IMPACTS OF THE 2008 FINANCIAL CRISIS AND THE 2011 EUROZONE CRISIS ON INVESTMENTS IN RENEWABLE ENERGY

IMPACTOS DA CRISE FINANCEIRA DE 2008 E DA CRISE DA EUROZONA EM 2011 NOS INVESTIMENTOS EM ENERGIA RENOVÁVEIS

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Abstract: This paper aims to discuss how the international financial crisis of 2008 has impacted on the investments in renewable energy for electricity production in the world. It analyzes how renewable energy can be considered a strategic and important investment in power generation, highlighting its connection to energy security and environment challenges, the need and potential of investments in the sector; then, it discusses how the crisis of 2008 has affected investments in renewable energy in the world, followed by the Eurozone crisis in 2011. It can be seen that we can characterize the financial crisis of 2008 as an important intervening variable when analyzing investments between 2004 and the second quarter of 2015, considering the Eurozone crisis of 2011 related to the previous one. The qualitative research was based on IRENA (International Renewable Energy Agency) and BNEF (Bloomberg New Energy Finance) data, between 2004-2015, and the qualitative research was developed in a systematic analytical review of specialized literature, highlighting the greater stimulation of investments in the global clean energy market where emerging economies (especially China) compensate, even partially, the slowdown of investments in developed countries.

Key-Words: Energy Security. Investments. Political Economy.

Resumo: O presente artigo busca discutir como a crise financeira internacional de 2008 impactou os investimentos em energia renovável para a produção de energia elétrica no mundo. Analisa-se como a energia renovável pode ser considerada politicamente estratégica e importante investimento na geração de energia, destacando sua conexão com a segurança energética e os desafios ambientais, a necessidade e potencial de investimentos no setor; Em seguida, discute-se como a crise financeira de 2008, seguida pela crise na Eurozona em 2011 afetaram os investimentos em energia renovável. Percebe-se que podemos categorizar a crise de 2008 como uma importante variável interveniente quando analisados os investimentos entre 2004 e o segundo trimestre de 2015, e considerando a crise na Eurozona relacionada à primeira. A pesquisa quantitativa foi feita com base em dados fornecidos da IRENA (International Renewable Energy Agency) e do BNEF (Bloomberg New Energy Finance), entre 2004-2015, e qualitativamente, por uma revisão sistemática analítica da literatura especializada, destacado um maior estímulo dos investimentos no mercado global de energia limpa onde economias emergentes (como a China) compensam, ainda que parcialmente, a redução dos investimentos em países desenvolvidos.

Palavras-chave: Segurança Energética. Investimentos. Economia Política.

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Initial considerations

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Energy is an indispensable resource for the development of countries (from the mere notion of economic growth to broader forms of understanding "development", as human development): a country that does not have secure access to energy is hardly able to produce goods, provide services, even guarantee basic conditions for the welfare of its population.

During the twentieth century, debates related to politics, economy and energy had much of its scope taken by discussions related to fossil fuels, and focusing, according to Hancock and Vivoda (2014, p. 206), on issues related to oil, including the Organization of the Petroleum Exporting Countries (OPEC), the "resource curse", oil companies and the rich countries' domestic policies. Still, with the Cold War and the emergence of new international actors, it was noticed the resurgence of a new area for the analysis of the relationship between politics, economy and energy, which was driven by growth in demand from emerging economies (HUGHES & LIPSCY, 2013), making room for the need to stimulate diversification of the energy matrix of countries, increasing investments in non-fossil energy mix, especially in renewable and clean energy.

Growth in investment in renewable energy registered record annual growth since the beginning of the century, until the financial crisis of 2008 broke this cycle, later followed by the crisis in the Eurozone in 2011.

The purpose of this paper is to discuss how the world financial crisis that erupted in the second half of 2008 impacted the investments in renewable energy (for electricity production) in the world, followed by the crisis in the Eurozone in 2011. This paper is subdivided as follows: Initially, it will be analyzed how renewable energy can be considered a strategic and important investment in the energy sector – especially for electricity production, highlighting its relationship to energy security; then, it will be discussed the impact of contemporary global financial crisis on investments in clean energy in the world, divided into two stages: the first, the post-crisis drop in investments in 2008, and the second, the measures for the recovery of investments and the subsequent crisis in the Eurozone in 2011 and its consequences. At the end of it, it will be preliminarily highlighted the investment indices reaction difference in developed countries and in developing countries, especially China. Methodologically, the quantitative research was based on data provided by IRENA (International Renewable Energy Agency) and BNEF (Bloomberg New Energy Finance), between 2004 and 2015, and qualitatively, an analytical systematic review of specialized literature was done.

1. Renewable energy as an important element in the energy sector

Energy is an indispensable resource for the functioning of economies, being necessary to the production of goods and the supply of all services (MARTINS, 2013, p. 1). One of the important features of the current energy system, born with the Industrial Revolution of the eighteenth century,

is the importance of fossil fuels in the energy matrix of the countries that initiated the process of economic development. First coal and then oil (especially after World War II) were important fuels for the generation of heat and electricity, a situation that still prevails (JANNUZZI, 2014, p. 1).

The first wave of publications relating politics and energy took place during the decades of 1970-1980 and focused on the responses of governments to oil crisis: the crisis of 1973, during the Yom Kippur War and the 1979 crisis, resulting from political crisis in Iran. In the early 1980s it was already predicted that in the twenty-first century, the control of energy resources would result in serious risks involving national security (OMENA, SOUZA and SOARES, 2013, p. 84).

Until the mid-1970s, the need for energy matrix change had the sole developmental purpose of achieving growth at any cost, even if at that time the United Nations Conference on the Human Environment (Stockholm, 1972) had first warned about the consequences of human intervention on nature. The environmental issue became more visible from the late 1980s with the release of the report Our Common Future, and early 1990s, with the achievement of UNCED - United Nations Conference on Environment and Development held in Rio de Janeiro, 1992 (OMENA, SOUZA and SOARES, 2013, p. 84-85), taking advantage of the new flexibility in the international agenda after the end of the Cold War.

Since the 1970s, three components started playing most relevant role in the development of the energy sector: a) technological progress, enabling even more efficient conversion of renewable primary sources of fuels and electricity; b) major changes in energy policies considering social-environmental impacts and global climate change; and c) the concept of energy security highlighting local alternative energy production. These factors enable the advancement of alternative technologies and policy instruments gradually interact to conventional generation systems, distribution and energy use based largely on fossil fuels (JANNUZZI, 2014, p. 1). These characteristics became more evident after the decade of 1990. The recurring debate surrounding the depletion of fossil fuel reserves and environmental effects arising from their use reflects the importance of research related to new energy sources on a global scale (OMENA, SOUZA and SOARES , 2013, p. 79).

Renewable energy is energy derived from natural processes that are or may be constantly replenished (SCHOLTEN & BOSMAN, 2013, p 12). It also refers to energy generated from natural resources at sustainable levels that can come from non-fossil energy sources (BJORK et al., 2011, p. 12), and its refueling is done by natural processes in a rate either equal or higher than their use (GREENPEACE, 2013).

The sustainable energy is the one that maintains a balanced cycle of production and consumption, because it is spent in such quantity and speed that can be replenished by nature itself. The idea of clean energy is associated with pollution capacity resulting from its use: It is one that

does not pollute or that pollutes less than traditional mix (generally fossil fuels). The energy sources considered renewable in this paper are hydropower, solar energy, wind energy, geothermal energy, tidal energy and bio-fuels, which are sources indicated by the Climate Change Intergovernmental Panel as renewable (GREENPEACE, 2013, p. 23).

Criekemans (2011, p. 4) suggests renewable energy has stepped in recent years as a result of a combination of factors and trends: first, past decades have clearly shown that burning non-renewable fossil fuels leads to CO2 emissions, depletion of resources, local environmental degradation and climate change; second, the entry of two billion people in the global economy, especially in Asia, structurally impacts the demand for energy, and as a result, the shorten of (conventional) energy could turn into reality in upcoming decades. All these elements put pressure on decision-makers to new choices in the direction of using more renewable forms of energy.

The market also affects these processes: the price of fossil sources of energy can increase in a short period of time and create a market volatility. As a result, renewable energy becomes more economically interesting compared to other forms of energy (CRIEKEMANS 2011, p. 4).

1.1 Renewable Energy and Energy Security

In the twentieth century, from the perspective of international security, it was clear to most of the great powers that, without the control of infrastructure resources and modern energy technologies, a State could not defend the attack from an external enemy; on the other hand, energy is also closely linked to the capitalist logic of the international system (without energy there is no trade, no job creation, no consumption and welfare is threatened). For short, energy concerns the own structure of society and the maintenance of political order, becoming a key element for understanding the competition in the International System (OLIVEIRA, 2012, p. 19).

The high dependence on fossil energy sources, its location and the disparities in global consumption make these resources strategic and generate widespread insecurity. The global energy supply does not keep pace with increasing demand, resulting in higher prices, making the economies vulnerable in a scenario of political and economic instability in all continents (MARTINS, 2013, p. 1). The relationship between climate change, national security and energy dependence pushed energy security to the top of the agenda of policy makers, international organizations and companies (OMENA SOUZA and SOARES, 2013, p. 85).

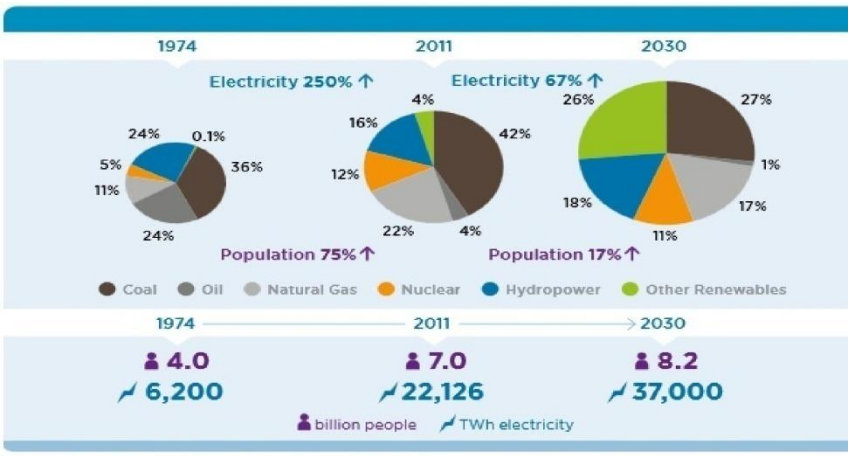
This current energy model raises concerns about the supply of oil and gas, creating uncertainty about the ability to respond to increasing demand driven by developing countries such as China and India. On the other hand, the supply of oil and gas is provided by countries located in unstable regions and may create uncertainty for importing countries (MARTINS, 2013, p. 1).

Energy security is a multidimensional concept and may involve defining political and military issues, technical, economic, and so forth. Part of the difficulty in defining energy security seems to be that energy itself is also a multifaceted and politicized concept (SOVACOOL, 2011, p. 1). Ciuta (2010, p. 132) lists energy security to the security of energy supply, demand safety, energy infrastructure, energy with focus on the environment. It is at the top of the agendas of both States and international organizations, as well as non-governmental organizations, and yet, it has received little conceptual attention (although the literature is abundant, where meanings of the term proliferate). The International Energy Agency defines power supply as "safe" if it is appropriate, affordable and reliable (ÖLZ, SIMS and KIRCHNER, 2007, p. 13). In contemporary international debates, the energy issue has been dealt from multiple views: geopolitical, military, economic, or commercial.

Security of energy supply is a major challenge faced by both developed and developing countries. The risks include: the failure of an electricity infrastructure system to meet the growing demand (there may be technical problems such as blackouts); the threat of an attack on energy production facilities, transmission and distribution networks and pipelines; or global constraints resulting from oil supply policy actions (market instabilities). The extreme volatility of oil and gas markets can present a safety hazard. Overall, the scenario is complex: in many circumstances diversify supply and increase internal capacity to use local energy sources to meet future growth of energy demand can make positive contributions to energy security (ÖLZ, SIMS and KIRCHNER, 2007, p. 7-13).

Figure 1 shows the estimated population growth and participation of different energy matrix for the production of electricity for the year 2030, according to the International Renewable Energy Agency - IRENA (2014), in perspective with 1974 and 2011 data:

Figure 1. Electricity generation and population growth (IRENA, 2014).



Source: World Bank (2014), IEA (2014a), IRENA (2014a)

We can see that between 1974 and 2011, the total population of the world increased by 75%, while electricity production was increased by 250%. In 1974, coal, oil and natural gas were together responsible for 71% of electricity generation, and in 2011 accounted for 68% and the estimate for 2030 is 45% of the total. The biggest changes are in the group of renewable energy: while in 1974 renewables accounted for only 0.1% of electricity generation in the world (outside hydroelectricity, which represented 24%) in 2011 it accounted for 4% (excluding hydroelectricity, which corresponded to 16%) and it is estimated to represent 26% of total electricity generation. This estimate of increased use of renewable resources for energy generation follows a perception that with the population growth, the fossil fuels, which are finite, could not match the demand, especially in developing countries.

A few years ago, the global concern about energy policy, in general terms, was restricted to the changes of the barrel of oil prices. Today, it is considered a strategic issue on the agenda of priorities of governments: the change of perspective of energy investments reflects, to a large extent, the relevance of the theme (BRANCO and KHAIR, 2010, p. 42). In this sense, it is clear that to reduce dependence on fossil matrix for energy production, to expand the use of renewable energy electricity production source can increase the perception of energy security.

The demand for energy has considerably increased from emerging countries, which, to enable the development of their economies, must show growing dependence on current oil reserves (BRANCO and KHAIR, 2010, p. 42).

The growing mobilization towards the change of the energy matrix has been motivated by two aspects, now considered strategic (OMENA, SOUZA and SOARES, 2013, p 85): first, is the dependence on imported energy resources by some nations; second, the need to reduce greenhouse gas emissions (GHGs).

Regarding the need to reduce greenhouse gases in the atmosphere, the environmental variable has apparently ensured its place in the search for renewable energy sources, however, this

has not been the main stimulus for the transition of matrix: the energy dependence, political instability in oil producing countries and the fear of new rises of oil prices, as occurred in 1973 during the Arab-Israeli war and in 1979 during the political revolution in Iran, representing threat to flow of energy markets: political and economic variables, continue to exert greater influence than climate change (OMENA, SOUZA and SOARES, 2013, p. 88). This is the scenario that stimulates the transition from fossil to renewable fuels, increasing in the investments (public and private) in the sector.

1.2 The need and investment potential in renewable energy

In the twenty-first century nations have ahead the challenge of designing energy autonomy strategies based on sustainable systems, so they can build more competitive economies and less exposed to geopolitical turmoil, considering that conflicts and tensions in some major regions represent a short-term risk in the supply of energy, as well as obstacles to investments in the sector (OMENA, SOUZA and SOARES, 2013, p. 90).

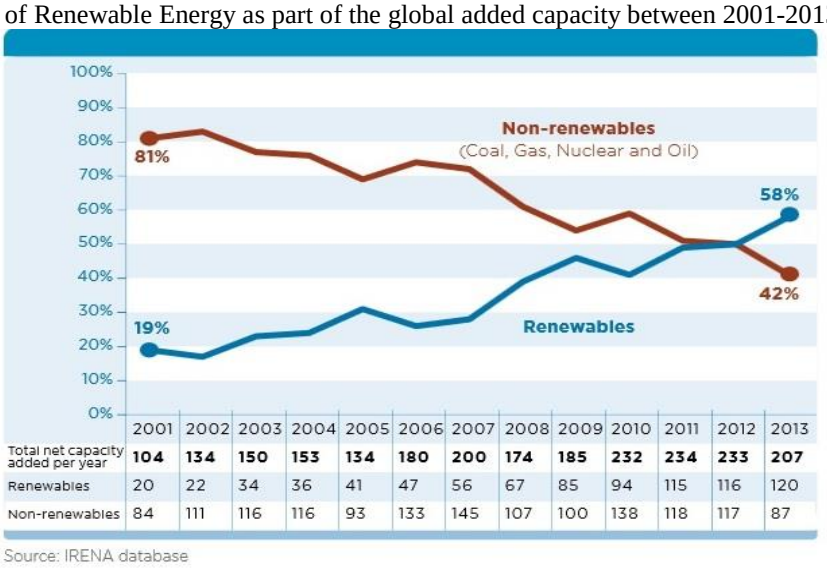
We consider that it is up to each State to facilitate, to invest and to promote the use of renewable energy, which should be increasingly considered in the energy policies of each country for its economic benefits and also to ensure the energy security of both developed and developing countries. However, in the current international stage, there are many variations in renewable energy development levels, some countries with relatively sophisticated levels of renewable energy development, while others show little progress (KINNER, 2010, p. 1).

Kinner (2010, p. 3) notes that the greatest barriers to the development of renewable energy is the lack of facilitative and regulatory frameworks policies, which are often domestic matters, especially in developing countries. There is a variety of obstacles including costs, infrastructure, incentives and policies that can act as barriers between the developing countries and renewable energy (KINNER, 2010, p. 5), and such barriers may be technical, educational, cultural and economic, depending on each case. Despite the barriers, the prospect is that in the global scenario, investments in renewable energy will considerably increase each year, both by public and private sector.

According to Justice (2009, p. 23), investments in renewable energy can be well suited to the business of banks' financial activity, pension funds, private equity and venture capital, as financial institutions operate on a risk basis and return, evaluating each potential opportunity of any investment possibility, including renewable energy. The increase in investments in this sector (since the beginning of the twenty-first century) suggests this has been a major attracting sector for both public and private investments.

By observing Figure 2, we can see that between the power capacity added from 2001 to 2013 there is a drop in the total share of investment in non-renewable energy (coal, natural gas, nuclear energy and oil) when comparing to investments in renewable energy, and there is a significant shift in the end of 2012: in 2013, new investments in renewable energy reached 58%, while new investments in non-renewable energy reached 42% of the total.

Figure 2: Share of Renewable Energy as part of the global added capacity between 2001-2013 (IRENA, 2014).



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Total net capacity added per year	**104**	**134**	**150**	**153**	**134**	**180**	**200**	**174**	**185**	**232**	**234**	**233**	**207**
Renewables	20	22	34	36	41	47	56	67	85	94	115	116	120
Non-renewables	84	111	116	116	93	133	145	107	100	138	118	117	87

Source: IRENA database

When comparing the share of renewable energy as new added overall capacity, with the participation of the new capabilities added in non-renewable energy, we realize this new scenario in total investments: nowadays the added amount of renewable energy per year exceeds the investments in new power capacity of fossil matrix. What matters now is to maintain an appropriate environment so that this ratio will continue to increase in favor of renewables.

For investments in the renewable energy sector, there needs to be clear policies to generate economic projects that attract the private capital. Political and regulatory conditions remain central to ensure long-term stability to revenues and operation: it is imperative that both regulation and policies are clear, long-term and legally guaranteed to increase investment in renewable energy. Renewable energy projects in markets and developing countries face additional challenges such as unstable political regimes, currency volatility or lack of infrastructure (JUSTICE, 2009, p. 23).

Justice (2009, p 21-22) also points out that in emerging markets or developing countries, some additional issues should be considered: the stability and maturity of the political system; the legal, regulatory, tax and business; local currency (investments in local currency may be subject to currency fluctuations, devaluations or instability in domestic monetary policy); energy and infrastructure market (lenders and investors should be aware of the differences in the markets, lack of infrastructure, needs of technologies, networks and renewable energy projects). All these aspects

must be considered, including the analysis of the costs of construction and operation of projects (JUSTICE, 2009, p. 22). In emerging markets, public funding can be a very effective way to make possible the renewable energy projects, particularly given the highest risk level, normally associated with developing markets.

Forward, it will be shown how 2008 and 2011 crisis negatively impacted the investments in renewable energy (in this case, specifically clean energy), and the role of developing countries, particularly China, in the total amount of investments.

2.The impact of the global financial crisis of 2008 and the Eurozone crisis of 2011 in the investments in renewable energy

After the records in the global growth of the renewable energy sector after 2004, in the end of 2008, the impacts of the financial crisis began to appear, particularly in the loan flow from banks to renewable energy developers (UNEP, 2009 p. 1).

The 2008 financial crisis was the largest since the 1929 crisis (BRESSER-PEREIRA, 2009, p. 133), and began, according to Farhi et al. (2009, p. 135), in mid-2007, after the explosion speculative real estate bubble of high risk (*subprime*) in the US, acquiring such proportions that eventually turned, after the bankruptcy of Lehman Brothers investment bank in September 2008, into a systemic crisis.

To Farhi et al. (2009, p. 135), the unfolding of the crisis has questioned the international financial architecture, to the extent that it exposed the limitations of basic principles of the regulatory system and current banking and financial supervision, and questioned the survival of a specific financial institutions. Cano (2009, p 607) highlights two dimensions of the crisis: the real side and the financial, being the latter, its trigger.

Given the heightened deregulation of the international and most of domestic financial system imposed by the Washington Consensus and some of the rules of the Basel Accords, it is systemic and hit major banks and international financial intermediaries (CANO, 2009, p. 607). Cano (2009) notes the nature of the 2008 crisis is more complex than the previous ones: its outbreak was manifested by financial side, only after reaching the real economy (consumption, investment, trade).

The other crisis considered in this paper, the crisis in the Eurozone in 2011, is certainly not isolated from the financial crisis of 2008. Manzi (2013, p. 77) explains that initially the outbreak of the financial crisis in the euro area, starting at the bankruptcy of US investment bank Lehman Brothers in 2008, had its roots in the growing interdependence of financial markets in the United States and Europe. However, for the author (MANZI, 2013), the deepening of the crisis in the euro area was due to the existence of economic imbalances that have built up since the introduction of

the euro in 1999 and, from 2009, those economic imbalances have become a crisis of the sovereign debt of national governments.

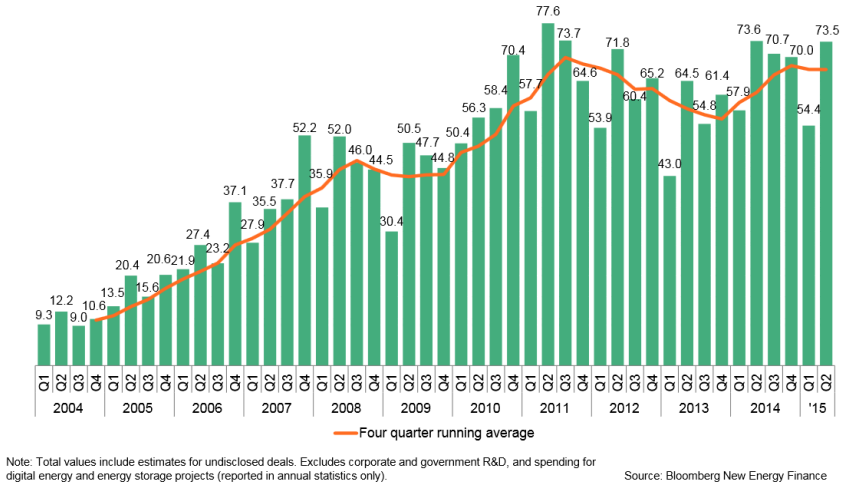
Secches (2013, p. 20) points out that it was expected that to join the monetary union, Member States fulfilled the convergence criteria for the control of public debt, monitoring the public deficit growth, stability of the exchange rate of its national currency, low inflation and interest rates. Rushed for winning a stronger currency, the block, according to the author (SECCHES, 2013) turned a blind eye: countries like Italy, Greece, Spain and Portugal did not meet the required profile, but adopted the euro. The lack of convergence in a reality where the monetary instruments of macroeconomic intervention are supranacionalized and fiscal autonomy persists, prevents more efficient responses to the impacts of the global crisis, which started with the collapse of Lehman Brothers. The collapse of international liquidity in 2008 precipitated an almost immediate contagion among euro countries and the European Union markets with which they maintain a close relationship (SECCHES, 2013, p. 21).

Manzi (2013, p. 12) states that the concern with the possible reproduction of what happened the day after the bankruptcy of Lehman Brothers, European banks restricted their daily lending operations to other financial institutions, leading to higher interest rates on interbank markets in Europe and threatening the stability of the international financial system.

Hermann (2009, p 138) considers that each financial crisis marks the end of an economic cycle of growth and debt: in modern capitalism, which has sophisticated financial systems and where investments that underpin growth assume increasing proportions, to the challenges of competition on an international scale, there is no economic growth without increasing debt – although the reverse is not always confirmed. In the case of the 2008 crisis and 2011 Eurozone crisis, we cannot say that those crises are unrelated, but being the second crisis, despite its own characteristics, one of the possible "side effects" of the first one. The investment reductions in renewable/clean energy in the years following the initial milestones of the two crises are directly related to the crisis in financial markets.

The global financial system is highly complex and, with the 2008 crisis and the crisis in the Eurozone, became politically sensitive. Markets were averse to risk (more than ever). Meanwhile, renewable energy markets in general, were still relatively young and "floating" with a wide range of technologies and sub-sectors at different stages of maturity and with different financing needs (IRENA, 2012, p. 14). Figure 3 shows the average of new investments in clean energy in the world from the first quarter of 2004 (Q1) to the second quarter of 2015 (Q2):

Figure 3: New investment in clean energy in the world from 2004 to the second quarter of 2015 (in billions of dollars) (BNEF, 2015).



Note: Total values include estimates for undisclosed deals. Excludes corporate and government R&D, and spending for digital energy and energy storage projects (reported in annual statistics only).

Source: Bloomberg New Energy Finance

After a sequence of growth, the first decline in investments was noticed during the 2008 crisis, and began to recover in the last quarter of 2009, leveraging a recovery until the second quarter of 2011, when we once more notice a continuous and even stronger decline, due to the crisis in the Eurozone by the end of 2013. Next, it will be highlighted the direct impact of each crisis in investments in renewable/clean energy.

2.1 First moment: drop in investments in renewable energy with the 2008 crisis

With the 2008 crisis, access to finance became more difficult and expensive, and the renewable energy sector, which was managing to resist since 2007 credit crisis, especially because of high oil prices in the period, strongly felt the impact of the crisis from the end of 2008, with the sharp limitation of financing (UNEP, 2009, p. 4).

Sophie Justice (2009, p 17) points out that the financial crisis of 2008 significantly restricted the lending capacity of banks (both to other banks and to external borrowers): the impact of credit (volume, cost and duration) hit many sectors in the economy, including renewable energy, which caused many projects to be postponed until market conditions improved.

The impact on credit and capital (banks and investors) was diverse in different institutions: for banks, liquidity (money available for loans) was reduced, and many investors waited for the improvement of market conditions, the bureaucracy for lending grew up, the cost of borrowing increased substantially, the reduce of loan payment periods, and some banks turned to domestic markets (especially in countries where the government injected capital or stimulated conditions of national activity) (JUSTICE, 2009, p . 17-19).

On the other hand, investors have become reluctant to invest or to make acquisitions, some companies were forced to sell assets or either stop or delay projects because they could not have access to capital to develop their activities, some investors were asked to justify their risk

investments during the peak of the market (before October 2008), the shares and the capitalization of some renewable energy companies fell, some investors and pension funds could have an investment limit in renewable energy in the infrastructure investment amount, and in this case, the investment in non-renewable energy is increased, whereas the investments in renewable energy is reduced (JUSTICE, 2009, p. 17-19).

Geels (2013, p. 1) states that the first years of the crisis (2008-2010) created a window of opportunity for positive solutions (the resumption of investments in renewables from 2009 was a symptom), but from 2010 to 2011 this window seemed to shrink with the crisis negatively influencing sustainable transitions. For Geels (2013, p. 24), the effect of the crisis on the public attention was mostly negative, leading to a drop in interest in the discussion on climate change and sustainability.

The effects on finance were initially positive, because the speach of "green growth" resulted in more sustainable stimulus programs, but this positive aspect seemed to come to an end with the austerity programs of the countries in crisis, especially in the Eurozone and still in the United States, and recent declines in most other investment categories. Overall, still according to Geels (2013, p. 35) the problem is not the lack of resources for investment in renewable energy, but the lack of investor confidence, which still needs to be evaluated in the long run.

2.2. Second moment: measures for the recovery of investments in renewable energy and crisis in the Eurozone in 2011

Justice (2009, p. 19-20), when analyzing potential measures to boost the recovery of investments in renewable energy during the crisis, identified different approaches used by both financial institutions and government stimulus packages to improve access for renewable energy finance.

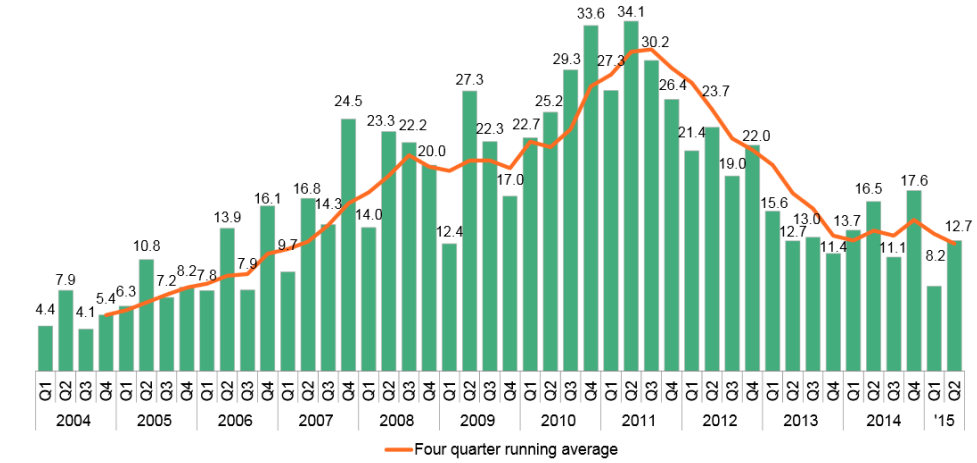
On the financial side, the idea, according to the author (JUSTICE, 2009), was to reduce risks and, thus, financing costs (through the implementation of structural financing solutions, as loan guarantees from government institutions), and seek alternative sources of funds, including public sources of finance, facilitating the conditions of the banking sector (including government grants, facilitations for government loans to keep the investment in infrastructure, which may or may not include renewable energy, and the considerable increase in the involvement of government financial institutions such as the European Investment Bank and multilateral financial institutions. Private investment (pension funds and institutions, mainly) have been identified, in post-crisis moment, as a major potential source of new funds for the renewable energy sector (JUSTICE, 2009, p. 19-20).

After resumption of growth of investments in renewable energy from 2009 in 2012, there was another sharp drop in new investments in the world. One of the reasons of the new drop in investments in 2012 was the crisis in the Eurozone in 2011 (IRENA, 2012, p. 17), restricting credit

for the entire planet. Uncertainties regarding the incentive policies for the industry in Europe and even in the United States (still in recovery) fell about 12% in 2012.

Figure 4 highlights new investments data in clean energy in Europe from 2004 to the second quarter of 2015. It is important to notice that the post-crisis drop in the Eurozone in 2011 was even more intense than the 2008 post-crisis (especially when we consider the average investment per year, as outlined by the orange line).

Figure 4: New investment in clean energy in Europe from 2004 to the second quarter of 2015 (in billions of dollars) (BNEF, 2015).

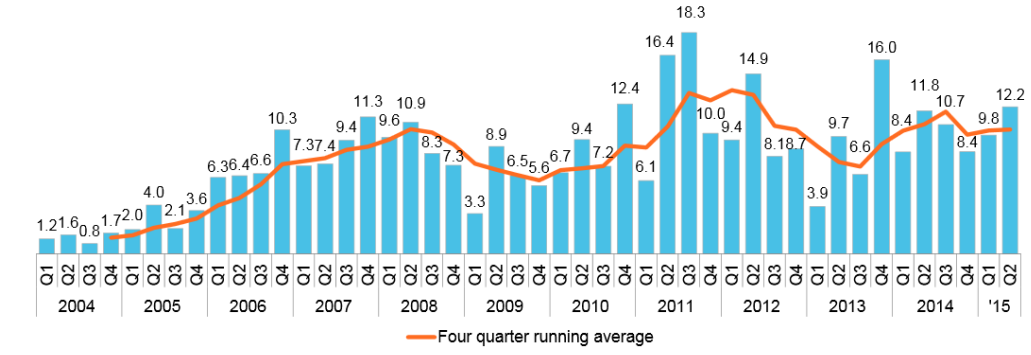


Note: Total values include estimates for undisclosed deals. Excludes corporate and government R&D, and spending for digital energy and energy storage projects (reported in annual statistics only).

Source: Bloomberg New Energy Finance

Although the total volume of investments in renewable energy is lower than the one in Europe, in the United States, the downward trend was similar from the end of 2011, with the difference that from 2013 on, the signs of recovery have apparently been better. For comparative purposes, please consider Figure 4 in combination with Figure 5.

Figure 5: New investment in clean energy in the United States from 2004 to the second quarter of 2015 (in billions of dollars) (BNEF, 2015).



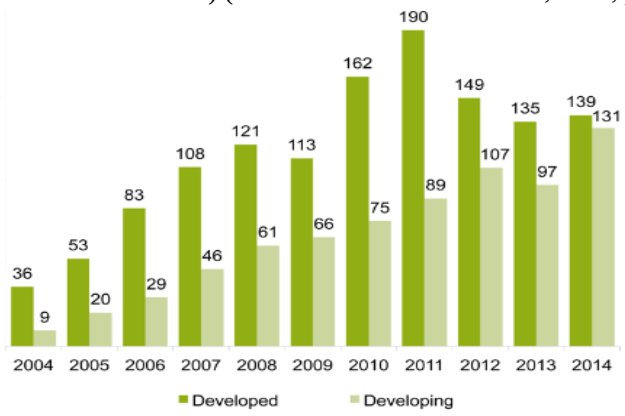
Note: Total values include estimates for undisclosed deals. Excludes corporate and government R&D, and spending for digital energy and energy storage projects (reported in annual statistics only).

Source: Bloomberg New Energy Finance

When we checked the total new investment in clean energy in the world (Figure 3), we can clearly see a fall after the crisis of 2008 and after the crisis in the Eurozone in 2011, but with seemingly less sudden drops than when only Europe is observed (figure 4) or even when we observe the United States alone (figure 5). One reason that has helped to hold the levels of investment in clean energy in the world (or at least preventing from a sharp fall) is the role of developing countries, and in this particular case, China.

The sharply lower prices for solar and wind technology also exerted pressure on investment volumes, although allowed higher levels of facility installation per dollar. The decline between 2011 and 2012 was felt among developed countries (from $ 190bi to $ 149bi, falling further in 2013, stabilizing at $ 135bi). Among developing countries, the rise of investments in renewable energy remained strong between 2011 ($ 89bi) and 2012 ($ 107bi), with a small reduction in 2013 ($ 97bi), but returning to its growth in 2014 ($ 131bi) when for the first time, almost matched investments with developed countries ($ 139bi). See Figure 6:

Figure 6: New global investments in renewable energy - developed countries versus developing countries - 2004-2014 (in billions of dollars) (FRANKFURT/UNEP/BNEF, 2015, p. 16).

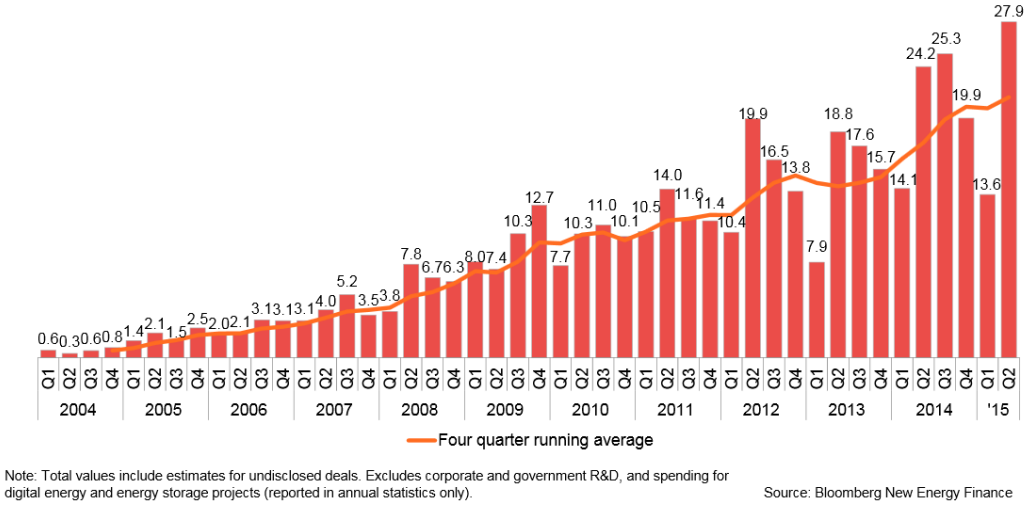


New investment volume adjusts for re-invested equity. Total values include estimates for undisclosed deals. Developed volumes are based on OECD countries excluding Mexico, Chile, and Turkey.
Source: UNEP, Bloomberg New Energy Finance

According to Bloomberg New Energy Finance (2013), the highlight was the US $ 67.7 billion record investment in China, a 20% increase over the previous year, thanks to the boom in solar energy, and the total was more than 50% above the United States' investments (other significant performances were those of South Africa and Japan, with the new emphasis on renewable energy, boosted after the Fukushima nuclear disaster).

Figure 7 shows the new investments in clean energy in China, during the same period of the previous one. Although in some quarters the total value of investments has fallen, the overall average (orange line) shows a continuous growth in investment flows.

Figure 7: New investment in clean energy in China from 2004 to the second quarter of 2015 (in billions of dollars) (BNEF, 2015).



Note: Total values include estimates for undisclosed deals. Excludes corporate and government R&D, and spending for digital energy and energy storage projects (reported in annual statistics only).

Source: Bloomberg New Energy Finance

Since 2009, investments in clean energy in China have already surpassed investments in the United States, and from the second quarter of 2013, investments in China are higher than investments in Europe (see Figure 7 combined with figures 5 and 4).

For the International Renewable Energy Agency (IRENA, 2012, p. 16), developing countries with growing economies face the need of new energy capacities and, in many cases, have great potential for renewable energy production, such as strong winds, extensive sunlight, geothermal reserves, resources for biomass etc.

The global financial crisis of 2008, followed by the crisis in the Eurozone in 2011 tightened credit around the globe. Financing conditions became more difficult in most countries; governments have become more reluctant to take measures to increase energy prices. The major developing countries made heavy use of public banks for renewable energy financing (74% of banks in India, at least 69% in China and 45% in Brazil) (IRENA, 2012, p. 17).

Renewable energy investors in developing countries include governments, banks, capital companies (*equity firms*), insurance companies, pension funds, industry, clean energy companies, project developers (*startups*). In some developing countries, like India and Brazil, there is a growing "appetite" for investment in renewable energy, particularly from pension funds and insurance companies. As a result of the financial crisis, public institutions played an especially critical role in providing capital that would be otherwise unavailable in the private sources (IRENA, 2012, p. 17).

While on the one hand, investment fell quickly and sharply (North American and European markets), on the other hand, data points to an investment growth in developing countries (China, mainly). Geels (2013, p. 1) distinguishes four views on the impact of the financial and economic

crisis on sustainable transitions. The first three visions highlight the possibility of positive impacts of the crisis on sustainable transitions and joint solutions: a) a transformation of the capitalist system; b) a "green" industrial revolution; c) a "green growth". The fourth vision perceives the impact of the crisis as particularly negative, as the crisis undermines public visions, corporate policies and environmental problems.

There is still much to be evaluated so that we can know the real impact of periods of instability, whether in energy security, whether in investment in renewables, but we can indicate that it is important to follow the new investments in renewable energy not only in a global perspective, but with attention to the participation of each market, either in developed or developing countries.

Final considerations

The recurrent debate surrounding the depletion of fossil fuel reserves and environmental effects arising from their use reflects the importance of research and investments related to new energy sources on a global scale, especially renewable energy.

Several factors and trends confirm the need for investment in the sector: on the environment side, CO2 emissions, depletion of resources, local environmental degradation and climate change; on the social, political and economic side, the entry of two billion people in the global economy, especially in Asia, structurally impacts the demand for energy, and as a result, the shortage of energy (conventional) could turn into reality in upcoming decades. The markets also influence these processes: the price of fossil energy sources can increase in a short period of time and create market volatility. As a result, renewable energy starts to become more interesting compared to other forms of energy.

All these elements put pressure on decision-makers to new choices in the direction of using more renewable forms of energy, making room in the market for investment, both public and private, in this sector, which has broad growth prospect in the upcoming years.

After the global growth of the renewable energy sector has continuously beaten its own records after 2004, in the end of 2008, the impacts of the financial crisis began to appear, particularly in the loan flow from banks to renewable energy developers. The investment began to recover in the last quarter of 2009, leveraging growth until the second quarter of 2011, when we note again a continuous fall even stronger, due to the crisis in the Eurozone by the end of 2013.

We can characterize the crisis of 2008 an important intervening variable when analyzing the investments in renewable energy in the world between 2004 and the second quarter of 2015, considering the crisis of 2011 related to the previous one.

When we check the total new investment in clean energy in the world, we can clearly see that the fall after the 2008 crisis and the Eurozone crisis in 2011 were apparently less abrupt than when we observe by the isolated data from Europe and from the United States. One reason that the total investment in clean energy in the world has not fallen so sharply is the role of developing countries, and in this particular case, the role of China.

We believe that we may be facing a change in the nature of the global market for clean energy, with emerging economies (especially China) compensating, even partially, the slowdown of investments in mature markets (Europe and America) caused by economic and political uncertainty. There is no way of knowing whether this trend will continue, especially as we do not know if China will escape the economic and financial crisis, and we do not know what the next years will bring for emerging economies (especially in the case of Brazil, currently facing a huge economic crisis).

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