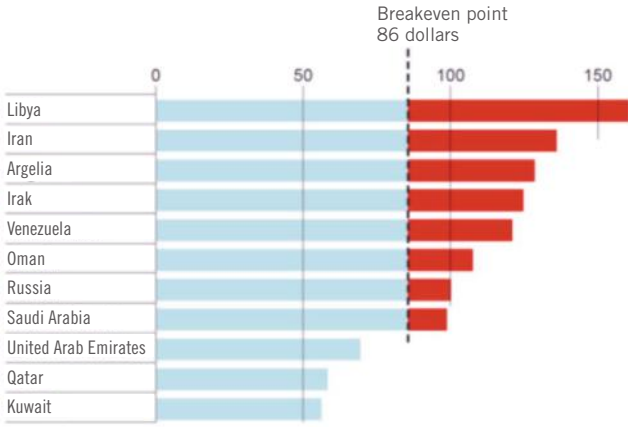
MAIN OIL PRODUCERS (IN THOUSANDS OF BARRELS PER DAY)



Source: *El País*[12]

On November 27, 2014, OPEC announced that it would not reduce its production despite an excess of supply, which disconcerted some members of the organization, such as Venezuela, who would not benefit from this decision. Indeed, the breakeven point is different for the different OPEC members, which are do not operate under the same conditions, as shown in the graph below:

BUDGET BALANCE IN OIL PRODUCTION (PER BARREL)



Source: *El País*[13]

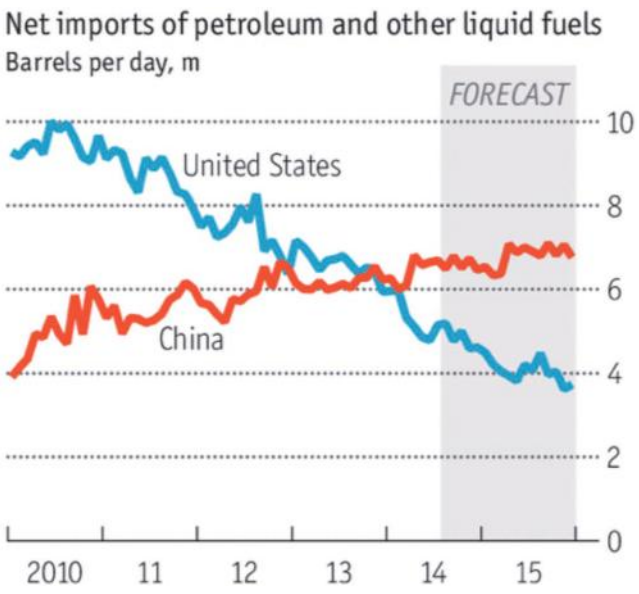
12 El País (November 13, 2015), "Hacia un nuevo orden petrolero global."

13 El País (November 13, 2015), "Hacia un nuevo orden petrolero global."

In the opinion of some analysts,[14] the reasons behind this shift in OPEC's policy can be attributed to the role of Saudi Arabia and its desire to maintain/increase its market share in view of the fracking revolution and the rise in the U.S. production of shale and tight oil. The drop in the prices of conventional crude may cast doubt on the feasibility of non-conventional projects and producers, which have high operating breakeven prices, notably Canada's tar sands production.

As we are all aware, the rise in non-conventional resources such as oil and shale gas has led a country like the United States, which was a major energy importer until recently, to considerably decrease its imports from outside NAFTA, among other reasons because of Canada's significant tar sands production, the main recipient of which is the United States. On the other hand, we should note that the United States has always been a major coal exporter with a global regulatory role, and that it has also always exported refined products. The increase in its exports of refined products and the growing dependency of Latin America on the U.S. refining capacity is striking. All things considered, the forecasts say that between 2015 and 2020, the United States could consolidate its global leadership as the main producer of oil and gas as a result of the oil and shale gas revolution. If so, not only would it wrest primacy from Saudi Arabia and the remaining OPEC countries, but it might also manage to achieve self-sufficiency in its energy supply in net terms. All of this is being debated as the persistently low prices of crude are prompting tensions regarding the profitability of non-conventional productions. This impact is not uniform, and the constant improvement in productive efficiency is leading to surprises in terms of our ability to adapt to a world with substantially lower prices than in the past three years.

THE SHALE FACTOR



Source: U.S. Energy Information Administration

14 G. Escribano (October 2014), "¡Son los saudíes, Europa!" opinion, Real Instituto Elcano, pp. 1–5.

Similar and even larger forecasts can be made for Canada, where, according to estimates, the oil and shale gas reserves in some provinces are even larger than those of its southern neighbor, which would reinforce Canada's current position in the production of non-conventional oil from tar sands. Brazil's deep waters also hold enormous potential.

In short, new technologies and novel extraction systems in areas with specific natural and geological resources are shifting the geopolitical weight of oil and gas production: the United States' tight oil, Canada's tar sands and the deep waters of Brazil are new actors on the supply side, which may challenge the leadership that the OPEC countries have maintained until now. The forecasts today are already showing a glimpse of changes in the framework that has been in place up to the present, "OPEC countries vs. OECD and emerging countries," in other words, supply versus demand. The epicenter of the new geopolitical energy scheme is clearly in the Americas and, for the time being, specifically in North America (NAFTA area).

The revolution that the North American economy is experiencing based on fracking is difficult to extrapolate to other geographic areas since it does not depend only on specific geological conditions; there are also many other determining factors. Indeed, the fact that fracking has been a true revolution, bearing in mind that it is a business initiated by small producers (i.e., independent producers, as opposed to large companies in the sector), and that this extraction method has turned the United States into a new energy power in world energy geopolitics, stems from reasons that are specific to the environment and context of the United States. The physical conditions are combined with a regulatory and labor framework that facilitates investments and business; there is an abundance of financing for risky new products; and there is a property ownership system in which landowners are also owners of the subsoil and can therefore exploit its mineral resources. Last but not least, social acceptance and the oil culture in regions like Texas and the Dakotas play a fundamental role. Furthermore, in the short term, all of these competitive advantages of the United States could potentially be strengthened on a regional level through the controversial project to build an oil pipeline, known as the Keystone XL, which would connect the Canadian region of Alberta, where crude oil is produced from tar sands, and the Dakotas with the refineries in Texas located on the Gulf coast.

In Europe, Poland was the first country where the development of shale gas seemed likely to become a reality. However, some of the large companies that were exploring there, such as ExxonMobil, Total, Marathon Oil and Chevron, have recently abandoned their prospecting, motivated, according to the press, by a significant downgrade in estimated resources, geological conditions which were more adverse than expected and a regulatory framework that remains uncertain. Ecological sensibility is a further impediment in Europe,[15] which is aggravated by the dense demographics of some of these regions. In short, non-geological factors are at least as important as geological ones.

15 Stevens, P. (August 2012), "The 'Shale Gas Revolution': Developments and Changes," Briefing Paper, Chatham House, p. 9; see the interesting table comparing the conditions and factors that explain the revolution in the United States and the reasons it cannot be extrapolated to Europe.

Returning once again to the role of Saudi Arabia, some analysts downplay the credibility of the conspiracy theory and this country's interest in maintaining/increasing its market share. They argue that the production of conventional crude oil has not increased since 2008 and that, at present, the global supply is being covered due to the non-conventional production of Canada and the United States. As such, we can deduce that conventional oil is not sufficient to cover the current demand.

Regardless, even if it is not an explicit strategy, it is nonetheless true that Saudi Arabia can maintain its production at a low price and relegate the goal of ensuring a high price bracket (from $90 to $110/barrel) to the background, in order to increase, or at least not reduce, its market share. We should not lose sight of the fact that OPEC still has a monopoly on sufficiency, as well as the ability to introduce stability or volatility into oil prices. It seems reasonable to correlate the drop in oil prices with economic reasons involving supply and demand; yet at the same time, the question of "why right now?" could perhaps be attributed to the decisions made by the Saudi regime.

In this geopolitical analysis, we also need to consider the consequences in the area of international trade, since, as discussed above, the United States could become a selective energy exporter/supplier for the rest of the world, and particularly for Asia, where the increase in imports from China, India and other southeast Asian countries, in response to demand, will reinforce the shift in the current patterns of the global energy business in the coming years.[16] Some people are already talking about the new "Pacific Age"[17] in reference to the changes that will take place and to the new world trade pattern based on exports from the United States to Asia. This growth and the changes in international trade do not only affect oil. According to estimates from the *WEO-2014*, natural gas will be the source of energy with the steepest growth in its projections through 2040; the European Union, in turn, will be the region with the highest dependency on gas imports,[18] and China will be the world's main oil consumer in 2030.[19]

16 Exports from Russia, Latin America and Africa will also follow the same dynamic of change to cover Asia's demands for imports.
17 *The Economist* (November 15, 2014), "The Pacific Age," special report, pp. 1–9.
18 International Energy Agency, *World Energy Outlook 2014*, pp. 80–84.
19 International Energy Agency, *World Energy Outlook 2014*, p. 23.

1.4 Winners and Losers (in a Context of Moderate Prices)

The current state of oil prices has several immediate effects, and other indirect effects, and it is leaving clear geopolitical winners and losers in its wake.[20] The clearest consequence is unquestionably the impact on the global economy.

Entering into further detail, the winners include economies with a high external oil dependency (since this situation has positive effects on their trade balances and competitiveness). Thus, importing countries like India, China, Indonesia, Turkey and South Africa are benefiting the most from the current situation, as illustrated in the table below, which shows the weight of crude oil imports in the GDP (in percentages) and in the trade balances.

CURRENT ACCOUNTS AND OIL IMPORTS, 2013

(% of GDP unless otherwise indicated)

	Current-account balance	Oil & fuel imports (% of total imports)
India	-2.6	35.0
Indonesia	-3.4	24.0
South Africa	-5.8	4.6
Turkey	-7.9	14.2

Source: The Economist Intelligence Unit[21]

However, these benefits may also increase the risk that some of those countries might take advantage of the situation to continue consuming oil comfortably, while disregarding improvements in energy efficiency or advances in alternative technological developments.

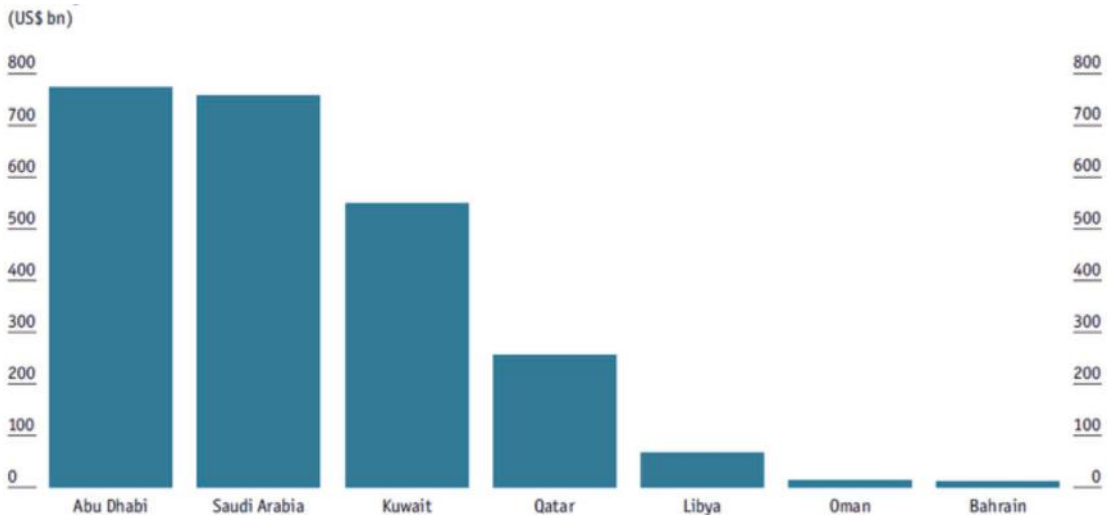
Europe is also benefitting from the current situation in the short term, since the price of natural gas is linked to the price of oil in most of its long-term supply contracts, so a drop in price has a positive effect in reducing Europe's competitive disadvantage compared with the United States.

From the industrial standpoint, the chemical, aeronautical and aviation industries are the clear winners worldwide, as they are particularly sensitive to the price of crude oil.

On the losing side are the exporting countries, among which there are major differences since not all of them are affected equally, as mentioned above. On the one hand, the oil-exporting countries whose trade balance depends most on oil are the ones that are suffering most from the current price drops. Countries like Venezuela, Nigeria, Russia and Angola are some of the nations suffering the direst effects. In contrast, purely exporting countries like Saudi Arabia, Abu Dhabi and Kuwait are not as affected in the short term thanks to their large reserves and the sovereign wealth funds they have accumulated in recent years. The graph below illustrates the strong financial state of sovereign wealth funds in the latter countries, which are better poised to manage an era of low prices during the forthcoming years.

20 World Economic Forum (February 24, 2015), "Four winners and four losers from the oil price drop"; *El País* (March 7, 2015), "Tres sorpresas del petróleo barato."
21 The Economist Intelligence Unit (2014), "The business of cheaper oil," pp. 1–29.

SOVEREIGN WEALTH FUNDS, 2013



Source: The Economist Intelligence Unit[22]

However, we should note that the countries with large sovereign wealth funds shown above will also need to cover their public budgets given the drop in crude prices, and may be forced to monetize part of these funds, which would have a significant impact on the value of the assets worldwide. This effect could neutralize the current tendencies, resulting from the existing liquidity and the low price of money, driven by the expansionary monetary policies of central banks in many of the currency areas.

Along with the geopolitical impact and the consequences for the world economy, the drop in oil prices has also sparked a resounding response in the form of disinvestment and cutbacks on the part of oil companies, both domestic and international. Capital investment in oil and gas is estimated to drop by around $24 billion this year. This is a small figure in an industry where global investment hovers at around $1 trillion, but it is indicative of the adjustment processes that will be seen in many companies in the forthcoming months or years.

On the other hand, we could also cite other consequences which are less direct and perhaps less visible, yet no less interesting, such as the possible effects on public policy and the opportunities it provides for its transformation and the revision of certain subsidies and taxes in the area of energy.

> "The plunging price of oil, coupled with advances in clean energy and conservation, offer politicians around the world the chance to rationalize energy policy. They can get rid of billions of dollars of distorting subsidies, especially for dirty fuels, whilst shifting taxes towards carbon use."[23]

22 The Economist Intelligence Unit (2014), "The business of cheaper oil," pp. 1–29.

23 *The Economist* (January 17–23, 2015), "Seize the day: How falling oil prices and new technology offer a chance to transform energy policy."

2. DEMOGRAPHIC PROSPECTS AND ENERGY CHALLENGES

Demographic prospects also play a crucial role in the debate on the future of the energy industry. The energy demand may double or triple by 2050 as the population rises and poverty declines, while developing countries expand their economies and progress.

2.1 Global Growth and Urbanization

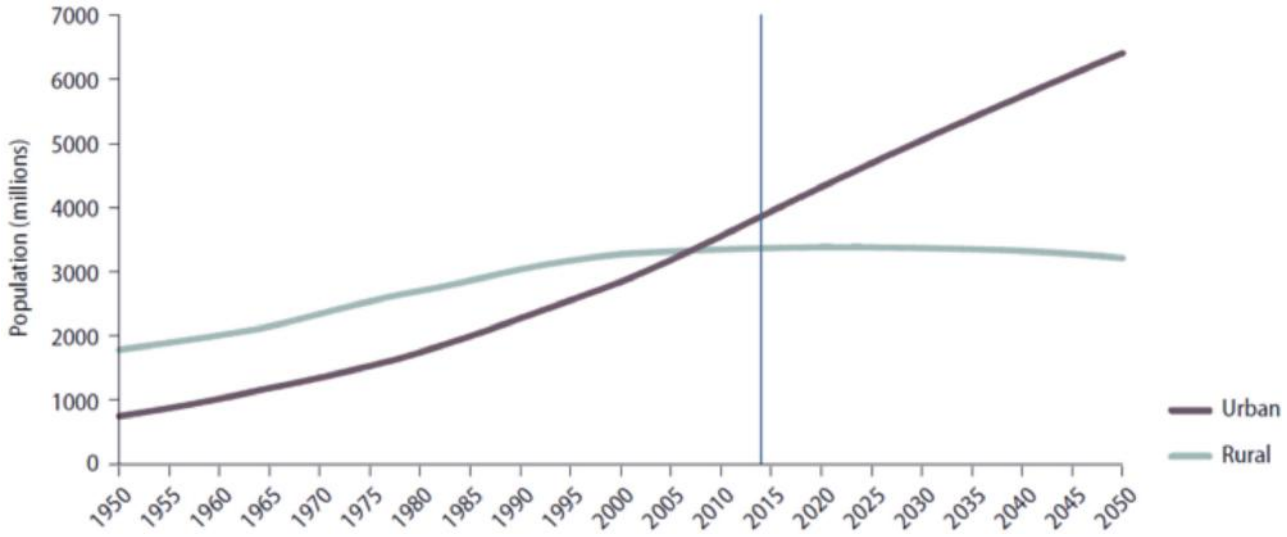
Forecasts say that the world population, which is currently 7.2 billion people, may reach 8.1 billion by 2025 and 9.6 billion[24] by 2050. The United Nations' estimates say that growth will be uneven and will vary considerably by region: Africa will be the continent that will lead half the expected growth until 2050, while Europe's population will decline by 14%. India will surpass China in the number of inhabitants (and their youth), and Nigeria's population will exceed that of the United States. Along with these countries, others like Indonesia, Pakistan and the Philippines will be among the most populous countries.

This demographic context must be analyzed along with the rapid process of urbanization of the world population in recent years, which has led some cities in countries like China, Indonesia and India to experience unprecedented growth rates.

Today, 54% of the world population lives in urban areas, and by 2050 this percentage is expected to reach 70%.[25]

24 United Nations (2014), *World Population Prospects: The 2012 Revision, Methodology of the United Nations Population Estimates and Projections*, United Nations Department of Economic and Social Affairs, Population Division, New York.
25 United Nations (2014), *World Urbanization Prospects: The 2014 Revision, Highlights*, United Nations Department of Economic and Social Affairs, Population Division, New York.

URBAN AND RURAL POPULATION OF THE WORLD, 1950-2050



Source: United Nations World Urbanization Prospects[26]

The United States is the most urbanized region on the planet (with more than 80% of the population living in urban areas), while approximately half of the population in Africa and Asia lives in rural areas (40% and 48% respectively, with India and China being the countries with the highest proportion of rural population). However, it is estimated that the percentage of urban population on these two continents will reach 56% and 64%, respectively, by 2050. Specifically, India, China and Nigeria will account for 37% of the world's urban growth between 2014 and 2050.

Today, half of the population lives in small cities with fewer than 500,000 inhabitants. However, there is a notable proliferation of urban agglomerations. The forecasts on urbanization and the growth of mega-cities through 2030 are illustrated in the table below, which shows the largest cities today and which will be the largest in 2030:

26 United Nations (2014), *World Population Prospects: The 2012 Revision, Methodology of the United Nations Population Estimates and Projections*, United Nations Department of Economic and Social Affairs, Population Division, New York.

Population of the 30 Largest Urban Agglomerations in 2015 Ranked by Population Size							
Urban Agglomeration	Country or area	Population (millions)			Rank		
		1990	2015	2030	1990	2015	2030
Tokyo	Japan	32.53	38.00	37.19	1	1	1
Delhi	India	9.73	25.70	36.06	12	2	2
Shanghai	China	7.82	23.74	30.75	19	3	3
São Paulo	Brazil	14.78	21.07	23.44	5	4	11
Mumbai (Bombay)	India	12.44	21.04	27.80	6	5	4
Ciudad de México (Mexico City)	Mexico	15.64	21.00	23.86	4	6	10
Beijing	China	6.79	20.38	27.71	21	7	5
Kinki M.M.A. (Osaka)	Japan	18.39	20.24	19.98	2	8	13
Al-Qahirah (Cairo)	Egypt	9.89	18.77	24.50	11	9	8
New York-Newark	United States of America	16.09	18.59	19.89	3	10	14
Dhaka	Bangladesh	6.62	17.60	27.37	22	11	6
Karachi	Pakistan	7.15	16.62	24.84	20	12	7
Buenos Aires	Argentina	10.51	15.18	16.96	10	13	18
Kolkata (Calcutta)	India	10.89	14.86	19.09	7	14	15
Istanbul	Turkey	6.55	14.16	16.69	23	15	20
Chongqing	China	4.01	13.33	17.38	27	16	17
Lagos	Nigeria	4.76	13.12	24.24	25	17	9
Manila	Philippines	7.97	12.95	16.76	18	18	19
Rio de Janeiro	Brazil	9.70	12.90	14.17	13	19	22
Guangzhou, Guangdong	China	3.07	12.46	17.57	29	20	16
Los Angeles-Long Beach-Santa Ana	United States of America	10.88	12.31	13.26	8	21	24
Moskva (Moscow)	Russian Federation	8.99	12.17	12.20	15	22	27
Kinshasa	Democratic Republic of the Congo	3.68	11.59	20.00	28	23	12
Tianjin	China	4.56	11.21	14.66	26	24	21
Paris	France	9.33	10.84	11.80	15	25	28
Shenzhen	China	0.88	10.75	12.67	30	26	25
Jakarta	Indonesia	8.18	10.32	13.81	16	27	23
London	United Kingdom	8.05	10.31	11.47	17	28	29
Lima	Peru	5.84	9.90	12.22	24	29	26
Seoul	Republic of Korea	10.52	9.77	9.96	9	30	30

Source: *United Nations World Urbanization Prospects*[27]

27 United Nations (2014), *World Urbanization Prospects: The 2014 Revision, Highlights*, United Nations Department of Economic and Social Affairs, Population Division, New York.

2.2 Universal Access to Energy: Challenges and Solutions

According to figures from the International Energy Agency, 18% of the world's population (1.3 billion people) has no access to electricity and 38% (2.6 billion people) has no clean energy for cooking. Some 84% of these people live in rural areas.

The clarity of these figures has made the debate on universal access to energy the target of special attention for the United Nations. That is how the Sustainable Energy for All (SE4All) initiative was born and the inclusion of energy as one of the essential vectors in the development of the "Sustainable Development Goals."[28] The purpose is to achieve universal access by 2030. Likewise, the goal is recognizing that the fight against poverty also implies addressing the issue of access to energy, since energy is key to gaining access to water, healthcare, education and, of course, sustainable development.

There is no doubt that the figures and growth prospects of the world population as outlined above directly affect the energy industry. The continuity of the intense process of reducing poverty that has been taking place in recent decades will increase per capita energy consumption, especially in many emerging countries. The global demand for energy will rise 37% by 2040 at a rate of more than 2% per year. This growth will primarily come from Asia (60%), Africa, the Middle East and Latin America. Meeting today's needs, with the prospect of the world population growing by two billion people before 2050, is a huge challenge from the standpoint of climate, technology, finances and management.

If we focus solely on electricity, the majority of experts agree with Carmen Becerril[29] when she says that "we are unlikely to be able to implement the universalization model based on the conventional patterns of grid extensions. As such, alternatives have been proposed which use small local grids fueled by renewable energies (primarily photovoltaic, wind and biomass) or hybrid energies (including diesel generators) and even with household systems that cover basic family needs, usually with photovoltaic panels and batteries." Indeed, photovoltaic energy may play a major role in this question, since it has a vast potential for expansion, along with the ability to contribute to the development of many countries that do not yet have widespread access to electricity. For example, if we spotlight Africa, solar technology still plays a modest role in much of the continent, but it has an enormous potential for development, particularly bearing in mind that Africa has an average of 320 days of sunlight per year and radiation levels close to 2,000 kWh per square meter per year (kWh/m^2) (twice as much as the average for Germany).

28 See: http://www.undp.org/content/undp/en/home/mdgoverview/post-2015-development-agenda.html.
29 Carmen Becerril, independent Board member of Acciona and former president of Energía sin Fronteras.

From this standpoint, the same author[30] believes that even though the challenges are formidable, there are viable, affordable solutions. Indeed, she argues that today, "technology is no longer a barrier given that, in recent years, the lower prices of renewable technologies and the huge advances in energy storage using new kinds of batteries lets us imagine affordable solutions. However, other conditions are needed before we can reach this goal. First, we need government commitment; they have to define a clear strategy and reliable regulations that can provide for developing economically viable business models to handle the energy supply in isolated areas. Second, business initiative must be encouraged. These developments must be defined as a service and then treated and managed as such. Third, there must be financial facilities adapted to small projects which should support the expansion of electrical services to rural areas. These three requirements are easy to list, but extraordinarily difficult to apply. Nonetheless, more and more governments, entrepreneurs and banks are wholeheartedly committed to finding a solution to this enormous challenge."

In short, the rise in the energy demand in developing countries, universal access to energy, the definition of sustainably urban growth models, city models,[31] the need for infrastructures and services, and new mobility patterns (electric cars, alternative fuels, etc.), among other challenges, require a profound reflection on the energy architecture of the future. These are challenges that must also be tackled from an ecological perspective, as is reflected in the OECD document "Environmental Outlook to 2050,"[32] which identifies four major areas in which urgent, comprehensive action is needed: climate change, biodiversity, water and the impact of pollution on health.

30 Carmen Becerril, independent Board member of Acciona and former president of Energía sin Fronteras.

31 P. Berrone, R. Costa, & J. Enric, ST-366-E, "IESE Cities in Motion Index 2015," IESE, March 2015.

32 OECD, Environmental Outlook to 2050. *The Consequences of Inaction. Highlights*, 2012, pp. 1–12.

3. ENERGY AND CLIMATE CHANGE

The debate on energy and climate change is not merely a technical debate about emissions levels or the environmental effects on different regions of the planet. Nor is it a debate that is solely limited to global energy architecture. However, it is important to know that two-thirds of global emissions come from the energy industry and that harnessing natural resources has ecological consequences. The energy tripod – comprised of economic development and growth, sustainability, and security – would be meaningless were it not for the close relationship between climate change and the energy mix.

The reports issued by the Intergovernmental Panel on Climate Change[33] document the fact that the temperature of the Earth and the surface of the ocean rose 0.85 ºC from 1880 to 2012, which confirms the human impact on the process of global warming. The panel's conclusions on the causes and consequences of the rise of CO_2 in the atmosphere determine the urgency of lowering emissions to prevent the global temperature from rising more than 2 ºC, which would lead to irrevocable changes in the climate. To prevent this, the panel recommends that the concentration of greenhouses gases remain below 450 ppm (parts per million), which would entail a considerable effort on the part of all countries. The *WEO-2014* presents different scenarios for analyzing the possible evolution of energy markets by 2040. In the scenario presented by "New Policies" the expected energy demand for that year would result in an increase in the concentration of greenhouse gases by 650 ppm, the equivalent of a 3.5 ºC rise in the Earth's temperature.

Nor does the debate on climate change end with the promotion of renewable energies, since it involves broader considerations that are also associated with energy efficiency; policies on transportation, urban planning and construction; the existence of subsidies that encourage wastefulness; and the aforementioned demographic growth. Once we have recognized the challenge posed by climate change, it should also be noted that policies to mitigate and decrease emissions depend on world governing institutions being more efficient than they are today.

In short, the dialogue on energy and climate change is the sum of many debates, and most importantly it is a discussion on the sustainability of the current growth and development, though it is necessary to eradicate the poverty in which much of humanity lives today. For the time being, we do not have another planet in reserve, and so we have to address the sustainability of our growth model so that this planet can continue to satisfy the aspirations of the coming generations. From this perspective, the questions of energy and climate change require more than a national vision; the outlook must be global and strategic. We are not talking about an isolated phenomenon or a short-term situation; this is something that needs to be framed within a broader context in terms of its timeframe and the factors to be considered.

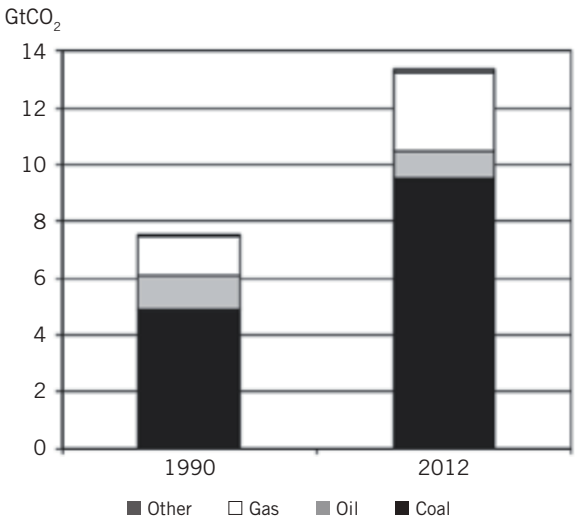
The aforementioned OECD outlooks for 2050 are clear and unequivocal: "Urgent – and comprehensive – actions are needed today to avoid significant costs and other consequences of inaction in both economic and human terms."[34] There are also other benchmark reports that defend the need to promote urgent changes to deal with the impact of global growth on CO_2 emissions. These policies tend toward more sustainable, ecological scenarios for world growth if we are really to face the challenge of environmental degradation and its consequences.[35]

33 Intergovernmental Panel on Climate Change (IPCC) (2014), *Climate Change 2014, Fifth Assessment Report, Synthesis Report*, 2014, pp. 1–138. Furthermore, we should take into account other important reports from the same panel: *Climate Change 2013: The Physical Science Basis*, 2013, pp. 1–1552; Climate Change 2014: *Impacts, Adaptation and Vulnerability. Part A: global and regional aspects*, 2014, pp. 1–1150; and *Climate Change 2014: Mitigation of Climate Change. Part B: Regional aspects*, 2014, pp. 1–696. They can be found at http://www.ipcc.ch.
34 OECD (2012), OECD, Environmental Outlook to 2050: The Consequences of Inaction. Highlights, 2012, pp. 1–12.
35 Club Español de la Energía, PricewaterhouseCoopers (2007), *The World in 2050: Global growth and climate change policy. Implications of global growth for carbon emissions and climate change policy*, pp. 1–56.

3.1 Transition to a Decarbonized Model. New and Old Players in the Energy Mix: Renewable Energies, Nuclear Energy, Gas, Oil, Coal and Biomass

Electricity generation around the world depends heavily on coal. In countries like Australia, China, India, Poland and South Africa, more than two-thirds of the electricity generated comes from this energy source. In Germany, the fourth most powerful economy in the world, this proportion is one-half. CO_2 emissions in the industry doubled between 1990 and 2012 due to the rise in energy generation using coal, as illustrated in the graph below.

CO_2 EMISSIONS FROM ELECTRICITY AND HEAT GENERATION*



*Refers to main activity producers and autoproducers of electricity and heat.

Source: CO_2 Emissions from Fuel Combustion 2014, International Energy Agency

There is a broad consensus concerning the benefits of increasing the proportion of renewable energies and reducing the role of coal in the current and future energy mix. Still, as analysts have pointed out, the transition to a low-coal economy implies many technological changes, changes intended to make the most of the best available technologies, changes in the industrial model, as well as behavioral changes, changes in risk perception and structural changes.

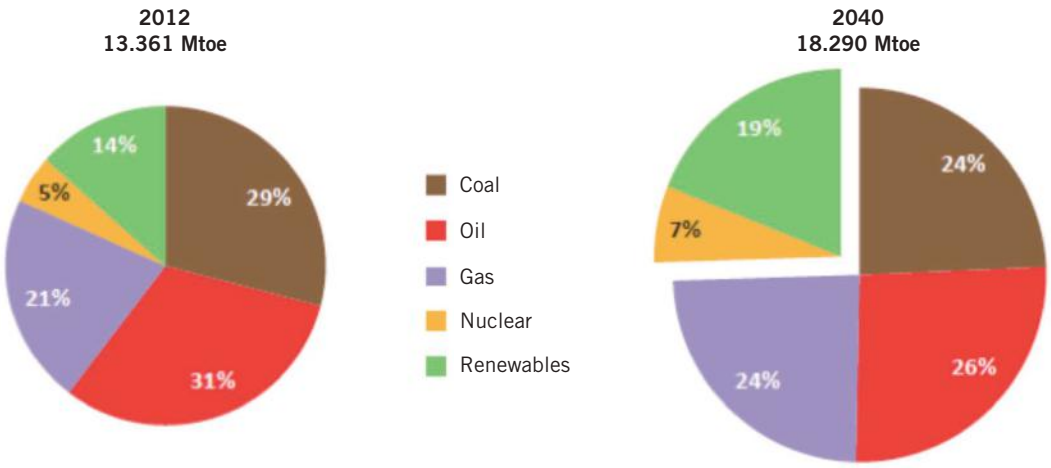
Generally speaking, the transition to decarbonized energy models is a reality that already exists, although it is taking root slowly. More than one-third of the 125 countries analyzed in the "Global Energy Architecture Performance Index Report 2015"[36] still show a low percentage (less than 10%) of primary energy sources that do not come from coal or other fossil fuels.

Today, coal, oil and natural gas cover 81% of the world energy demand, compared with 14% from renewable sources and 5% from nuclear energy.[37] Likewise, according to the estimates of the International Energy Agency for 2040, the energy mix will continue to be primarily divided into/comprise oil, gas and coal.

The aforementioned *WEO-2014* examines several possible perspectives not only according to the expected demand – which varies by region and has its own particular challenges in each, especially in Africa and other areas where the vast majority of the population does not have widespread access to either electricity or gas – but also according to whether the same policies are maintained or new ones are put into place. In this sense, the central scenario of the study, "New Policies" advocates for the real adoption of policies directed at energy efficiency, the use of alternative fossil fuels and investment in renewable energies. In this scenario, the energy mix could be organized into framework similar to the one shown in the graph below, which refers to the global primary energy demand through 2040:

36 World Economic Forum (December 2014), *Global Energy Architecture Performance Index Report 2015*, pp. 1–34.
37 World Economic Forum (2013), *Energy Vision 2013: Energy Transitions: Past and Future*, p. 6.

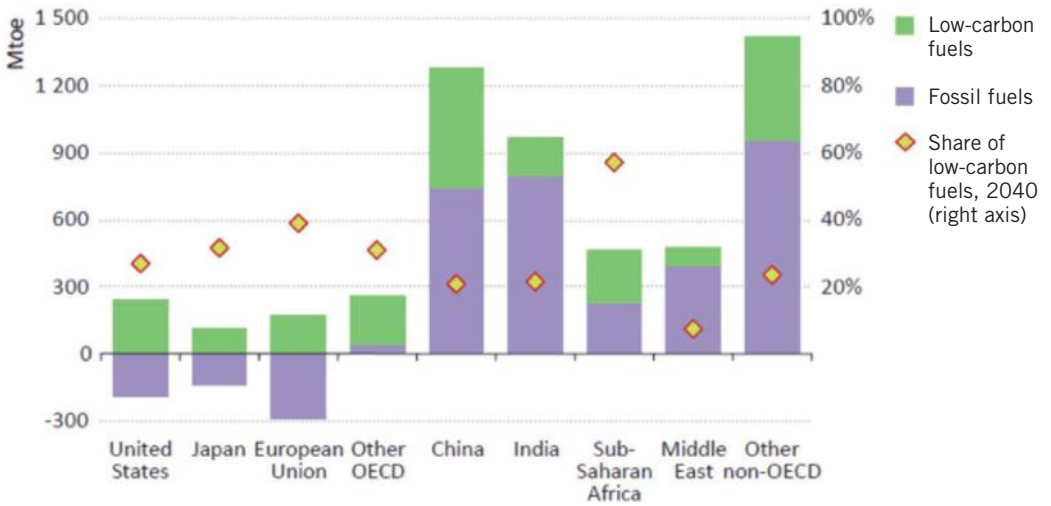
FUEL SHARES IN WORLD PRIMARY ENERGY DEMAND IN THE NEW POLICIES SCENARIO



Source: *WEO-2014*, p. 57

This rise in renewables or low-carbon resources (such as gas) in the energy mix would mainly be applied in OECD countries, but it would also grow in countries like China, as shown in the illustration below:

PRIMARY ENERGY DEMAND GROWTH BY REGION AND FUEL TYPE IN THE NEW POLICIES SCENARIO, 2012-2040



Source: *WEO-2014*, p. 57

The main growth in renewable energies is expected to occur in the electricity generation mix. Accordingly: this would entail up to 37% in the OECD countries and 31% in countries that are not OECD members (in the same year), which would contribute to the fact that 33% of the electricity generated would come from renewable, emission-free energy sources.[38]

RENEWABLES-BASED ELECTRICITY GENERATION BY REGION IN THE NEW POLICY SCENARIO

	Renewables electricity generation (TWh)				Share of total generation		Share of variable renewables* in total generation	
	2012	2020	2030	2040	2012	2040	2012	2040
OECD	**2 219**	**3 039**	**3 996**	**4 893**	**21%**	**37%**	**4%**	**17%**
Americas	998	1 329	1 770	2 200	19%	33%	3%	14%
United States	527	766	1 081	1 397	12%	27%	4%	15%
Europe	1 026	1 376	1 739	2 056	28%	47%	8%	23%
Asia Oceania	195	334	487	637	11%	28%	1%	13%
Japan	128	212	288	364	13%	32%	1%	13%
Non-OECD	**2 588**	**4 224**	**6 221**	**8 336**	**22%**	**31%**	**1%**	**9%**
E. Europe/Eurasia	294	366	466	602	17%	24%	0.4%	3%
Russia	169	209	272	361	16%	24%	0.0%	1%
Asia	1 395	2 565	3 863	5 081	19%	28%	2%	10%
China	1 010	1 933	2 646	3 209	20%	30%	2%	12%
India	177	315	620	993	15%	26%	3%	11%
Middle East	22	42	123	317	2%	17%	0.0%	10%
Africa	118	232	463	780	16%	35%	0.4%	7%
Latin America	759	1 019	1 306	1 556	66%	69%	0.6%	7%
Brazil	456	616	779	904	83%	78%	0.9%	9%
World	**4 807**	**7 263**	**10 217**	**13 229**	**21%**	**33%**	**3%**	**12%**
European Union	788	1 136	1 447	1 712	24%	46%	8%	25%

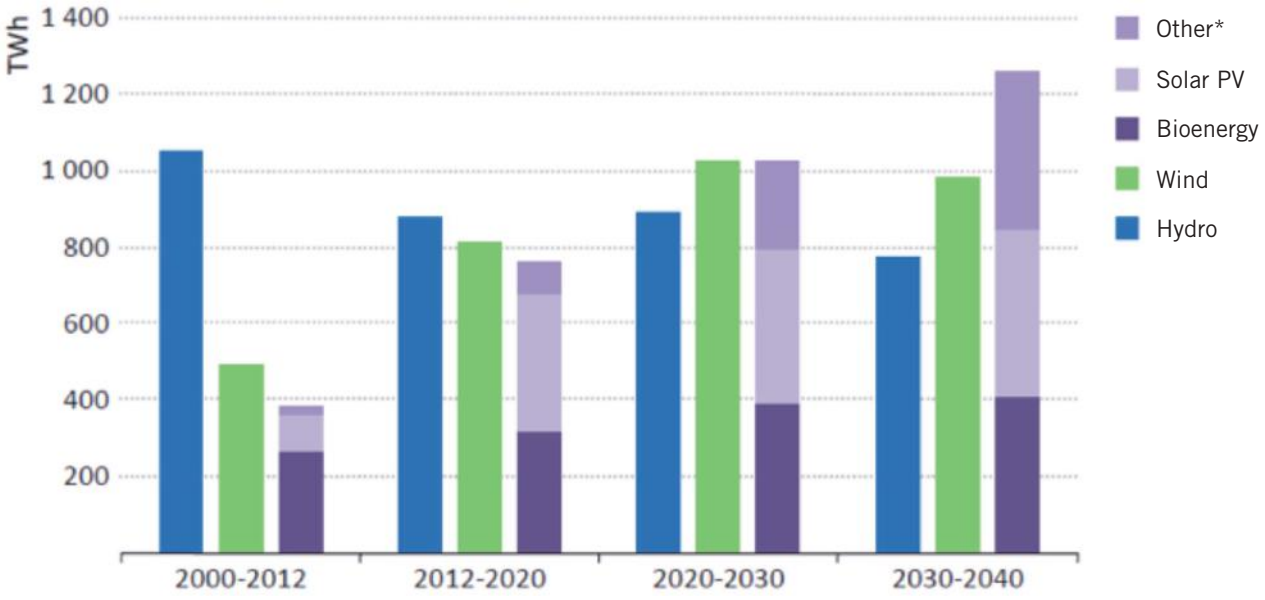
*Variable renewables here include solar PV and wind power.

Source: *WEO-2014*, p. 184

38 International Renewable Energies Agency (IRENA) (2015), *A World of Renewables*, pp. 1–68. See other publications and insights in http://www.irena.org. See also: International Energy Agency, "Renewable Energy Outlook," in *World Energy Outlook 2014*, pp. 239–278. 239–278.

The graph below illustrates the contributions of each resource to these growth trends depending on the type of source (solar, wind, water, kinetic and biomass):

INCREMENTAL GLOBAL ELECTRICITY GENERATION FROM RENEWABLES BY TYPE IN THE NEW POLICY SCENARIO

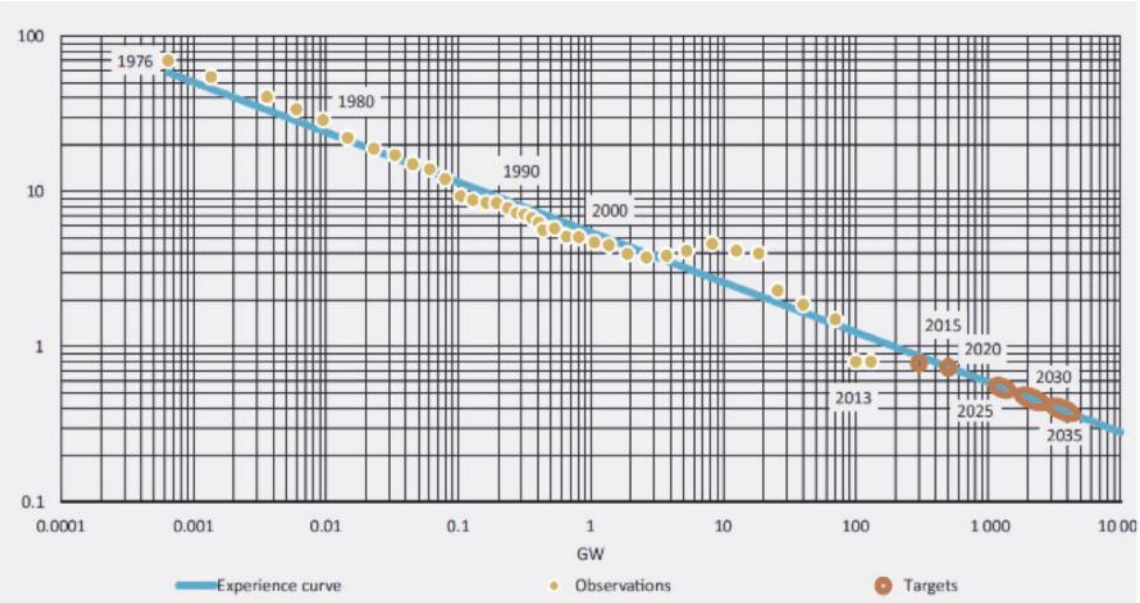


*Other includes geothermal, concentrating solar power and marine.

Source: *WEO-2014*, p. 184

These forecasts also show the need to keep investing in renewable energies, and particularly to deal with some of the main challenges, such as energy storage, transportation and infrastructures. To date, apart from private investment, government policies to support renewable energies have taken shape in two kinds of measures: rates and price-setting for coal, and direct subsidies. For example, one of the cornerstones of Europe's environmental commitment policy has revolved around promoting renewable technologies. These subsidies are mainly concentrated in Spain, Germany and Italy, although they also play a major role in other countries, such as the United States, China and Japan, as a complementary measure to promoting the investments needed in this sector. Since this is a new industry with a steep learning curve, the subsidy policy is the subject of debate today in some countries – especially in Spain – not so much because it supports a nascent industry but because it is implemented through the use of instruments that are poorly suited to the task (in the opinion of most analysts), such as the electricity bill, without the mediation of competitive objectification and without taking into consideration either the degree of technological maturity or the potential of the different options.[39] The graph below, for example, reflects the learning curve in the field of photovoltaic (PV) energy:

LEARNING CURVE OF THE PHOTOVOLTAIC (PV)



39 The issue of the rate deficit is not due exclusively to the inclusion of policies to promote renewable energies, since there are other additional issues, as we shall see below. However, it has generated a great deal of confusion in this regard, not to mention a substantial economic deficit. See: Department of Industry Meetings, IESE Business School (2014), *IESE Energy Industry Trends Summary, 2014*, pp. 1–31. See in http://www.iese.edu/industrytrends.

3.2 The Sixth Energy Source: Efficiency and Savings

In the debate on climate change, we also have to talk about what some authors call the "sixth energy": energy efficiency, i.e., reducing energy consumption through a more rational use of primary energy resources and sources and the resulting impact on improving sustainability, decreasing CO_2 emissions and reducing costs. Much more than half if the primary energy we use is not consumed efficiently. This is due, on the one hand, to the current technological limitations, coupled with the failure to use the best available and mature technological options. However, it is primarily due to wastefulness or poorly implemented policies, which is a shame because the potential to reduce CO_2 emissions is substantial.

The majority of experts and think tanks claim that the role of energy efficiency is equally or more important than the role of renewable energies in achieving the goal of preventing global temperatures from rising more than 2 ºC (global warming).[40] Indeed, some institutions, such as the World Energy Council, claim that the transition toward a cleaner and more sustainable energy model could take place using only the technology available today, bearing in mind not just the role of renewable energies but energy efficiency as well (and the potential of gas):

> "Global resource abundance, meaning that energy efficiency potentials combined with renewable energy sources and shale gas potentials provide an abundance of energy that can be made accessible with currently available technologies."[41]

In fact, back in 2009, the International Energy Agency suggested 25 measures related to energy efficiency policies in seven priority areas: construction, applications and equipment, lighting, transportation, industry, end uses and cross-cutting actions. If these recommendations were implemented in the short term, we would prevent the emission of 8.2 gigatons of CO_2 per year by 2030, compared with a reference scenario in which new policies are not adopted and additional reduction objectives are not set.

In some geographic areas, the focus on energy efficiency is a political priority because it encompasses issues of regulation, taxation and urban planning models, among others. For example, in Europe, energy efficiency is one of the three objectives of the current energy policy: the threefold objective of 20/20/20 for 2020 includes a 20% drop in CO_2 emissions, 20% of the energy in the EU coming from renewable sources, and a 20% increase in energy efficiency. The Energy Efficiency Directive and its current update as part of the 2030 climate policies are framed within this context.[42] Some analysts have even ranked these priorities in order: first, energy efficiency; second, the cost of energy; and third, reducing emissions.

40 Among other references: Rocky Mountain Institute: http://www.rmi.org. *The Economist* (April 11, 2015), "Green around the edges."
41 World Energy Council (October 2014), *Global Energy Transitions: A Comparative Analysis of Key Countries and Implications for the International Energy Debate*, p. 25.

42 Directive 2012/27/EU of the European Parliament and Council dated October 25, 2012, on energy efficiency, which amends Directives 2009/125/EC and 2010/30/EU and repeals Directives 2004/8/EC and 2006/32/EC. See also: http://ec.europa.eu/clima/policies/2030.

In the United States, the Environmental Protection Agency announced the adoption of the U.S. Clean Power Plan in June 2014[43] which not only aims to reduce emissions but also includes a list of specific measures aimed at more efficient energy use, particularly electricity in buildings and homes. In other countries, such as Mexico or Chile, energy efficiency measures have also been adopted in certain energy-intensive industries, as well as for vehicles. In China and India, specific measures are also being adopted concerning pollution and vehicle efficiency. China, in turn, is studying measures related to the efficient use of coal, spotlighting certain more intensive regions and industries, such as metallurgy, plastics and construction.[44]

Finally, efficiency, just like renewable energies, requires innovation and technology. In fact, the technologies involved in developing this issue already exist throughout the entire supply chain and have an impact on end consumption and the reduction of energy intensity. The losses that occur in the processes of manufacturing, supply and use, either through inefficient technologies or poor user habits, come with high economic costs which ultimately affect the end energy cost paid by the users themselves.

One illustrative example of the disconnect between the growth in the GDP and the evolution in energy demand (electricity in this case) is already happening in some countries, as shown in the graph below, which reflects the case of Australia:

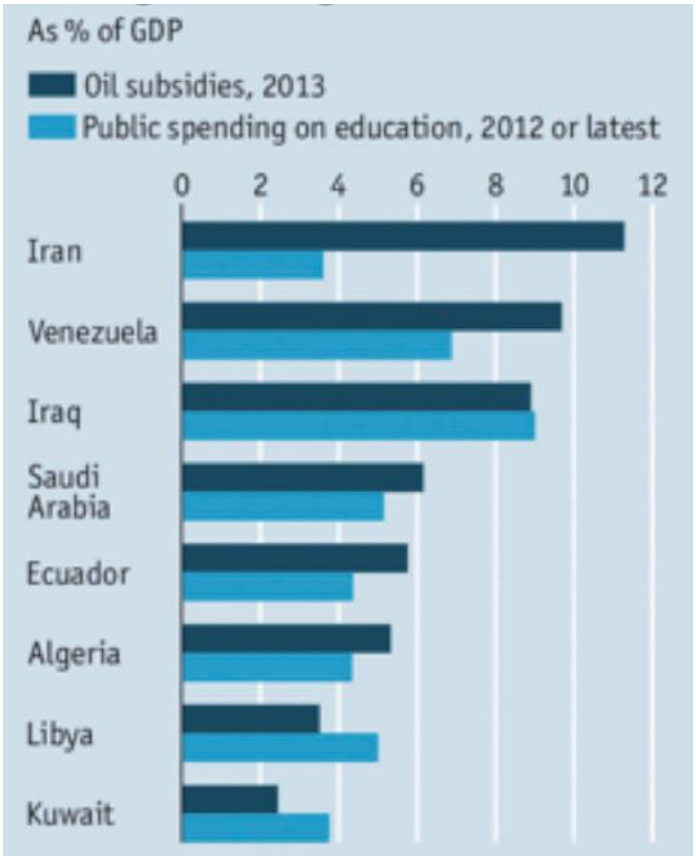
AUSTRALIA. CURRENT ELECTRICAL GRID VS. EXPECTED DEMAND 2004–2024

Source: Australian Energy Market Operator, Reserve Bank of Australia, Bloomberg New Energy Finance.

43 They can be found at http://www2.epa.gov/carbon-pollution-standards/clean-power-plan-proposed-rule.
44 International Energy Agency, "Energy efficiency outlook," in World *Energy Outlook 2014*, pp. 279–313.

On the other hand, oil and coal subsidies do not contribute to the objectives of energy efficiency. In some countries, subsidies are perceived as a crucial factor in maintaining social stability. The global value of subsidies for fossil fuels rose 60% between 2007 and 2013, reaching almost US$550 billion, according to the International Energy Agency. In many countries, these subsidies exceed the budgets for healthcare or education.

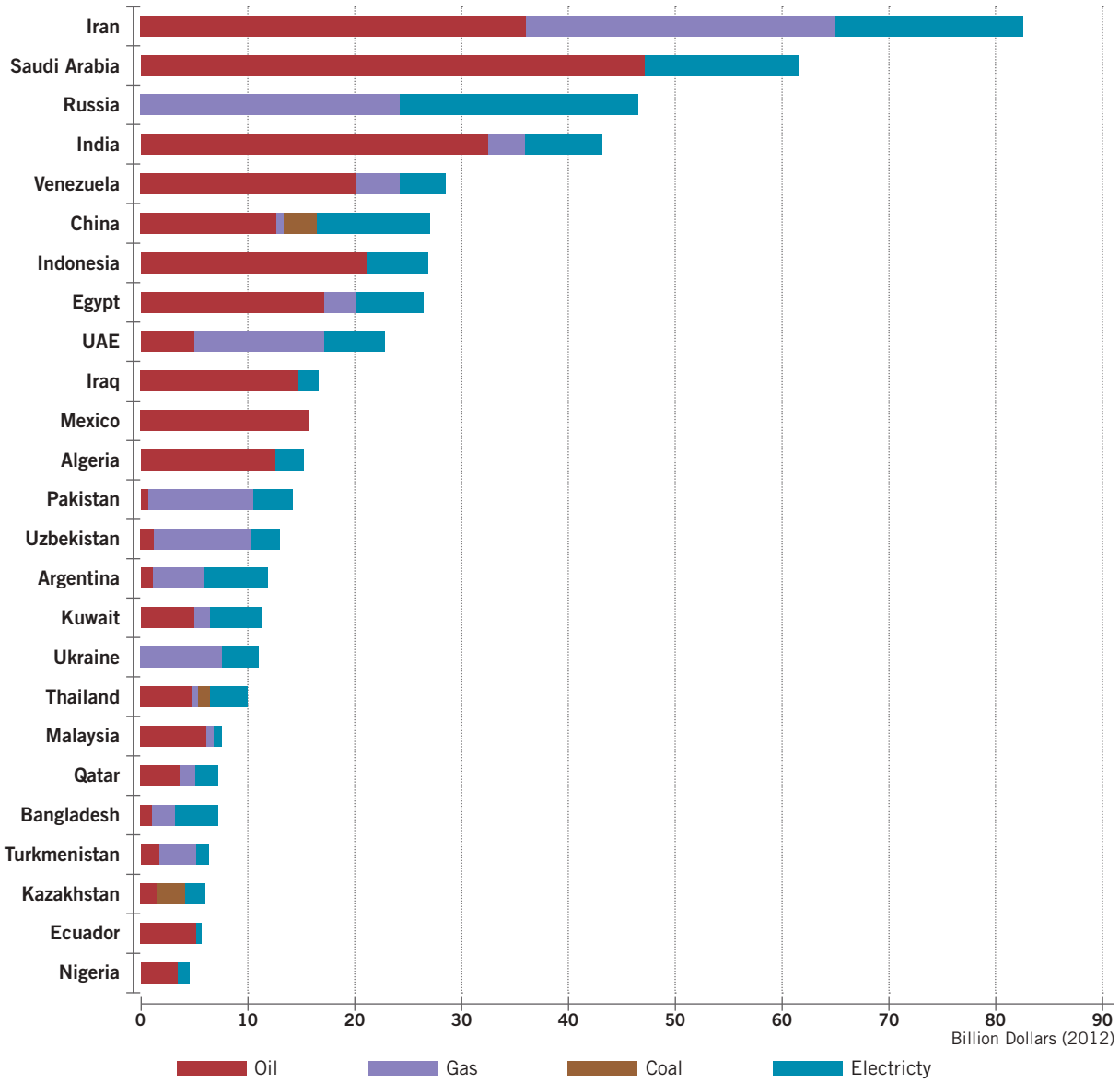
DRIVING V LEARNING



Source: IEA World Energy Outlook; World Bank; national sources

SUBSIDIES FOR FOSSIL FUELS

First 25 countries



$544 billion in 2012:
Oil $124 billion
Gas $124 billion
Coal $7 billion
Electricty $135 billion

The International Energy Agency recommends removing subsidies in order to improve efficiency

Source: *WEO-2013*

3.3 Paris 2015: Energy and Climate Diplomacy Needs a Strategic Vision to Face the Challenges of the Coming Decades

The 2015 Paris Summit (COP 21), scheduled for November 30 to December 11, 2015, will be crucial in addressing all of these issues, as well as the aforementioned trends. The priorities of the Summit include reaching a new legally binding agreement, with the goal of ensuring that global warming does not exceed 2 ºC by 2050. The regulation update of the United Nations Framework Convention on Climate Change and its current Kyoto Protocol[45] has been preceded by different regional gatherings, during which headway has been made toward proposing a specific agenda.

The main challenges/issues for the Summit are as follows: first, achieving a legal agreement that incorporates a maximum number of countries; second, ensuring that the national contributions (i.e., each state's participation in the global effort) are coherent and realistic in keeping with the ultimate goal; third, addressing the financial structures and levels of investment needed for a carbon-free world that will be resilient to climate change and ensuring that this commitment becomes part of the agendas of major financial institutions, development banks, the G-20, the G-7+, the EU, etc.; and, finally, involving not only national governments but other stakeholders as well (cities, regions, companies, NGOs, etc.). In this way, the outcome of Paris 2015 will depend on how extensive and universal the agreement is, the countries' level of contribution, how much progress is made on the financial front and how the other stakeholders are involved.

When we talk about national contributions, we mean each state's technological and regulatory adaptations and investments targeted at mitigating the impact of CO_2 emissions and adapting their economic, industrial and social reality. Without a doubt, the energy transition toward a secure, affordable and sustainable model requires investments to be made and measures to be adopted throughout the entire value chain. These national measures and commitments must also be monitored before and after Paris 2015, since they are part of a long-term project.[46]

Today, the efforts and commitments in the fight against climate change are asymmetrical and, in some analysts' opinion, not very ambitious. Still, the November 2014 bilateral framework agreement between the United States and China signaled headway in these two countries' commitments (given their responsibility as the leading producers of emissions: together they account for 40% of all emissions), but it is still not enough. The United States has pledged to reduce its emissions somewhat tentatively by 2025; and China by 2030.

In an X-ray of the energy mix of the United States, China and the EU, it is interesting to note the evolution of each case in recent years; even though this is a global issue, the fact is that national agendas play a heavy role.

45 The Convention and Protocol can be found at the official United Nations website: http://unfccc.int/essential_background/items/6031.php.

46 For a detailed analysis of the possible agreements and technical and institutional advances in Paris 2015, see: E. Haites, F. Yamin, & N. Höhne (October 2013), "Possible Elements of a 2015 Legal Agreement on Climate Change," IDDRI Working Paper, no. 16/13, pp. 1–24.

Electrical mix in the United States and its evolution		
Composition	2005	2013
Hydroelectric	6.9	6.7
Nuclear	18.9	19.1
Fuel	3.3	0.8
Gas	18.2	26.7
Coal, lignite	50.2	40.0
Wind energy	0.4	3.9
Solar energy	0.0	0.3
Geothermal energy	0.4	0.4

Source: Enerdata

Electrical mix in China and its evolution		
Composition	2005	2013
Hydroelectric	15.9	17.2
Nuclear	2.1	2.1
Fuel	2.4	0.1
Gas	0.5	1.8
Coal, lignite	78.8	75.3
Wind energy	0.1	2.4
Solar energy	0.0	0.2
Geothermal energy	0.0	0.0

Source: Enerdata

Electrical mix in the European Union and its evolution		
Composition	2005	2013
Hydroelectric	10.4	12.3
Nuclear	30.0	26.8
Fuel	4.3	2.0
Gas	20.1	15.7
Coal, lignite	29.9	27.6
Wind energy	2.1	7.3
Solar energy	0.0	2.6
Geothermal energy	0.2	0.2

Source: Enerdata

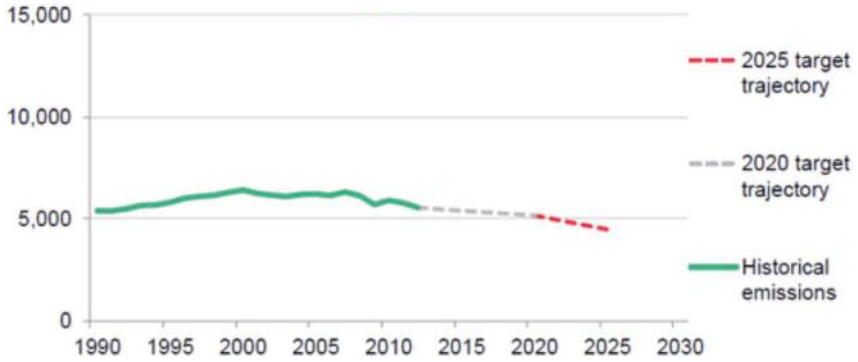
In summary[47]:

- United States:
  - Shift to gas.
  - Decline in coal.
  - Increase in wind and solar energies.
- European Union:
  - Major development of wind and solar energies (10% of electricity generation in the EU).
  - Slight drop in coal and significant decline of gas in the mix.
  - Slight drop in total production (1.85%).
- China:
  - Minor drop in coal in relative terms, but a large increase in absolute terms.
  - Increase in wind and hydroelectric energy.
  - Slight rise in natural gas.
  - Noticeable rise in total electricity generation.

47 These figures and their interpretation were presented by Teresa Ribera at the IESE Energy Industry Meeting in a fascinating talk on the 2015 Paris Summit and climate change. See articles and publications by the director of the IDDRI at http://www.iddri.org.

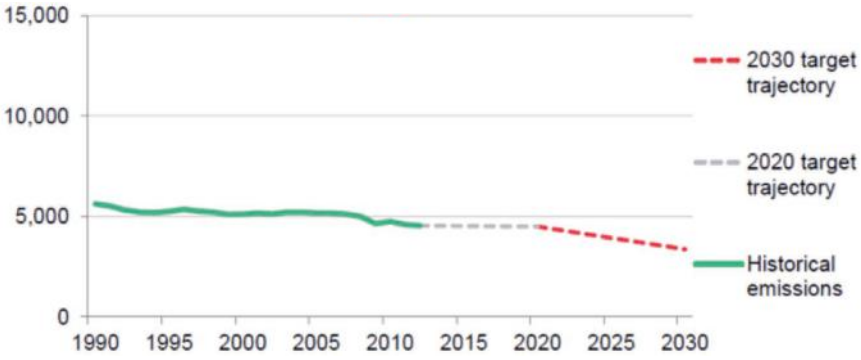
The analysis of recent years also provides a certain perspective on the emissions levels for the forthcoming decade. According to the pledges made by the United States, the EU and China for Paris 2015, their projected emissions for 2030 present the following evolution (in millions of tons of CO_2):

UNITED STATES



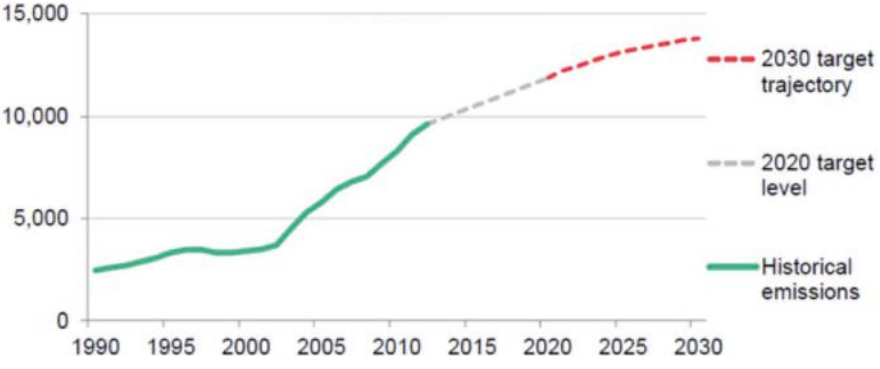
Source: Bloomberg New Energy Finance, UNFCCC

EUROPEAN UNION



Source: Bloomberg New Energy Finance, UNFCCC

CHINA



Source: Bloomberg New Energy Finance, UNFCCC

In the particular case of China, we should stress a fact that might be significant in the global debate on climate change: the rising concern with air quality in its main cities. Today, as seen in its energy mix, this Asian giant is a coal-intensive country and has acknowledged pollution and air quality problems in its megacities. The use of energy, especially coal, has tripled since 2000 due to the economic growth, the development of infrastructures and the urbanization process that has taken place over the past decade. This has led China to outstrip the EU in energy consumption in 2007, the United States in 2010 and all of North America in 2013. The authorities' acknowledgement and the change in tack are new factors which are translating not only into measures intended to improve the air quality conditions – the Chinese government recently published its Action Plan for controlling atmospheric pollution 2013–2017, which includes 10 measures to reduce pollution, many of which are related to the energy industry – but also into measures aimed at diversifying its energy mix in order to reduce its dependence on coal.[48]

All the same, as seen in the table below, the estimates in the WEO-2014 confirm that China will still be the country that consumes the most coal in the next few decades, followed by India.[49]

COAL DEMAND BY REGION IN THE NEW POLICIES SCENARIO (MTCE)

	1990	2012	2020	2025	2030	2035	2040	2012-2040	
								Delta	CAAGR*
OECD	1 543	1 457	1 378	1 264	1 105	992	931	- 526	-1.6%
Americas	701	656	647	588	505	468	450	- 206	-1.3%
United States	658	607	591	534	458	427	411	- 196	-1.4%
Europe	645	462	404	362	306	253	234	- 228	-2.4%
Asia Oceania	198	340	327	314	294	271	247	- 93	-1.1%
Japan	109	160	153	147	142	130	120	- 41	-1.0%
Non-OECD	1 643	4 084	4 637	4 869	5 098	5 283	5 424	1 340	1.0%
E. Europe/Eurasia	525	355	332	336	341	346	345	- 10	-0.1%
Russia	273	191	167	169	171	168	162	- 28	-0.6%
Asia	991	3 543	4 090	4 293	4 494	4 651	4 767	1 224	1.1%
China	762	2 824	3 134	3 174	3 191	3 149	3 033	209	0.3%
India	148	506	647	748	863	975	1 092	586	2.8%
Southeast Asia	18	127	210	258	310	381	474	347	4.8%
Middle East	1	4	6	6	7	7	7	3	1.8%
Africa	106	150	167	184	197	214	235	84	1.6%
South Africa	95	139	142	146	146	145	145	6	0.2%
Latin America	21	31	43	51	59	65	70	39	2.9%
Brazil	14	22	30	33	36	40	42	20	2.4%
World	3 186	5 541	6 015	6 133	6 203	6 275	6 354	813	0.5%
European Union	651	420	356	312	257	206	187	- 233	-2.9%

*Compound average annual growth rate

Source: *WEO-2014*, p. 184

48 For more information on the "Action Plan for controlling atmospheric pollution 2013–2017," launched by the Ministry of Environmental Protection, see: http://english.mep.gov.cn/News_service/infocus/201309/t20130924_260707.htm.

49 International Energy Agency, *World Energy Outlook 2014*, pp. 191–194.

From this vantage point, the major challenge of climate change will also be to get China, India and the other emerging countries to pledge to lower their emissions, since the growth in the world energy demand in the forthcoming years will come from these countries. Some benchmark institutions, from a pragmatic vantage point, claim that:

> "It could be necessary for the wealthier OECD economies to become pioneers in developing new technologies and lowering emissions in the next two decades, since it is not very realistic to expect the emerging economies that are experiencing the steepest growth (like China and India) to cut back their emissions levels, since they are more likely to do so at a later stage in their economic development process."[50]

The greatest challenge may be not only finding new technologies that make better use of the primary energy they consume but, even more importantly, making sure the technologies that have existed for some decades are actually put to use, such as combined cycle gas turbines (CCGT) and supercritical or ultra-supercritical coal power plants, since they are commercially viable for some of the countries that consume the most gas or coal. With these measures, we could lower emissions by around 50% due to the shift toward more efficient technology.[51]

50 Club Español de la Energía, PricewaterhouseCoopers (2007), *The World in 2050: Global growth and climate change policy. Implications of global growth for carbon emissions and climate change policy*, p. 10.
51 http://www.premiercoal.com.au/EnergyForOurFuture/Low_Emissions_Technology.aspx.

4. THE EUROPEAN UNION AND ITS ENERGY POLICY

As is well known, the EU's energy policy seeks to reduce energy dependence and ensure the security of the supply needed to improve social welfare and economic competitiveness, while also keeping up its fight against climate change and in favor of sustainability. The EU has pledged to reduce its emissions 40% by 2030 (with 2005 as the reference year) and to increase the proportion of renewable energies in the mix of the final energy demand and energy efficiency by 27%.

4.1 Leader in the Struggle Against Climate Change and the Impetus for Renewable Energies

Thus, one of the cornerstones determining European policy in recent years is the environment, which is reflected in its energy mix and the significant development of wind and solar energy. The threefold goal of the 20/20/20 for 2020 – 20% drop in CO_2, 20% rise in energy efficiency and 20% of the energy in the EU from renewable sources – as mentioned above, is framed within this scenario. The potential of renewable energies to achieve the EU's goals is analyzed in a variety of documents, such as the report titled "Renewable Energy Technology Roadmap: Up to 2020" published in 2007 by the European Renewable Energy Council.[52] The report shows how it would be possible to achieve 20% renewable energy consumption in 2020 based on a growth scenario for the different renewable energies. The results of the report show that renewable energies will be capable of producing between 33% and 40% of the electricity that Europe consumes in 2020, depending on the advances made in energy efficiency, along with 25% from the production of heat and 10% from biofuels.

52 This report is available at http://www.erec.org.

4.2 Recent Advances in the Energy Union

More recently, other reports have been published which have been reflected in the official documents on Europe's energy policy. Thus, "2030 climate and energy goals for a competitive, secure and low-carbon EU economy"[53] and "Roadmap 2050"[54] examine different ways of achieving the goals that have been set. The decarbonization of the energy system in Europe (reducing emissions through renewable energies, with 40%, 60% and 80% reduction goals) would be possible technologically, according to different studies which propose complementing renewable energies with nuclear fission and coal burning, including CO capture and sequester technologies. These analyses take into consideration solar energy from North Africa and a more important role for geothermal energy.[55]

Regarding the impetus of these environmental priorities, there are diverging opinions among those who believe that it should remain at the core of the energy policy and those who, conversely, argue that without denying the importance of the issue, other equally or more crucial issues should be prioritized, such as the development of connection infrastructures, industry and its competitiveness, the price differences among EU countries, the promotion of other non-conventional energy sources, the security of the supply and dependence on imports; in short, the full materialization of the internal energy market. In summary, a robust physical and institutional organization is needed to ensure these goals can be achieved.

There is no doubt that the EU is at a crucial juncture in the current energy context. In our 2014 summary of trends in the energy industry,[56] we highlighted this question and outlined some of its problems, pointing to disunion as a major challenge, due to the high costs that not only affect prices but also the competitiveness of many industrial sectors. This challenge has consequences in terms of security, supply and geopolitics.

Today, we cannot yet claim that the EU has a well-defined energy policy, but there is broad consensus regarding the need to step up the Europeanization of energy so that it unifies divergent (and even contradictory) national strategies and effectively manages to form a single market, along with national policies and regulations that are aligned with the goals that have been set. The challenge of achieving an internal market is still a crucial issue. Right now, simultaneously, we see consistent convergence in the different energy regulations, as well as divergence in the energy policies that are carried out. As such, a physical organization of Europe with more robust gas and electricity connection networks – though this is particularly urgent – will not suffice. Above all, there needs to be greater institutional organization.

53 See the press release, European Commission, Brussels, January 22, 2013, and all the documents on the 2030 plan at http://ec.europa.eu/clima/policies/2030/index_en.htm and http://europa.eu/rapid/press-release_IP-14-54_es.htm.

54 "Roadmap for moving to a low-carbon economy in 2050." Available online at: http://ec.europa.eu/clima/policies/roadmap/index_en.htm.

55 Technical analyses of this issue from expert institutions that have served as the foundation for the European Union's energy policies can be found at: http://europeanclimate.org.

56 Department of Industry Meetings, IESE Business School (2014), *IESE Energy Industry Trends Summary, 2014*, pp. 1–31.

Before the Lisbon Treaty entered into force, the founding treaties did not include provisions or break down specific competences in this area, even though energy issues lie at the very origin of what was then called the European Economic Community. Today, article 194 of the Treaty on the Functioning of the European Union does lay out a specific legal framework for energy-related issues, which states the following:

Article 194

"1. In the context of the establishment and functioning of the internal market and with regard for the need to preserve and improve the environment, Union policy on energy shall aim, in a spirit of solidarity between member states, to:

"(a) ensure the functioning of the energy market;

"(b) ensure security of energy supply in the Union;

"c) promote energy efficiency and energy saving and the development of new and renewable forms of energy; and

"(d) promote the interconnection of energy networks."

Therefore, energy is a competence that is shared between the EU and its member states according to article 4 of the Treaty on the Functioning of the European Union, and this means that the EU can legislate and adopt legally binding acts in this area, albeit subject to the principle of subsidiarity. In other words, the EU will intervene when its action is more effective than the actions of the member states separately, and it must justify its actions in this way.

Despite this legal provision and the stimulus coming from the European Commission, as well as from other EU institutions, in dealing with the issue of energy policies, the main obstacles in this realm are still the fragmentation of logistics infrastructures, regulatory division and the associated institutional fragmentation. We should also add that not all the member states are equally receptive, nor is energy a priority for all of them. We should recall that the EU is a regional organization made up of 28 states whose logic of negotiations and coalitions plays an important role, and that there is also disparity among the different members.

For example, the context in Spain[57] is quite different from that of other surrounding countries. Despite the fact that it has a balanced mix, its main weaknesses, until quite recently, have been the structural deficit of regulated activities in the electrical and gas sectors, as well as a lack of capacity in the electrical and gas connections. The lack of a clear, predictable regulatory framework is yet another of its major weaknesses – since this leads to a high rate of litigation due to a lack of trust – as well as an inconsistent framework for investments that require long-term stability. However, we should stress the positive corrective advances made since 2013 to remedy these weaknesses, with a considerable sacrifice by investors, customers and taxpayers.

57 *El País* (April 22, 2015), "La factura energética española se abarata un 34% en el arranque de año."

Still, the Energy Union needs to organize a single market and a common external energy policy.

Without a doubt, the conflict between Ukraine and Russia has served to drive the progress made in this area, since the dependence on Russian gas imports has made diversification a priority, and new agreements and gas pipelines have been promoted in order to facilitate energy imports from North Africa.[58] We should recall that the countries that show the best performance in the Global Energy Architecture Performance Index Report 2015[59] are those that have diversity in their energy mix and therefore diversity in their partners and imports. This entails mitigating the risks of an interruption in the supply due to geopolitical tensions or dependence on one country. In this sense, it is true that the surge in geopolitical tensions with Russia adds tension to the European energy order: the sanctions imposed by the United States and the EU based on the conflict in Ukraine[60] have major repercussions on investments and on exploration and prospecting projects. For example, in October 2014, Shell suspended its joint venture with Gazprom Neft. Furthermore, these sanctions also displace Russia's energy movements toward China.[61]

Beyond geopolitical tensions, there is a widespread consensus among analysts and the main think tanks and research centers in Europe[62] that the debate on the Energy Union and its external dimension must be based on the reality of an integrated, secure, interconnected, diversified and competitive European market that also takes advantage of economies of scale and location. In this sense, for example, some people defend the need for optimizing investments and subsidy policies for renewable energies in Europe in order to get the maximum performance from them, bearing in mind the climates of the individual countries, but based on a pan-European vision. For example, while Spain has 65% more solar radiation than Germany (1750 compared with 1050 kWh/m^2), Germany has 600% more installed solar capacity (33 GW compared with 5 GW).[63]

The construction of the internal energy market in the EU encompasses different projects. This includes the creation of a European gas and electricity network, which includes several interconnection projects, such as the Baltic and Mediterranean rings; the maritime wind network; the gas corridors in the west and southeast of the European Union; and the infrastructure of distribute liquefied natural gas. Some significant headway was made in this past year: the goal of 10% of interconnections for 2020[64] seems to be gaining wider acceptance.

58 For a more detailed analysis, see: A. Loskot-Strachota & G. Zachman (December 2014), "Rebalancing the EU-Russia-Ukraine Gas relationship," *Bruegel Policy Contribution*, Bruegel Policy Contribution, pp. 1–14.
59 World Economic Forum (December 2014), *Global Energy Architecture Performance Index Report 2015*, pp. 1–34.
60 *El País* (April 22, 2015), "La UE desafía a Rusia y abre una batalla legal contra Gazprom."
61 *QCM* (August 1, 2014), "Business as Continuation of Politics by Other Means: The Sino-Russian Gazprom Deal."

61 Real Instituto Elcano (http://www.realinstitutoelcano.org); Chatham House (http://www.chathamhouse.org); Bruegel (http://www.bruegel.org). In particular, the comments and opinions of some analysts: G. Zachmann (September 10, 2014), "Elements of Europe's Energy Union," Bruegel Policy Contributions, Bruegel; G. Escribano (November 2014), "¿Qué nos deparará 2015 en energía?" opinion, Real Instituto Elcano; G. Escribano (November 2014), "Unión de la Energía ¿con o sin interconexiones?" opinion, Real Instituto Elcano; G. Escribano (September 2014), "Una Unión Europea digna de tal nombre," opinion, Real Instituto Elcano.
63 World Economic Forum and Bain & Company (January 2015), *The Future of Electricity: Attracting Investment to Build Tomorrow's Electricity Sector*, p. 12.
64 Communication from the Commission on Achieving the 10% Electricity Interconnection Target – Making Europe's Electricity Grid Fit for 2020 – COM (2015) 82 dated February 25, 2015.

Some important steps in this direction include:

1. The new electrical connection line between Spain and France, opened on February 20, 2015, is a very positive step forward since it doubles the interconnection capacity between both countries to 2,800 MW. This line will start operating within the next few months.

2. The Energy Interconnections Summit held in Madrid on March 4, 2015, which was attended by Spain, France and Portugal, along with the president of the European Commission, Jean Claude Juncker, and the president of the European Investment Bank. At this summit, the memorandum called the "Madrid Declaration"[65] was signed, which recognized and agreed to the following priorities, among others:

   - A fully interconnected European network is one of the key preconditions to achieving the ultimate goal of the Energy Union, i.e., to ensure secure, affordable and sustainable energy, which is a key tool for reinforcing the competitiveness of European industry and therefore growth and job creation across the EU. Thus, it is a matter of urgency to build all the necessary energy infrastructures in order to achieve an efficient internal energy market, specifically cross-border interconnections of the electricity and gas networks.

   - The three governments also agree to set up a new regional High Level Group for South-West Europe on interconnections, which will be put in place by the European Commission. It will ensure regular monitoring of the progress of the projects and provide adequate technical assistance to the member states with a view to monitoring the definition of the exact routes between the selected start and ending points of the Pyrenees projects, thereby facilitating the EU's construction, presentation, selection and financing of Projects of Common Interest to attain the interconnections goals set for 2020.

   - The European Commission plans to prepare a comprehensive liquefied natural gas (LNG) strategy based on the need to diversify our gas supply, which also addresses geopolitical concerns. In this strategy, it is urgent that all the necessary energy infrastructures for energy security be built, regardless of whether those infrastructures fulfill transport, storage or import needs.

Logically, the construction of an Energy Union requires not only these agreements among the states but also a broad investment program.[66] In this regard, some factions recommend turning a "mountain of investments" into a veritable "industrial investment project"[67] in the field of energy which has a coherent, unified framework.

To conclude, the debate on climate change cannot be addressed or led by a single actor, given that it is a challenge everyone shares. In this regard, Paris 2015 should be a good forum for dialogue on climate and energy diplomacy and on a sustainable model for the forthcoming decades. The challenge is still relevant today, and we will observe and closely monitor the 2015 Paris Summit, a new international cooperation effort that will look to specify measures aimed at addressing climate challenges not only for the next five years, but for the next few decades.

65 Madrid Declaration, Energy Interconnections Summit, Spain-France-Portugal-European Commission-EIB. Madrid, March 4, 2015, at http://www.lamoncloa.gob.es/presidente/actividades/Documents/2015/DECLARACI%C3%93N%20DE%20MADRID%20esp%20FINAL.pdf.
66 C. Von Hirschahausen, et al. (July 2014), "European energy sector: Large investments required for sustainability and supply security," *DIW Economic Bulletin*, pp. 31–36.
67 M. Derdevet, (2015), *Énergie, l'Europe en Reseaux. Douze propositions pour une politique commune en matière d'infrastructures énergétiques*, La Documentation française, Paris, pp. 1–136.

5. TECHNOLOGY AS A FACTOR OF CHANGE

The geopolitics of oil, demographic trends and environmental challenges are compounded by the role of technology as a key factor in the energy transition. As mentioned above, projections on the evolution in energy consumption in the world, made with models based on different methodological approaches and on the data available, note that the primary energy resources needed to cover the expected growth in the demand already exist. However, at the same time, they warn that there are risks that can affect the supply, especially because of the difficulties in exploiting the new resources due to the higher extraction costs and the need to build new distribution infrastructures, among other reasons. In short, the root of this challenge lies in the technological development needed to deal with it.

However, all future forecasts and estimates are always based on one condition: they are planned based on today's knowledge and technological advances. However, in reality technology and its advances have always been transformative factors in the energy industry.

5.1 In the Short Term: Fracking and Renewable Energy Technologies

As discussed above, what we call the non-conventional revolution today is the sum of many factors: specific geological conditions in given geographic areas of the United States, social and environmental acceptance, and specific regulatory and labor frameworks. However, the most important of all is the technological factor, driven by the outstanding network of research universities and spurred by the incentives of the immense U.S. market, which has an industrial cluster that engages in technological innovation. Innovative developments have been needed in order to use non-conventional resources such as heavy and extra-heavy crude oil and tar sand, shale and schist, in order to address their impact on the environment. Hydraulic fracturing (fracking) in rocks and the extraction of shale oil and shale gas as non-conventional energy sources is a technological advance that has had major implications on the world energy scheme, despite the questions they pose regarding environmental risks. Indeed, this technological change and the advantages derived therefrom, especially in the United States, have signaled a change in the world balance of oil supply and demand as well as a shift in terms of the geopolitical power of OPEC and its member states, as discussed above.

On the other hand, as analyzed in the previous section, renewable energies will play a prominent role in the road to designing a new and more sustainable energy system. And in theory at least, they have the potential to cover part of the expected demand. The International Energy Agency's 2050 projections on the proportion of renewable energies in the energy mix stand at between 65% and 79%, while other sources show higher percentages;[68] in any event, they will become increasingly important.

In short, the rise, growth and capacity of renewable energies to cover an increasing proportion of the energy mix in the next few decades will depend on technological development, improvements and innovations.[69]

5.2 In the Medium-Long Term: Methane Gas Hydrates? Exploration of the Arctic? Competitive Medium-Scale Electricity Storage?

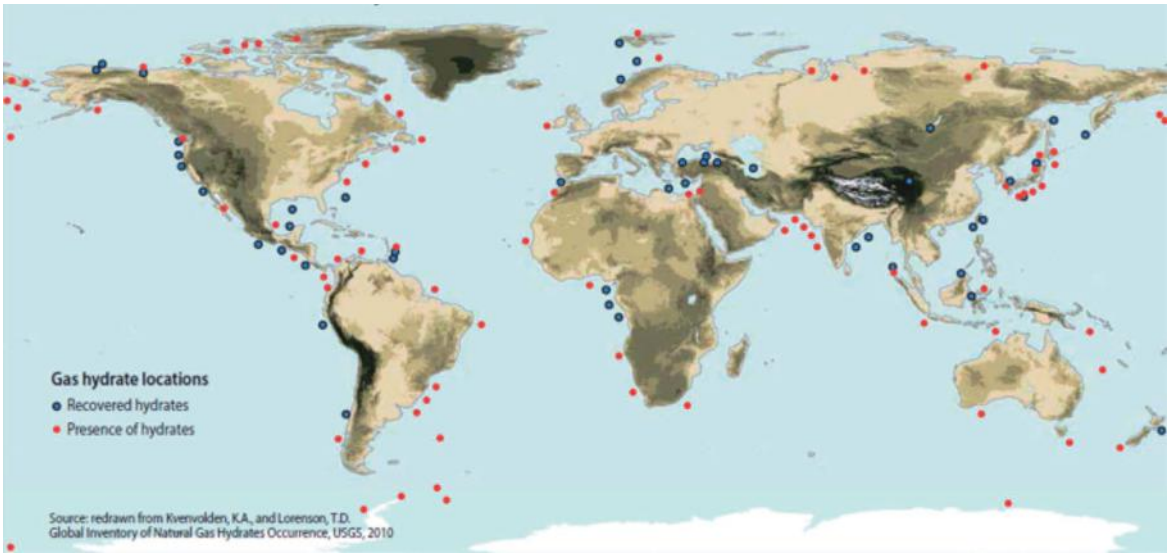
Once again, technology will be the crucial factor in answering some of the questions that are already being studied with an eye on the long term: Will methane gas hydrate reserves be the next great energy evolution? Does the Arctic harbor 20% of the world's crude oil?[70]

The United Nations Environment Program and the United States Geological Service, among other benchmark institutions, note that methane gas hydrate reserves (compact, frozen combinations of water and gas that are deposited on sea floors in their solid state) might surpass oil, natural gas and coal reserves combined.

Their location has been the subject of analysis for several decades. Some recent estimates indicate several locations in different geographic areas, as shown in the maps below, including Alaska, northern Canada, the Gulf of Mexico, Siberia and the coasts of Japan, in addition to other marine areas that are difficult to access, such as the Arctic and other polar regions.

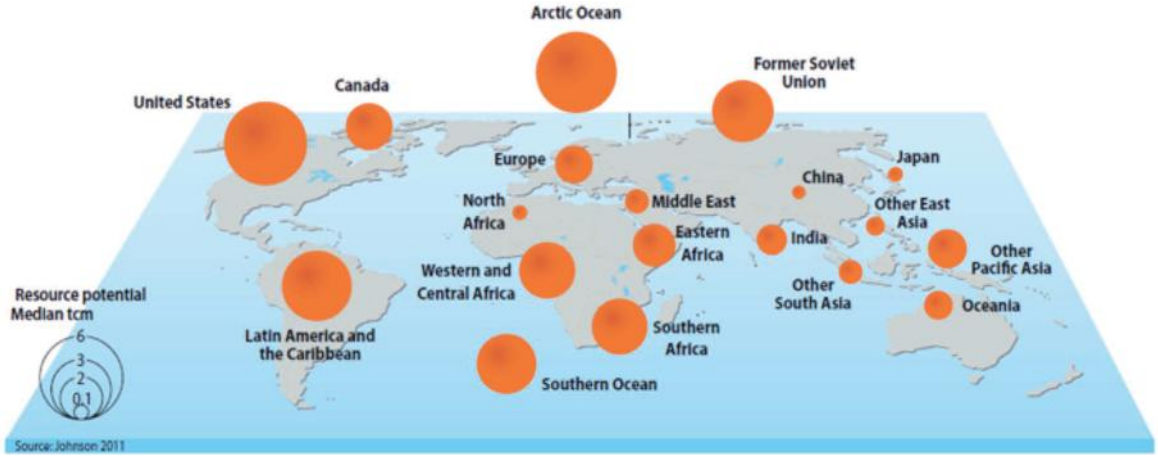
68 WWF, ECOFYS & AMO (2011), *Energy Report: 100% Renewable Energy by 2050*, pp. 1–252.
69 FECYT and OPTI (2011), Informe de prospectiva de energías renovables, pp. 1–104.
70 J. James Henderson (November 4, 2014), *The Prospects and Challenges for Arctic Oil Development*, Oxford Institute for Energy Studies, pp. 1–66. See also the recent news report: *El País* (April 22, 2015), "Gas del Ártico para España."

GLOBAL OCCURRENCES OF GAS HYDRATES



Source: United Nations Environment Program[71]

GAS HYDRATES RESOURCE POTENTIAL BY GLOBAL REGIONS



Source: United Nations Environment Program[72]

71 United Nations (2014), *Frozen Heat: A Global Outlook on Methane Gas Hydrates, Executive Summary*, United Nations Environment Program, pp. 1–29.

72 Ibid.

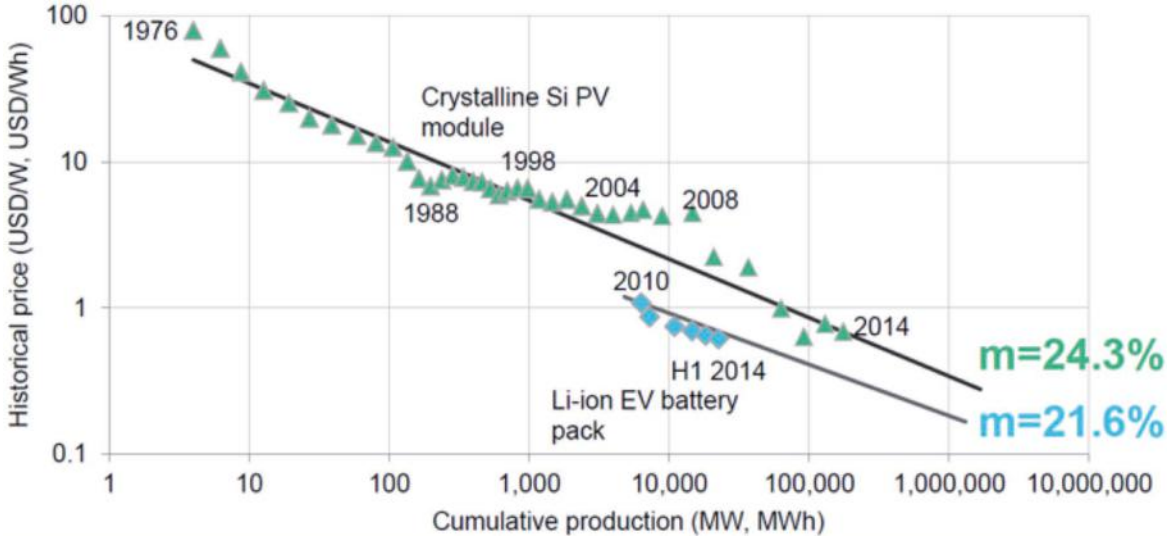
The challenges to be met before the new energy revolution can be declared include precisely the technical and technological difficulties: Do we currently have enough technology to extract methane from the gas hydrates in sediment?

The first difficulty lies in our ability to explore deep waters in order to confirm the reserves and amounts that exist. The second involves the extraction techniques and their environmental effects, since the technical combustion process and change in temperature may lead to variations in the ocean's temperature and to climate change (carbon dioxide is also given off in this process). Plus, the alteration of the sea floors must still be researched from a geological standpoint.

The third challenge consists of its short-term economic feasibility. Pilot exploration and extraction projects have been conducted to date, but the development of the infrastructures needed to exploit the entire potential of this new energy resource in order to make it marketable requires major investment.

On the other hand, we are witnessing an advance that might be revolutionary: competitive medium-scale electricity storage. This would profoundly change the traditional electricity business model. Without a doubt, some essential paradigms would shift if alternatives other than large-scale reversible hydroelectric power plants emerged; other than solutions not large enough in scale and yet extraordinarily expensive such as the ones that we use for mobile phones; or other than very low energy density storage solutions, such as the batteries we use in cars. In this sense, as illustrated by the graph below, we can notice advances that are insufficient right now but that somehow parallel the learning curve that we have successfully experienced with photovoltaic electricity.

LITHIUM-ION EV BATTERY EXPERIENCE CURVE COMPARED WITH SOLAR PV EXPERIENCE CURVE



Source: Bloomberg New Energy Finance, Maycock, Battery University, MIIT.

In conclusion, the future opportunities will emerge in seismic exploration technologies, techniques to exploit the beds in deep waters and the development of systems to boost the current energy retrieval factors through the injection of water, gas or other fluids. Likewise, opportunities will arise linked to the storage of electricity and in the realm of alternative energies for transportation, in addition to other issues that will require the launch of large-scale R&D projects with enough financing with the goal of gaining new knowledge and technologies that will allow all the energy sources to develop in a balanced fashion. To this end, the group of energy experts in the World Economic Forum has suggested creating a forum to develop a program (i.e., a partnership agenda among states for the innovation and development of energy-related technologies). This forum should include not only the current members of the International Energy Agency but also other countries with major investment and innovation projects in the field of energy, such as China, India and South Africa.[73] One recent example of how far we can go and what kind of projects can become the target of R&D partnerships in the energy industry is the joint research by India and Japan to research the existence and potential methane hydrate reserves in the Indian Ocean.[74]

73 World Economic Forum, *Global Agenda Council on Energy Security 2013*, pp. 1–5.
74 See at: http://www.ibef.org/news/india-japan-to-carry-out-gas-hydrate-survey.

6. THE CONSUMER: NEW ACTOR IN THE SYSTEM?

Technology as a catalyst is also spearheading changes in consumers' needs and demands, especially for electricity. Technology is providing consumers with new tools. One clear example is the control that each person can exert over their real energy consumption costs in their homes thanks to technology, along with many other available applications of intelligent measurement.

The electrical grid will be one of the most important transformations in the next few years.[75] According to estimates from the International Energy Agency, the demand for electricity will grow at an average annual rate of 2.1% until 2040, owing to the increasing need to cover the needs of digitalization, as well as electrical services related to urbanization processes, among the other global trends mentioned above.

Among the numerous debates related to the electrical system, there is one that may not be new but has been gaining increasing attention in recent years: self-consumption.

The concept of *self-consumption or distributed generation* refers to consumers' ability to install generating units to produce part or all of the energy they consume, even though they remain connected to the grid to ensure their supply. This is called self-consumption with a net balance that should be instantaneous. There are numerous reasons driving or motivating this trend.

6.1 Ideological Motivations

Self-consumption is related to an ideological approach that is broadly linked to ecological sensibility and electrical generation through renewable sources that are easy to install and economical; however, this is not its only conceptual affinity. Some people also associate the self-consumption trend to approaches that advocate individual self-sufficiency in many spheres, from food to energy. However, this does not solely occur on an individual scale; there are also self-consumption initiatives within communities and companies.[76] For example, companies like Apple are already supporting self-supply models using solar energy.[77]

The approaches encompassed in Rifkin's[78] vision of what this author calls the "third industrial revolution" are also closely related. This phrase is used to refer to a new "common, collaborative" economic scheme in which the marginal production costs in areas like technology, energy (especially renewable energies) and many other goods and services will drop to almost zero, and they will thus become abundant and almost free, prompting a widespread alteration in the market's current economic schemes. According to Rifkin, renewable energies, along with new technologies, will create new forms of stored and distributed electricity; hence, this energy self-sufficiency is related to the issue of self-consumption. This approach ignores the intensity of the capital costs of this kind of option, which have to be recovered regardless of the opportunity offered by extremely low operating costs.

75 For more comprehensive analyses, see: International Energy Agency, "Power sector outlook," in *World Energy Outlook 2014*, pp. 201–238; World Economic Forum and Bain & Company (January 2015), *The Future of Electricity. Attracting Investment to Build Tomorrow's Electricity Sector*, pp. 1–30.

76 For examples, see: Bloom Energy (http://www.bloomenergy.com) and First Solar (http://www.firstsolar.com), companies that already offer self-supply solutions through renewable energies.

77 See also, the news report published in *El País* on Apple's investment in a future self-supplied plant: http://economia.elpais.com/economia/2015/02/11/actualidad/1423640674_067563.html.

78 J. Rifkin (2014), *La sociedad de coste marginal cero: el Internet de las cosas, el procomún colaborativo y el eclipse del capitalismo*, Paidós Ibérica. J. Rifkin (2011), La tercera revolución industrial, Paidós Ibérica.

6.2 Economic Motivations

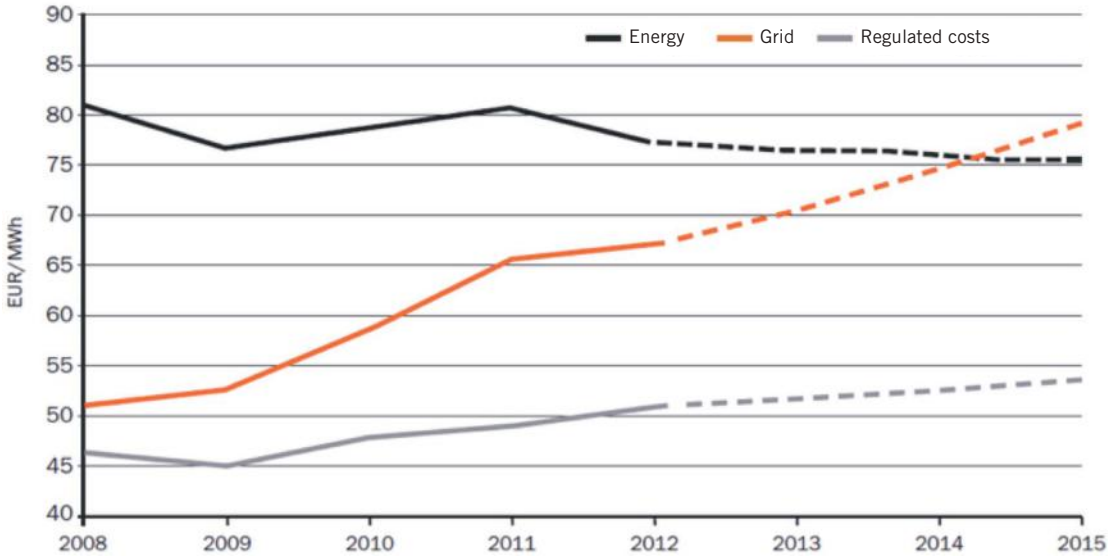
These ideological reasons are also joined by economic motivations. From the economic standpoint, a consumer will choose to produce their own energy when the cost of doing so is lower than the cost of purchasing it directly from the grid. With the current rate system, this is easy. Here we can glimpse one of the current problems of the electrical system in many countries, especially in Europe and in Spain in particular: the electric bill.

Today, consumers primarily pay for two things with their bill:

- The costs of buying energy incurred by the sellers in the wholesale market, and their margins.
- The access costs, also called regulated costs, which include the costs of the transportation and distribution systems (tolls) as well as other additional costs, such as industrial policies (waste, cogeneration, etc.), environmental policies (development of renewable energies), social policies (promotion of national coal) and economic policies (related to the deficit in the rate from previous years).

The graph below illustrates how energy costs have actually remained virtually steady over the past few years, while the remaining access or regulated costs have led to an increase in the rates that are ultimately paid by consumers.

INCLUDED COSTS IN THE FINAL RATES OF ELECTRICITY IN EUROPE



Source: Eurelectric[79]

79 In C. Navarro, & J. L. López Cardenete (February 17, 2015), "El 'consumidor generador': Implicaciones del autoconsumo en el sistema eléctrico," *Papeles FAES*, no. 178, pp. 1–26.

There is a fairly widespread consensus on the need to clarify and reorganize electrical rates so that all the costs unrelated to the supply are rechanneled to other sources of financing, through the general state budgets, for example. This would unquestionably contribute to putting an end to consumers' confusion as they end up not understanding exactly what they are paying for.

Eliminating these inefficiencies would truly help consumers make the decision on self-consumption in a more equitable way for the system, since self-consumption has consequences not only for the individual consumer but also for consumers as a whole. Energy has fixed costs that are still there, regardless of private consumption (i.e., variable costs). With distributed generation or self-consumption, consumers stop paying part of these fixed costs, although the other consumers will then pay them. Free-riders are not an equitable response, since everyone else ends up paying the fixed costs that self-consumers stop paying because of their self-consumption.

Still, self-consumption should not be perceived as an issue that runs counter to the system. Beyond the economic and ideological reasons that might exist in some cases, ultimately self-consumption is also a response to regulatory excess. And as such, it reflects the fact that a regulatory policy can explain how activities that are highly regulated find outlets in areas that are not so regulated.

On the other hand, consumers can also bring value, since they can consume responsibly and thus reduce the demand in peak times and improve the optimization of fixed costs in inframarginal power plants. In other words, they can also bring value to the energy market capacity and in the price of the energy market. Likewise, self-consumption has the obvious advantage of reducing losses in the grid and contributing to decreased CO_2 emissions.

In short, the goal is to lay out its advantages and disadvantages in a reasonable, equitable way for society as a whole, as well as to seek solutions so that the decision to choose self-consumption or conventional consumption is an efficient resolution from the standpoint of profitability, while ensuring that it is also equitable. To do so, an improvement in the current rate design might allow for greater transparency in terms of profitability and greater equity in the allocation of costs.

Nonetheless, the advent of new technologies and activities in the sector should be welcomed if their competitive advantages enrich society as a whole, setting aside the occasional or short-term advantages that might be found at any given time in the regulatory flaws in electricity and its associated taxation.

CONCLUSIONS

- The debate on energy revolves around its transition toward a more diversified, decarbonized model.

- This transition, however, should not solely be approached from the standpoint of the resources and the energy mix (old and new actors, like oil, gas, coal and renewable energies); instead, we can also talk about the transition in geopolitical terms, that is, as a shift in the key countries and institutions: from the OPEC countries to the leadership of the United States, or the roles of Europe and China, among other agents of world governance.

- Today, this transition draws from engines of change; that is, it draws from catalysts that are already determining the current energy agenda and its evolution in the forthcoming decades, and will continue to do so even more in the future. These engines of change can be identified as:

(1) The geopolitics of oil, current prices and, in the medium term, its reasons and changes on the world scene.

(2) Demographic and urbanization trends, as well as the challenges they bring: the rise in energy demand, access by more people to energy and the potential of some renewable energies (such as photovoltaic) in this process of demographic growth and human development.

(3) The environment and its associated challenges: the decisive 2015 Paris Summit, the advances in and focus on renewable energies, the commitment needed from all nations in a global challenge and the importance of efficiency.

(4) The technological advances that make new extraction techniques (such as fracking) possible and will make the extraction of new resources possible in the future (such as methane gas hydrates or exploration of the Arctic), as well as new electricity storage techniques.

(5) The prominence of consumers and their role as consumers and generators at the same time.

BIBLIOGRAPHY

Baffes, M.J. & Kose, A., & Ohnsorge, F. & Stocker, M., *The Great Plunge in Oil Prices: Causes, Consequences, and Policy Responses*, Policy Research Note, World Bank, 2015, pp. 1-60

International Energy Agency (2015), *Medium-Term Oil Market Report, Executive Summary*, pp. 1–7.

International Energy Agency (2014), *World Energy Outlook 2014*, pp. 1–711.

International Renewable Energy Agency (IRENA) (2015), *A World of Renewables*, pp. 1–68.

World Energy Council (October 2014), *Global Energy Transitions: A Comparative Analysis of Key Countries and Implications for the International Energy Debate*, p. 25.

Club Español de la Energía, PricewaterhouseCoopers (2007), *The World in 2050: Global growth and climate change policy. Implications of global growth for carbon emissions and climate change policy*, pp. 1–56.

Derdevet, M. (2015), *Énergie, l'Europe en Reseaux. Douze propositions pour une politique commune en matière d'infrastructures énergétiques*, La documentation Française, Paris, pp. 1–136.

Escribano, G. (November 2014), "¿Qué nos deparará 2015 en energía?" opinion, Real Instituto Elcano.

Escribano, G. (November 2014), "Unión de la Energía ¿con o sin interconexiones?" opinion, Real Instituto Elcano.

Escribano, G. (October 2014), "¡Son los saudíes, Europa!" opinion, Real Instituto Elcano, pp. 1–5.

Escribano, G. (September 2014), "Una Unión Europea digna de tal nombre," opinion, Real Instituto Elcano.

FECYT and OPTI (2011), *Informe de prospectiva de energías renovables*, pp. 1–104.

World Economic Forum and Bain & Company (January 2015), *The Future of Electricity. Attracting Investment to Build Tomorrow's Electricity Sector*, pp. 1–30.

World Economic Forum (December 2014), *Global Energy Architecture Performance Index Report 2015*, pp. 1–34.

World Economic Forum (2013), *Energy Vision 2013: Energy Transitions: Past and Future*, pp. 1–48.

World Economic Forum (2013), *Global Agenda Council on Energy Security 2013*, pp. 1–5.

Intergovernmental Panel on Climate Change (IPCC) (2014), *Climate Change 2014, Fifth Assessment Report, Synthesis Report*, 2014, pp. 1–138.

Intergovernmental Panel on Climate Change (IPCC) (2014), *Climate Change 2014: Impacts, Adaptation and Vulnerability. Part A: Global and Sectoral Aspects*, pp. 1–1150.

Intergovernmental Panel on Climate Change (IPCC) (2014), *Climate Change 2014: Mitigation of Climate Change. Part B: Regional Aspects*, pp. 1–696.

Intergovernmental Panel on Climate Change (IPCC) (2013), *Climate Change 2013: The Physical Science Basis*, pp. 1–1552.

Haites, E., F. Yamin, & N. Höhne, (October 2013), "Possible Elements of a 2015 Legal Agreement on Climate Change," IDDRI Working Paper, no. 16/13, pp. 1–24.

IESE Business School (2014), *Energy Industry Trends Summary 2014*, pp. 1–31.

James Henderson, J. (November 4, 2014), *The Prospects and Challenges for Arctic Oil Development*, Oxford Institute for Energy Studies, pp. 1–66.

Linares Hurtado, J. I., B. Moratilla Soria (2007), *El hidrógeno y la Energía: Análisis de situación y prospectiva de nuevas tecnologías energéticas*, Universidad Pontificia Comillas, pp. 1–183.

Loskot-Strachota, A. & G. Zachman (December 2014), *Rebalancing the EU-Russia-Ukraine Gas relationship, Bruegel Policy Contribution*, Bruegel Policy Contribution, pp. 1–14.

Navarro, C., & J. L. López Cardenete, (February, 17 2015), "El 'consumidor generador': implicaciones del autoconsumo en el sistema eléctrico," *Papeles FAES*, no. 178, pp. 1–26.

United Nations (2014), *World Population Prospects The 2012 Revision*, Department of Economic and Social Affairs, Population Division, New York.

United Nations (2014), *World Urbanization Prospects* (2014): The 2014 *Revision, Highlights*, Department of Economic and Social Affairs, Population Division, New York.

United Nations (2014), *Frozen Heat: A Global Outlook on Methane Gas Hydrates, Executive Summary*, United Nations Environment Program, pp. 1–29.

OECD (2012), OECD, *Environmental Outlook to 2050: The Consequences of Inaction. Highlights*, pp. 1–12.

Rifkin, J. (2014), *La sociedad de coste marginal cero: el Internet de las cosas, el procomún colaborativo y el eclipse del capitalismo*, Paidós Ibérica.

Rifkin, J. (2011), *La tercera revolución industrial*, Paidós Ibérica.

Stevens, P. (August 2012), "The 'Shale Gas Revolution': Developments and Changes," *Briefing Paper*, Chatham House, pp. 1–12.

The Economist (February 21, 2015), "The Saudi Project, part two," pp. 1–3.

The Economist (January 17–23, 2015), "Seize the day: How falling oil prices and new technology offer a chance to transform energy policy."

The Economist (January 17, 2015), "Let there be light," special report, pp. 1–7.

The Economist (November 15, 2014), "The Pacific Age," special report, pp. 1–9.

The Economist Intelligence Unit (2014), "The business of cheaper oil," pp. 1–29.

Vives, X. (2014), "Energía y cambio climático," *Comentarios de coyuntura económica*, December, IESE Business School.

Von Hirschahausen, C., et al. (July 2014), "European Energy Sector: Large investments required for sustainability and supply security," *DIW Economic Bulletin*, pp. 31–36.

WWF, ECOFYS & AMO (2011), *Energy Report: 100% Renewable Energy by 2050*, pp. 1–252.

Zachmann, G. (September 10, 2014), "Elements of Europe's Energy Union," *Bruegel Policy Contributions*, Bruegela.

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12TH ENERGY INDUSTRY MEETING

Agenda

February 11, 2015

Introduction: Global Vision

- Prof. Juan Luis López Cardenete, Academic Director of the Meeting, IESE
- Jesús Navarro, Partner, Deloitte España, and co-organizer

Speaker: José María Marín Quemada, President, National Commission for Markets and Competition (CNMC)

United States, Europe and China Faced with Paris 2015: Responsibilities, costs and achievements

Moderator: Pedro Antonio Merino, Director of Environmental Studies and Analysis, REPSOL
Speaker: Teresa Ribera, Director, IDDRI (Institute of Sustainable Development and International Relations, Sciences Po, Paris)
Panel:

- Rafael Mateo, CEO, Acciona Energía
- José Miguel Villarig, President, APPA

Is the Current Status Quo a Future Option? Europe Faced with a "To Be or Not to Be"

Moderator: Claudio Aranzadi, Former Minister of Industry and Energy
Speaker: Prof. Gonzalo Escribano, Director of the Energy Program, Real Instituto Elcano
Panel:

- José Folgado, President, Red Eléctrica de España
- José Luis López de Silanes, President, CLH
- Marcelino Oreja, CEO, Enagás

The Paradigm of Consumers: Everything By and for Them… But with Them?

Moderator: Alberto Amores, Partner, Strategy Consulting Energy & Resources, Deloitte España
Speaker: Dr. David Robinson, Economics Consultant and Chief Researcher, Oxford Institute for Energy Studies
Panel:

- Julio Castro, General Manager of Regulation, Grupo Iberdrola
- Pedro Larrea, Executive President, FerroAtlántica
- Ignacio Soneira, General Manager, AXPO Iberia

Oil & Gas: The Impact of a Non-Conventional Revolution

Moderator: Mamen Gómez de Barreda, General Manager, CORES
Speaker: Jorge Piñón, Interim Director, Austin Center for International Energy and Environmental Policy, University of Texas
Panel:
•Luis Aires, Executive President, BP Spain and Portugal
• Luis Cabra, General Manager E&P, Repsol
• Luis Travesedo, General Manager E&P, CEPSA

The Future Energy Model: End of an Era? Turning Point in the Shape of the Industry?

Moderator: Jesús Navarro, Partner, Deloitte España
Speaker: Prof. Pedro Rivero, member of the advisory board, Cuadernos de Energía journal; Professor of Financial Economics and Business Accounting, Universidad Complutense de Madrid
Panel:
• José Bogas, CEO, Endesa
• Miguel Stilwell, CEO, EDP
• Rafael Villaseca, CEO, Gas Natural Fenosa

Closing Ceremony

• The Honorable José Manuel Soria, Minister of Industry, Energy and Tourism

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CEO,
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The Honorable José Manuel Soria
Minister of Industry, Energy and
Tourism,
Spanish Government

Miguel Stilwell
CEO,
EDP

QUOTATIONS

T

THE CLIMATE IS NOT ONLY A TECHNICAL ISSUE FOR EXPERTS BUT AN ECONOMIC ISSUE INVOLVING GLOBAL SECURITY, DEVELOPMENT AND SUSTAINABILITY.

Teresa Ribera,
Director of the Institute of Sustainable Development and International Relations, Sciences Po

T

THE CONFUSION COMES FROM ALL THE SEALS WE HAVE TO STICK TO THE BILL WHICH DO NOT CORRESPOND TO EITHER THE SERVICES OR THE SUPPLY. JUST REORGANIZING THE BILLS AND GROUPING THEM INTO THREE CATEGORIES WOULD HELP.

Julio Castro,
General Manager of Regulation, Grupo Iberdrola

W

WHO SETS THE RULES OF THE GAME? INNOVATION. FRACKING HAS SHIFTED CERTAIN PARADIGMS IN THE INDUSTRY, AND THAT IS ESSENTIALLY WHAT INNOVATION IS.

José Luis López de Silanes,
President, CHL

T

THERE HAS BEEN A LEARNING AND INNOVATION CURVE IN THE UNITED STATES THAT WOULD BE DIFFICULT TO REPLICATE IN OTHER MARKETS AND COUNTRIES.

Luis Cabra,
General Manager E&P, Repsol

A

AT $50, EVERYONE LOSES. THE NON-CONVENTIONALS LOSE. RUSSIA AND VENEZUELA LOSE. EVEN SAUDI ARABIA LOSES. A PRICE UNDER $50 IS NOT A BALANCED PRICE. A PRICE FROM $100–$120 ISN'T BALANCED EITHER.

Luis Aires,
Executive President, BP Spain and Portugal

N

NO ENERGY IS CLEANER OR MORE COMPETITIVE THAN THE KIND THAT IS NOT WASTED.

Juan Luis López Cardenete,
Academic Director of the Encounter, IESE Business School

T

THE RULES OF THE GAME ARE DICTATED FIRST BY THE BEST AVAILABLE TECHNOLOGY, SECONDLY BY CITIZENS AND THIRDLY BY CAPITAL.

Rafael Mateo,
CEO, Acciona Energía

T

THERE IS AN ENERGY TRANSITION IN GEOPOLITICAL TERMS AS WELL. THERE IS A HORIZONTAL TRANSITION.

Prof. Gonzalo Escribano,
Director of the Energy Program, Real Instituto Elcano

T

THERE HAD NEVER BEEN SO MUCH STORAGE CAPACITY TO EXTEND OVERPRODUCTION AS MUCH AS IS HAPPENING TODAY.

Luis Travesedo,
General Manager, E&P, CEPSA

T

THE NEXT NON-CONVENTIONAL REVOLUTION WILL BE METHANE GAS HYDRATES.

Jorge Piñón,
Interim Director, Austin Center for International Energy and Environmental Policy, University of Texas

S

SPAIN COULD BE A GOOD GAS PLATFORM FOR EUROPE.

Marcelino Oreja,
CEO, Enagás

I

IS IT POSSIBLE TO IMAGINE A EUROPEAN BODY THAT ESTABLISHES A MECHANISM OF GOVERNANCE IN THE FIELD OF ENERGY?

Claudio Aranzadi,
Former Minister of Industry and Energy

T

THE EUROPEAN ENERGY MARKET NEEDS OBJECTIVES, INTERCONNECTIONS AND REGULATION.

José Folgado,
President, Red Eléctrica de España

R

REGULATORY STABILITY IS GREAT, BUT REGULATORY TRANSPARENCY IS MORE IMPORTANT.

Luis Atienza,
Former President, Red Eléctrica de España

E

ESTABLISHING A DIRECT RELATIONSHIP BETWEEN THE RATE DEFICIT AND PREMIUMS ON RENEWABLE ENERGIES IS NOT SUSTAINABLE.

José Miguel Villarig,
President, APPA

W

WE HAVE TO SPEED UP THE UNIFICATION OF NATIONAL AND EUROPEAN REGULATIONS.

Prof. Pedro Rivero,
member of the advisory board, Cuadernos de Energía journal; Professor of Financial Economics and Business Accounting, Universidad Complutense de Madrid

T

TECHNOLOGY EMPOWERS THE CONSUMER.

Dr. David Robinson,
Economics Consultant and Chief Researcher, Oxford Institute for Energy Studies

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