

Indeed, the problem is quite complex...

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FQXi's 2014 Essay Contest, How should humanity steer the future?

I. THE SCOPE

How should humanity steer the future? What is the best state that humanity can realistically achieve? The answer to these questions are indeed quite complex. Basically, because it is not in the hands of only one person, organization or country to decide the fate of the world. Taking a look back at our history, we know, however, that a single historical event can change the course of humanity; World War II is such a clear example of this. Today the world population has reached 7.2 billion people. Statisticians believe that by 2050 this figure will raise up to 9.5 billion and possibly will reach 12 billion by the end of the century.¹ If today's situation is complicated for most people, how will it be when the world population reaches these figures? Of course, statisticians assume that no global events such as world wars or catastrophes will interfere with the global trends. Thus, to avoid unrealistic scenarios in this work, we will not extend our discussion beyond this century.

II. THE PLAYERS

A. Economy a respectable player

The history of mankind teaches us that wealthiness and poverty have been part of human evolution. Unfortunately, it appears that this disparity will continue to exist; wealthy and poor countries, and developed and undeveloped countries will not cease to exist at least for the rest of this century. From among the 7.2 billion people living on this planet, some few, around 0.9%, are the wealthiest in the world and posses around 39% of the global wealth.² Without a doubt, these people have the economic power to influence the course of the world in certain directions. If we analyze the economy from the perspective of the gross domestic product (GDP), according to the International Monetary Fund and The World Bank, USA and China lead the GDP for 2012 with US\$ 16 billion and US\$ 8 billion, respectively. They are followed by Japan, Germany, France, United Kingdom, Brazil, Rusia, Italy, India and Canada. It is revelant to mention the case of China in comparison to USA. This will give us a feeling of China's economical growth and power. Accordig to the World Bank, in 1980, China occupied the 12 position with a GDP of US\$ 0.189 billion, whereas the USA had a GNP of US\$ 2.862 billion. Ten years later, China increased it to US\$ 0.356 billion and reached the tenth position, whereas the USA made US\$ 5.979 billion. China and USA both doubled their figures in ten years. By 2000, China increased it to US\$ 1.198 billion, reaching the sixth position and the USA almost doubled it to US\$ 10.289 billion. The prediction is that by 2020 China will make US\$ 14 billion and the USA US\$ 22 billion, whereas the rest of the countries will lag behind below US\$ 6 billion. Perhaps, by 2050 China will surpass the USA. What is important to point out is China's ambition for economical growth that has been present for at least the last three decades.

Although we understand that economy plays a crucial role in the world affairs, we also recognize that humanity is not only moved by economy... culture, politics, religion, science and technology shape our world as well. Next I shall discuss how some of these factors impact society. Due to the lack of space, I shall briefly analyze the present status of humanity and, based on this analysis, I will envisage what would be the best state we can achieve. Finally, I propose some solutions and suggest what we should do once problems are solved.

B. The struggle for supremacy and hegemony

In their struggle for hegemony and supremacy, powers have fought against each other for the sake of pursuing and defending their ideals and interests. The struggle still continues until these days and it is not clear when it will end.³ During the first decades of the XX century, the URSS, the USA, Germany, France and England were among the leading actors in the world scenario. After World War II, however, only the URSS and the USA remained as the main players. For our surprise, in 1989, the URSS collapsed. Since then, Americans thought that they would be the only superpower on Earth. This joy, however, did not last more than a decade for the world is so dynamic

and new players always emerge. A new serious rival raised from the ashes of WWII at the end of the millennium. According to economical analysts and political scientists, China is raising its global influence at an unprecedented pace. To counterbalance NATO's power, in 2001, the Shanghai Cooperation Organization (SCO) was founded by six members: China, Kazakhstan, Kyrgyzstan, Russia, Tajikistan, and Uzbekistan. This huge economical, political and military block concentrates around 50% of the global energetic resources and a market of around 1.7 billion people. Not satisfied, in 2009, Brazil, Russia, India, China and South Africa (BRICS) surprised the world celebrating the first BRICS summit in Russia. This new economical, cultural and political block sums about 3 billion people and a combined nominal GDP of US\$ 16 billion.⁴ Despite this, the USA and their NATO allies still dominate the world economy and their political prominence is felt all over the world. Experts think, however, that the balance may change in the following two or three decades. Some even think that we may be on the verge of World War III.⁵ Whether this occurs or not in the following decades would greatly depend on whether the USA and China, as the leading powers, wish to work together for a better world. Concurrently, we have not found signs that this would happen since some economical and military conflicts have already taken place between these countries and their economical and political interests appear to be divergent. According to heartland theory,⁶ wars are part of human nature and in most cases, unfortunately, unavoidable. Fortunately, this has not occurred yet and we shall assume that no world war will occur at least for the next decades. There is an important factor that perhaps experts have not considered in their calculations. The fertility rate is declining and the grow rate of global population is also decreasing.

C. World population by 2050

It is already known that the global fertility rate is declining. About fifty years ago the average number of children per family were 5 and today is 2.5. In the following 50 years the average number will continue to drop. If this trend persists by the middle of the century we would have two scenarios: i) The world population will remain constant and stable for some time or ii) the world population will continue to decline for some time. It is hard to tell how much time is "some time". It could be a few years, decades or even centuries. Given past history, it is not probable that the fertility rate remains constant for many decades. So, we will consider that for a couple of decades the global population remains steady and then starts to slightly drop after 2050 (see Fig. 1). We believe that this is the most probable scenario because we assume that the world will observe the same trend as Europe.

The population in Europe remained nearly constant for three decades (1950-1990) and then started to drop from 1990 to present. According to statisticians, in order for a developed society to maintain the population constant, families should have an average of 2.1 children (in developing countries ranges from 2.5 to 3.3). This does not occur in Europe since 1990 when the number of children per family became approximately 1.6. As a result, the population decreases. We assume that this could be the case for the global population in the next 50 years.¹ Why the fertility rate decreases has been correlated to the degree of development in a society.⁷ Demographers found that the fertility rate of a country declines as the country increments its degree of development. Most industrialized countries are in this category. They are characterized by high standards of living and high (more than 0.8) Human Development Index (HDI). According to the so called demographic transition model, developed countries are in stages 3 or 4 of the model. These stages correspond to the tendency of the fertility rate to become small (less than 2 children per family). On the other hand, developing countries are in stages 2 or 3 that correspond to the transition when the fertility rate starts to lower. Most of the European countries have reached stage 4; North America, New Zeland and Australia are in stages 3 and 4; Central and South America and Asia are still in stages 2 and 3; while Africa is in stages 1 and 2. There are good reasons to believe that this continent will reach stage 3 by the end of the century. What we see is that in general all countries adhere to this tendency.

After reaching stage 4, new models predict that once the population reaches a high HDI, the fertility rate grows again.⁸ I think that this could be the case for the next century. Another reason to think that the population will grow, is that new advances in science will increase the lifespan. This has already occurred in the past and actually this was one of the main reasons that the fertility rate triggered in the last two centuries. The industrial revolution in England, the improvement in medical science (discovery of penicillin, etc.) and in general the benefits brought thanks to scientific and technological achievements such as the invention of trains, automobiles, airplanes, telephone and discoveries such as electricity, genetics, etc.⁹ were determinant for population growth.

D. Science and Technology

It is important to understand that science is a human activity whose main objective is to generate rational knowledge. Technology, on the other hand, is the application of this knowledge for the convenience of mankind. At this point, it is worthy mentioning some of the milestones in the history of science and technology. The list does not pretend to be exhaustive, rather its objective is just to illustrate how these discoveries and inventions have shaped the world. These are:

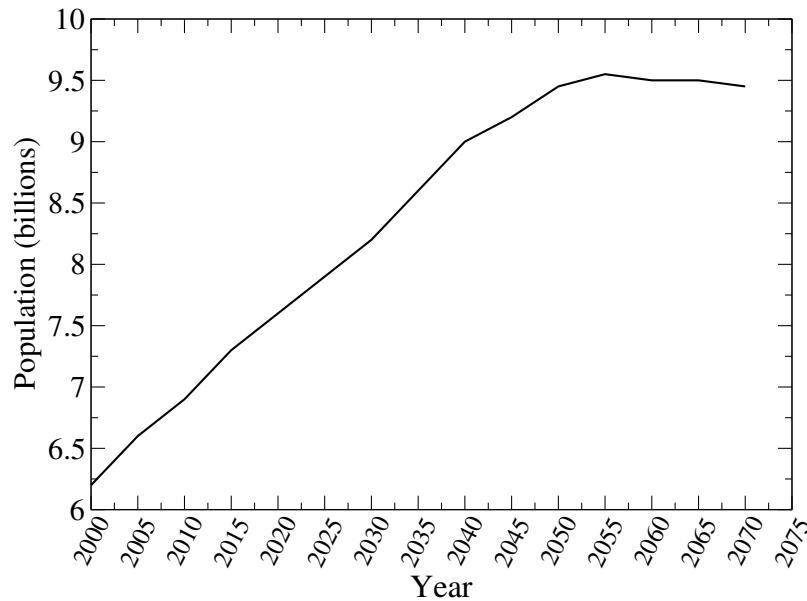


FIG. 1: Illustration of global population for the next 55 years. According to models, the population will continue to grow at least until 2050. After this decade, it is unknown whether the population will grow, remain constant or diminish. We assume that the the population will decrease obeying the same behaviour of Europe.

Microscope, telescope, weapons, atomic bomb, printing press, telephone, radio, TV, satellite, ship, train, automobile, airplane, rockets, electric motor, electric generator, batteries, light bulb, fluorescent lamp, laser, refrigerator, phonograph, camera, video camera, air conditioning, wheel, steam machines, combustion engine, turbines, money, furnace, pottery, electromagnetic waves, alternating and direct current, gunpowder, petroleum, TNT, radioactivity, nuclear energy, diode, transistor, integrated circuit, computer, video games, cellphone, internet, etc.

Biology and Medicine: Vaccines, anesthesia, morphine, DNA, cell division, biotechnology, etc.

Industry: Metallurgy, mining, food, textile, electric, electronics, military, film, agricultural, etc.

Many of these were derived from theoretical achievements in many fields of science such as mathematics, classical and modern physics, biotechnology, chemistry, etc. Certainly, most inventions intent to be beneficial for humans, although we acknowledge that many of them have also produce negative effects. Some of the most significant are: increment in the energy consumption per person, pollution, noise, and overexploitation of natural resources. From these many other problems derive such as climate change, health issues, conflicts, moral and ethic predicaments, etc.

In 1962, a nuclear crisis took place between the two major powers. Scientists, well aware of the possible consequences, were concerned that a third World War may lead us to extinction. Indeed, this risk was likely and neither of the two sides were willing to exterminate each other. The bottom line of this brief story is that science has reached a point in which human species may face extinction. From this, we learn that science and technology are indeed decisive in steering the course of the world. Knowledge and innovation are key ingredients for change, but science must not only be knowledgeable and innovative but also wise. Scientists and technologists need to know how to deal with the knowledge they produce.

III. WHAT KIND OF WORLD DO WE WISH?

Would it be possible to achieve a stable state in which all countries could live in relative peace in harmony, with no poverty and good quality of life? If we would like to have a united world and attain these goals we would have

to work together for the same ideals. But what ideals? What kind of world do we want for us and our descendants? What options do we have? As of now the world is divided by culture, language, religion and by diverse political and economical factors. In some other aspects we share something in common. In a united world, in a world free of poverty, it seems to me, there should be no borders, one common language, one economical, political, social, and cultural system; one common philosophy. Actually, the world appears to be moving in this direction. Today, english is the universal language... technology, science, political or economical systems are similar everywhere. These are signs that the world is narrowing their gaps and opening their borders. But the fact is that the world is so diverse that reaching such harmonious point in the near future appears not to be feasible. Everywhere we witness competition among nations... economical, political and military blocks, poverty and wealthiness; a series of contrasts that suggest a deeper reality. All of these are clear indicators of global instability, indicators of global struggle, indicators that we are far away from a unified world. We do not observe a global project, instead we see groups of countries having their own projects according to their own convictions which are sometimes antagonist from the others. I must emphasize that I do not wish to be pessimist but rather objective. That the world will unite and work together in the short term, seems to be, at this moment of history, utopic.

Regardless of this, most countries are facing similar problems and we should take advantage of this to unite our forces. We need to provide people with the means to live a worthy life. I believe this should be our major ideal that would steer our future. Governments are constantly developing programs and mechanisms to somehow assure equal conditions and opportunities for their people. This, of course, is in practice really complicated for there are many implications: we need to find constant sources of nourishment, water, energy resources, well paid jobs, homes and space to accommodate those who are about to come. The Earth has finite resources and we should be wise enough to use them rationally. To attain this, we need, again, a united world that works under the same ideals. I think this is the most troublesome part.

The first step is then to agree what we want for our future. Then we should identify our major problems and then propose solutions. The next step is to work together to reach our objectives. As long as we do not have the means to get extra resources from another place other than Earth, we should keep in mind that our planet has finite resources. This immediately limits the population that our planet can sustain and at the same time suggests that we should keep the population below that limit to guarantee the same quality of life for the future generations. During this time, perhaps, scientific and technological advances could take place at a pace that does not put at risk the current natural resources. Maybe these advances could even reduce the current energy consumption. This is one of the great challenges that science and technology are facing today.

IV. HOW SHOULD WE STEER OUR FUTURE?

A. The problems

Despite the struggle for hegemony, countries should create more effective an aggressive programs to improve the quality of life of the world population. In order to achieve this, we should identify the main challenges that humanity should address. First, it is necessary to guarantee the basic needs for every human being. Unfortunately, there are still many countries suffering extreme poverty and we should focus on solving this problem. Our first mission is then to create the conditions and means so that the present and future generations enjoy the basic human rights, namely: access to food and water, education, job and health. In the next decades, the global population will be larger and we will require more natural resources to satisfy these basic needs.

1. Food and water

Access to food and water should be a priority in our agenda. I propose that water should be treated after being used. All countries should have water treatment plants and projects to collect water in any of its three physical phases. Governments should ensure that every major city treat and collect water.

Food usually is obtained from agriculture, from fishing and livestock. Our means of food production should be more efficient and we are going in a good direction. I would like to illustrate, with a couple of examples, how we can enhance food production and reduce water consmption. At the end of the previous century, a Mexican engineer conceived a way to collect water.¹⁰ He developed a hydroabsorptive polymer whose absorbing capacity is at least 200 times its own mass in water. In this way one can store water in "solid state" (sort of a gel) and use it whenever is necessary for agriculture. This technology was called *solid rain* and it is very useful in places where agriculture strongly depends on rain. In conventional agriculture, crop is irrigated by sprinklers or channels. The inconvenience with this system is that water is absorbed by soil, so after one or two days the plant needs more water again. In order for the plant to obtain the nutrients, great quantities of water need to be supplied. The solid rain avoids the lost of

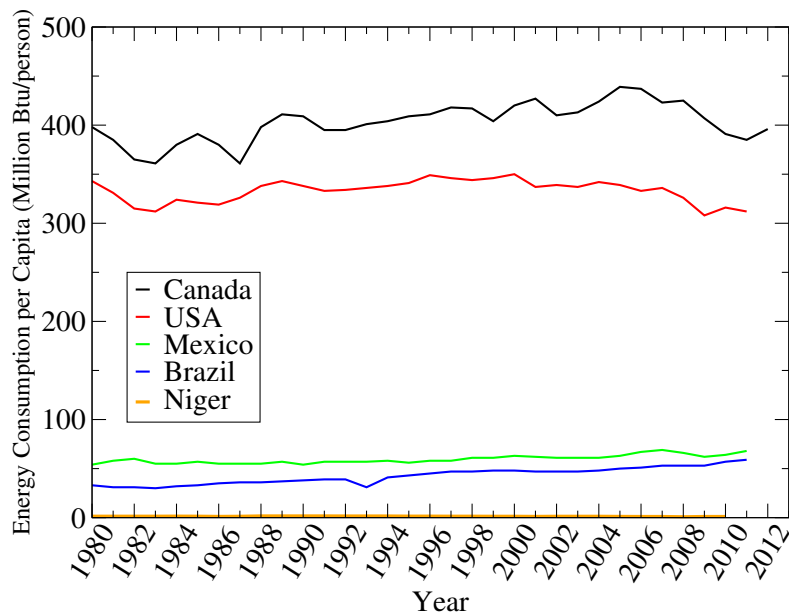


FIG. 2: Illustration of energy consumption per capita: developed vs developing countries. Source: US Energy Information Administration.

water by filtration and reduces water consumption at least 200 times (depending on the soil conditions, temperature, etc.). The technology is being applied in several fields in Mexico, India and other parts of the world with excellent results. The purpose of this technology is n-fold: firstly, it enhances agricultural production; secondly, it reduces energy and water consumption in agricultural activities, and thirdly, it reduces production costs.

A similar case occurred in food production. Researchers in the field of tissue engineering have developed “artificial” animal muscle for human consumption.¹¹ This kind of technology seeks to reduce illnesses related to animal meat and avoid the use of farm animals. Up to now this technology has already developed meat with similar characteristics to beef meat, however, it is still in the initial stages. Perhaps in the following decade, the *in vitro-cultured meat*, as it is known, could be brought to every place on the planet.

2. Education and Job

In contemporary life, individuals are somehow peaces of a complex machinery (civilization), working together for a specific end. Schools are institutions where individuas acquired knowledge and developed their natural skills that one day will be essential for the progress of humanity. In a job, one puts into practice the fundamentals that one learns. It is therefore of prime importance to educate people and provide them with jobs where they can apply what they learned. There is huge disparity in salaries between developed and developing countries. Our task here is to design integral projects that assure the creation of well paid jobs; raising the well-being of people and simulateously narrowing the gap of salary disparity.

3. Renewable Energy

To provide mankind with the basic needs, we require energy sources. We have two issues with energy: the first is energy consumption, and the second is energy generation. Figure 2 shows representative energy consumption per capita for developed and developing countries. Note that for more than 3 decades the energy consumption remains almost constant, although developed countries spend at least five times more energy than developing countries. Niger, one of the poorest countries in the world, spend 150 and 200 times less than USA and Canada, respectively. Our goal for the future is to balance these abismal differences without increasing the global levels of energy consumption.

In close connection with the energy consumption issue, we have the issue of energy generation. In the future we will need energy at low cost and in larger quantities. This has to be done reducing at the minimum the environmental

impact. For several decades scientists have struggled to reduce the dependence on oil and other conventional sources of energy such as hydroelectrics and thermoelectrics. Some of the alternative energy sources that have been proposed in the last three decades include: Solar energy, wind power, better batteries, alternative fuels such as hydrogen, biofuel, etc. Wind power is an alternative that has been embraced in many countries although many consider that this is not an elegant solution. Wind farms are noisy and do not produce enough power for larger cities. Sometimes the blades kill birds and bats and beautiful landscapes are ruined by the presence of wind turbines.

Hydrogen, biofuels and solar cells are other alternatives to mitigate the energy production problem. As of now, hydrogen and biofuels cannot be produced in large quantities and the production cost is much higher than conventional fuels. Solar cells suffer from the same inconvenience. A solar panel of $2\text{ m} \times 2\text{ m}$ that can supply electric energy to an average home costs around US \$50 000 and lasts around 20 years. If we performed a simple calculation, we would find out that, for an average home, we would spend around the same sum as in the case of our regular electric service (depending on country). Fortunately, in the last decade, advances in this field have been made. One of the challenges with solar cells is to increment the so-called cell efficiency. The quantity measures how much electromagnetic energy is being transformed into electrical energy.

There are many types of solar cells and each type have different efficiencies. The classification depends on the materials used in the fabrication process. There are solid state thin film cells made of CdTe, $\text{CuIn}_x\text{Ga}_{1-x}\text{Se}_2$ or CIGS, GaAs and Si. Some others are made of organic elements and chemicals. Today the record in solar cell efficiency is 44%. Solar cells with efficiencies larger than 20% are relatively expensive and therefore are not optimal options for commercial purposes. Solid state cells are cheaper but their efficiencies are relatively low. In 2013, a great step forward was given with the development of CdTe cells with a record efficiency of 18.7 %. Scientists think that CdTe cells with efficiencies of more than 20% will be routinely produced in the following two or three years.^{12,13} With these good news, using solar cells will be cheaper than conventional electricity. The effort does not end here of course, we will continue to improve cell efficiency and look for better alternatives.

4. Pollution and recycling

Solid waste is a great problem for the world. In the following 5 years, this computer, where I'm writing this essay now, will most probably end in China or Africa where workers dismantle the units to get the useful parts and then throw the rest in a dump or river. The toxic compounds will then be absorbed by soil or mixed with water causing health problems and pollution. This problem originates from the conception of the contrivance. Those who design and fabricate the contrivance usually never ponder what would be its final destination and how the product would affect the environment. The solution is developing an integral process for that product. Before releasing a new product, companies should carry out research and find out what would be its environmental implications. This will allow to design a recycling program and at the same time assess what could be the optimal materials they can use for the product. For instance, if an industry designs a new device, say a cell phone, the company should be in charged of collecting and recycling the cell phone once it is no longer useful. The company should dismantle it and recycle as much parts as possible and find an appropriate place to dispose the rest of the material, much the same as with radioactive and medical materials. Actually, many industries are doing this, but they are minority. Policies should be issued to force all companies to state a recycling plan for the items they produce. The consumer will be in charged of buying the product, use it and returning the used product to a store or designated place where the company will pick it up. The implications of this is that industries will spend more resources in transporting back and recycling the used product. Of course, this may increase the cost of the product. However, overall, this will reduce pollution and the use of natural resources, that in the long term will be beneficial for future generations. The way is being done now, misuses natural resources that will not be recovered in the future. This culture has already been implemented for certain products such as photographic cameras, can food, beverages, radiocative and medical materials, etc. I would recommend that this policy be extended to any other product.

Similar programs should be put into practice with the emission of gases and disposal of chemicals. Every year billions of tons of gases are discharged into the atmosphere and chemicals are deposited into rivers, oceans and lands. This also causes health problems and climate alterations. In theory, environmental policies of this kind exist, but in practice many of them they are violated. We should be strict with the fulfilment of the policies and we should develop more effective technologies to treat gas emission and chemical disposal.

B. Who will implement these ideas?

The ideas presented here should be implemented by governments, institutions, agencies, industries, scientists and technologists. All these spheres should work together under the same goal and prioritize projects towards improving the quality of life. Campaigns promoting the participation of the public in the solution of these problems should be encouraged. Citizens should also put their grain of sand. First, we should be informed as much as possible about the

global and local situations. If we are well informed and understand the problematic, we will be aware of its dimension and we will know what to do.

C. What's next?

One can compare the present state of humanity to an adolescent who is still forging his character and future. In the future, humanity will reach adulthood and will be able to make wise decisions. Hopefully by then, there will not be borders, poverty, or wars. Once our basic problems are solved, we will relax and enjoy our lives, just like retirees. Of course, this will not imply that progress will stop, it will mean that we have reached stability and that the world is united.

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- ¹ World Population 2300, *Economic and Social Affairs*, United Nations: New York (2004)
 - ² J. Becerra, P. Damisch, B. Holley, M. Kumar, M. Naumann, T. Tang and A. Zakrzewski, *Shaping a New Tomorrow, How to capitalize on the momentum of change*, Global Wealth 2011, Boston Company Group: Boston (2011)
 - ³ Zbigniew Brzezinski, *The Grand Chessboard, American Primacy and Its Geostrategic Imperatives*, Basic Books: New York, (1998)
 - ⁴ International Monetary Fund, *World Economic Outlook* (2013)
 - ⁵ Zbigniew Brzezinski, *Strategic Vision, America and the Crisis of Global Power*, Basic Books: New York, (2011)
 - ⁶ Halford J. Mackinder, *Democratic Ideals and Reality, A study in the politics reconstruction*, Henry Holt and Company: New York (1919)
 - ⁷ Caldwell, John C.; Bruce K Caldwell, Pat Caldwell, Peter F McDonald, Thomas Schindlmayr, *Demographic Transition Theor*, Dordrecht, The Netherlands: Springer. (2006)
 - ⁸ M. Myrskylä, H.-P. Kohler and F. C. Billari, *Nature* **460**, 741-743 (2009)
 - ⁹ R. William Fogel, *The Escape from Hunger and Premature Death, 1700-2100: Europe, America, and the Third World*, Cambridge University Press, New York.
 - ¹⁰ Solid rain, <http://www.silosdeagua.net>
 - ¹¹ P. D. Edelman, D. C. McFarland, V. A. Mironov, and J. G. Matheny, *Tissue Engineering*, **11**, 659 (2005)
 - ¹² P. Sinha, *Solar Energy Materials and Solar Cells*, **119**, 271 (2013)
 - ¹³ M. Gloeckler, *IEEE Journal of Photovoltaics*, **3**, 1389 (2013)