

Climate change scenarios as a driver for “Race to Zero” campaign

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Abstract. The Race to Zero is the largest credible alliance aiming to reduce twice emissions by 2030, with the main goal of moving towards a carbon-zero economy by 2050. Zero emission technologies can reduce the greenhouse gas concentrations in Atmosphere that can help to slowdown the Global Warming but for making the Earth's climate system more stable we need implement Negative emission technologies. Negative emission technologies can significantly reduce the greenhouse gas concentrations in Atmosphere that can getting down the global average temperature to the pre-industrial level and prevent Global Warming and future Sea Level Rise. The currently observed climatic changes cannot be completely explained by the increase in the concentration of carbon dioxide in the atmosphere. Taking into account the impact of methane emissions, including the Polar Regions and the World Ocean, it will be possible to explain rapid changes in the Earth's climate. For getting the Earth's climate system stable and predictable we need to reduce greenhouse gas concentrations in the atmosphere and the global average temperature to the pre-industrial levels. If this aims cannot be achieved then Climate Change and associated with Global Warming future Sea Level Rise in the nearest future would be the most important Risk factors in the Global World and World Economy, that can provide the world massive losses and economic crisis.

1 Introduction

In the present time the greenhouse gas (GHG) emissions from humanity exceed natural ones. This dramatically affects climatic conditions and increases the number and severity of natural disasters.

The World Bank's Disaster Risk Management data [1] reveals the huge increase of economic losses from natural disaster during the past four decades: “Since 1980, more than two million people and over \$3 trillion have been lost to disasters caused by natural hazards”. Over this period, total annual damage has increased six times from \$23 billion in the 1980s to \$150 billion in the last decade.

One of the new global trends is urbanization. The concentration of the population close to the transport infrastructures as roads, railways, airports, seaports, rivers and costal lines can cause the significant problems for Disaster Risk Reduction. According to the World

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Bank's report *Aftershocks: Remodeling the Past for a Resilient Future* [2] by Global Facility for Disaster Reduction and Recovery (GFDRR) in the nearest future by 2050 the models show that: "population growth and rapid urbanization alone could put 1.3 billion people and \$158 trillion in assets at risk to river and coastal floods". The previous World Bank's report *Investing in Urban Resilience, remodeling by 2030*, underline that without significant investment into making cities more resilient, natural disasters may cost cities worldwide \$314 billion each year [3].

Under the threat by climate change and enormous economic losses from natural disasters the UN Secretary-General António Guterres called on all leaders with reducing greenhouse gas (GHG) emissions by 45 per cent over the next decade, and to net zero emissions by 2050.

The global campaign "Race to Zero" was launched at the UNSG's Climate Action Summit 2019 by the President of Chile, Sebastián Piñera. The Race to Zero is the largest credible alliance aiming to reduce twice emissions by 2030. The main goal of moving towards a carbon-zero economy by 2050 looks very attractive. But one can put a question about the reversibility of climate change and how the proposed measures to reduce greenhouse gas emissions could affect the Earth's future climate.

Race to Zero the global campaign is mostly based on the reduction of CO₂ emissions, which reflects maximum effort toward or beyond a fair share of the 50% global reduction in CO₂ by 2030 identified in the IPCC Special Report [4] on Global Warming of 1.5 °C. The most of Race to Zero actions focused on the regulation of oil and gas consumption and other carbon related products. Looking on the Race to Zero Lexicon we can see the carbon related definitions: Climate neutral(ity); Carbon neutral(ity); Carbon negative; Like for Like. It also contains definitions related to greenhouse gas emissions: Net zero; Absolute zero; GHG neutral(ity); Climate positive (net negative); Offsetting; Insetting; Neutralization; Compensation; GHG reductions; GHG removals.

UN Secretary General António Guterres targets global community to reduce greenhouse gas emissions and this is a very precise definition. One of the Race to Zero Criteria is: "Pledge at the head-of-organization level to reach (net) zero GHGs as soon as possible".

The main measures of limiting Global Warming were working out in United Nations Framework Convention on Climate Change (UNFCCC): Conference of the Parties, Adoption of the Paris Agreement, 12 December 2015 [5]. With the coming into force of the Paris Agreement following the ratification of countries responsible for over 55% of global emissions, increased attention is focusing on the means by which Contracting Parties can implement the Agreement and achieve its objective of limiting global warming to 'well below 2 °C above pre-industrial levels' and 'to pursue efforts to limit the temperature increase to 1.5 °C above pre-industrial levels' [5, Article 2a]. As the primary means of achieving this, the Parties agreed to 'aim to reach global peaking of greenhouse gas emissions as soon as possible ... so as to achieve a balance between anthropogenic emissions by sources and removals by sinks of GHG in the second half of this century' [5, Article 4.1], at which time net emissions would be zero.

2 Zero or Negative greenhouse gas emissions

For getting the Earth's climate system stable and predictable we need to reduce greenhouse gas concentrations in the atmosphere to the pre-industrial levels. It is very important to understand that the World Ocean could not be no longer a deposit of carbon dioxide (CO₂) and methane (CH₄) during the warming of ocean water layers, just the opposite it can be the main source of GHG emissions in the atmosphere in the period of Global Warming.

On the aim of reducing greenhouse gas to net zero emissions by 2050 the Global Warming do not stop at 1.5 °C and it looks like a lowest possible estimation concerning for the best

scenarios. The different scientific groups provide various estimations from 1.5 °C up to 4 °C by 2050. We can look on it in details.

The Global Warming (GW) is estimated as aced of the year's globally averaged temperature (Earth's global annual temperature) above the levels since the Industrial Revolution (pre-industrial levels the baseline 1951-1980 mean). The rate of Global Warming is in relation of greenhouse gas concentrations. The M. Previdi et al. (2013) find the relation [6] of the climate sensitivity for doubled CO₂ concentrations of about 3 °C. Including in the model all other factors as reflection from ice sheet and vegetation albedo feedback the maximum level of GW can rise up to 4-6 °C [6].

The difference between the World Ocean surface temperatures in different parts can cause an increase in extreme weather related events. One of the leading US climatologist J. Hansen (2016) [7] stressed that the 2 °C global warming above the pre-industrial level is highly dangerous and he discussed a possibility to stabilize the Earth climate in the case of GHG emissions reduction [8]. Cooling Ocean surface in the North Atlantic with the simultaneously warming Southern Ocean surface provide the increase in wind speed and the Atmosphere kinetic energy that can provide the better conditions for more powerful storms [7].

Max Planck Institute for Chemistry (MPIC) in Germany provides a research on long-term meteorological datasets and climate modeling for socioeconomic and population projections. The leader of MPIC climatologists group J. Lelieveld et al., (2016) in his model predict the 4 °C global warming above the preindustrial level by 2050, this will provide the conditions for rising the maximum temperature during the hottest days up to 50 °C for more then one month [9]. This will cause the difficult climate conditions for North Africa and Arab states 500 million populations and can lead to the climate migration. These events can happen two times faster and two times higher (2 °C) than it was planned by COP21 in Paris 2015.

According to the NASA's Goddard Institute for Space Studies the year 2020 was the second (1.02 degrees Celsius) after the warmest on record 2016, exceeded both the Global Warming +1 °C level.

The paleoclimate data can be used for estimations of Sea Level as a function of the global annual temperature over the Globe [10-13].

Heat content accumulated in the World Ocean and Atmosphere after the relaxation period of the climate system will provide melting of the relevant to it ice deposits and as a result increasing the Sea Level. This model [12-16] based on logistic equation provides both the time series and the stationary solution for the future Sea Level as a reaction on global annual temperature increase.

The model stationary solution on Global Warming of one degree Celsius temperature increase above pre-industrial levels corresponds to the future Sea Level Rise on +7.5 meters [14-16]. This is our current perspective if in the nearest time the accumulated Heat content due to the GW will melt the relevant ice deposit.

In the case "to pursue efforts to limit the temperature increase to 1.5 °C above pre-industrial levels" [5, Article 2a] will be successful in the nearest future the Sea Level will rise on +11.25 meters [14-16].

If not, the limiting global warming to "well below 2 °C above pre-industrial levels" [5, Article 2a] it will provide the Sea Level Rise up to +15 meters [14-16].

This research was done for the different scenarios of Global Warming including the cases of +4 °C corresponding to SLR +30 meters and +8 °C accordingly to SLR +60 meters [14-16].

As an example [14] we provide an estimation for the influence of the SLR due to GW on the European airport infrastructure, including reduction of air traffic, passenger traffic and cargo transportation. In the case of "EU's adaptation strategy to the climate change of 2 °C, in the long run, this temperature will lead to rising sea levels up to 15 meters. Consequently,

this involves the flooding of 172 airports (19.9%), a reduction of 20.4% in passenger traffic and cargo by 14.7%” [14].

We discuss the future Climate Change due to the GHG emissions and its possible consequences on Global Warming and related to them Sea Level Rise during the International Conferences in: UAE (2012) [17]; Coimbra (Portugal, 2012) [18]; Belgrade (Serbia, 2013) [12]; Nice (France, 2000-2018) [14]; Belgrade (Serbia, 2016) [15]. The main proposals were: "Making efforts for the getting down of the global average temperature to the pre-industrial level that will reduce the number of Natural Disasters in times and stop the Sea Level Rise. For getting the Earth's climate system stable and predictable we need to reduce greenhouse gas concentrations in the atmosphere to the pre-industrial levels".

The proposals on implementing vitally needed Zero or Negative emissions of GHG for preventing Climate Change vs. Global Warming and future Sea Level Rise were widely discussed and published in Belgrade (Serbia, 2016) [15] and during IGU conferences in: Moscow (Russia, 2015); New Delhi (India, 2016) [16, 19]; Hyderabad (India, 2017).

In 2016 L. V. Sorokin was the only delegate from Russian Federation on the UN conference: "UNISDR Science and Technology Conference on the Implementation of the Sendai Framework for Disaster Risk Reduction 2015-2030" (27-29 January, 2016 | Geneva, Switzerland), with the report on "Weather Modification Application for Disaster Risk Reduction". During this event the suggestions on implementing Zero or Negative emissions of GHG and preventing methane emission from Arctic for stopping Climate Change were represented on the session Work stream 2 "Understanding disaster risk, assessment and early warning", Group 2 "Vulnerability and exposure", Chair R.B. Singh.

The next year the risks of economic losses from Climate Change, extreme weather related events and future Sea Level Rise (Thematic Area: National and local disaster risk reduction strategies integrated with climate change and sustainable development plans) were the topic of proposals made by L. V. Sorokin to the Leaders forum of the United Nations Global Platform for Disaster Risk Reduction (Global Platform, 22-26 May, 2017, Cancun, Mexico).

If the targets of getting down the greenhouse gas concentrations in the atmosphere and the global average temperature to the pre-industrial levels cannot be achieved then Climate Change and associated with Global Warming future Sea Level Rise in the nearest future would be the most important Risk factors in the World and World Economy, that can provide the world economic crisis and massive losses due to flooding of the coastal and low land areas of the Earth's land.

So to slow down the Global Warming and future Sea Level Rise the humanity need significantly reduce the concentrations of GHG in the atmosphere that will launch the era of Negative GHG emission technologies.

The importance of implementing the negative emissions of GHG is on mainstream of the leading climatologists. So T. Gasser et al., (2015) in the paper [20] write: "To limit global warming to <2 °C we must reduce the net amount of CO₂ we release into the atmosphere, either by producing less CO₂ (conventional mitigation) or by capturing more CO₂ (negative emissions)". The leading US climatologist J. Hansen et al., (2017) in his paper [21] devoted to the future generation stressed the requirement of implementing negative CO₂ emissions. European Academies Science Advisory Council (EASAC) prepares special policy report [22] dedicated to Negative emission technologies and their role in meeting Paris Agreement targets.

3 Link to Arctic Methane emissions

The currently observed climatic changes cannot be completely explained by the increase in the concentration of carbon dioxide in the atmosphere. Taking into account the impact of

methane emissions, including the Polar Regions and the World Ocean, it will be possible to explain rapid changes in the Earth's climate.

Using the NOAA satellite data of the GHG distributions we can see the inequality over the North and South Pole regions. The higher concentration of GHG was observed in the North hemisphere. This can be in connection with the Polar amplification. The Arctic amplification is polar amplification in the region of the Earth's North Pole only and Antarctic amplification is concerning the region of the South Pole. At the present time the Arctic amplification is stronger than the Antarctic amplification.

Taking into account the Arctic amplification we can see in Russian Federation the current rise of the polar region annual temperature two times higher than over the Globe.

From the NOAA satellite data in August 2015 the Arctic Ocean has a sea surface temperature anomaly up to +8 °C, at the same time the North part of Atlantic and Pacific Oceans has a surface temperature anomaly of +11.9 °C. This is an example of heating the sea surface water in the Earth's North Pole region. All this can affect the deep layers of ocean water, heating the layers of bottom sediments containing deposits of Methane hydrate.

Methane hydrate ($4\text{CH}_4 \cdot 23\text{H}_2\text{O}$) also known as methane clathrate is stable at low temperatures and high pressure typical for ocean depths of more than 300 m. Methane hydrate deposits in the World Ocean thousands of times more than the current content in the Earth's Atmosphere.

Clathrate gun hypothesis [23] is based on the stronger evidence of the uncontrolled runaway methane clathrate breakdown during the Global Warming periods. On our opinion this is most credible scenario of the Climate destabilization due to the Global Warming. In the paper [24] Carolyn Ruppel and John Kessler (2016) provide the analysis of the interaction of Climate Change and methane hydrates stability in the Ocean sediments. This research can be very important for modeling of methane clathrate breakdown during the current warming of deep layers ocean water.

One of the first research [25] on aquatic sources and sinks of CO_2 and CH_4 in Russian Polar Regions was done by I. P. Semiletov (1999). This was the base for recent discovery [26] of massive methane emissions from the Eastern Arctic Seas (EAS) into the atmosphere done by Shakhova and Semiletov et al., (2010). They were found that the amount of methane entering the atmosphere from the EAS shelf is higher than the methane emission from the Entire world ocean [27]. After that in 2011 they discovered in the Laptev Sea the mega-seeps of bubble methane, reaching 1000 meters or more across. The abnormal bubble fluxes can produce up to 100g of methane per square meter per day or more [28]. They found the high probability of a catastrophic release of methane into the atmosphere [29-31] in the Eastern Arctic Seas.

Another source of methane is the Polar Siberia region with melting huge permafrost areas. In research [32] G. E. Oblogov et al., (2020) provide an analysis of methane content and emission in the permafrost landscapes of Western Yamal, Russian Arctic region. Huge deposits of organic materials can be a source of methane emissions during the melting Siberian permafrost. The degradation of the permafrost landscapes can also be explained by an increasing the temperature in it's the upper layers.

In total the new evidences of the huge methane content and emission from Polar Siberia with melting huge permafrost areas and the mega-seeps of bubble methane in the Eastern Arctic Seas, together with methane emission from the World Ocean can explain the huge gap in GHG World balance.

4 Conclusions

1. Making efforts for the getting down of the global average temperature to the pre-industrial level that will reduce the number of Natural Disasters in times and stop the Sea

Level Rise. For getting the Earth's climate system stable and predictable we need to reduce greenhouse gas concentrations in the atmosphere to the pre-industrial levels.

2. Zero emission technologies can reduce the GHG concentrations in Atmosphere that can help to slowdown the Global Warming.

3. Negative emission technologies can significantly reduce the GHG concentrations in Atmosphere that can getting down the global average temperature to the pre-industrial level and prevent Global Warming and future Sea Level Rise.

4. The currently observed climatic changes cannot be completely explained by the increase in the concentration of carbon dioxide in the atmosphere. Taking into account the impact of methane emissions, including the Polar Regions and the World Ocean, it will be possible to explain rapid changes in the Earth's climate.

5. Taking in account the Arctic amplification we can see in Russian Federation the current rise of the polar region annual temperature two times higher then over the Globe. That can explain the heating the sea surface water in the Earth's North Pole region and can affect the deep layers of ocean water, heating the layers of bottom sediments containing deposits of Methane hydrate. The deposits of Methane hydrate in Ocean sediments can become unstable and provide a catastrophic release of methane into the atmosphere.

6. Clathrate gun hypothesis is based on the stronger evidence of the uncontrolled runaway methane clathrate breakdown during the Global Warming period. It can explain the overheating the Earth's atmosphere in the Arctic Polar region and Arctic amplification.

7. The main goal of preventing the worst-case scenario of Global Warming is preventing methane emission from Arctic region and World Ocean.

8. The Global Warming and future Sea Level Rise will terminate the interglacial period (warmer global average temperature lasting thousands of years with comfortable climate conditions).

9. Global Warming is the precursor of falling in the Next Glacial Period, which can last from 80 thousands years up to 120 thousands years (Last Glacial Period). The prerequisites for the beginning of the Next Glacial Period are the sea level rise, changing the trajectories of Ocean Currents and flooding of the coastal and low land areas of the Earth's land.

10. The strategy on adaptation to climate change does not consider the possibility of a Sea Level Rise at the upper level +1 m. In the case of the EU's adaptation strategy to the climate change of +2 °C in the nearest future the SLR can exceed 15 times the level of +1 m. This +1 m limitation on adaptation to climate change could lead to catastrophic economic losses due to the flooding of the coastal and low land areas with huge infrastructure.

11. Climate Change and associated with Global Warming future Sea Level Rise in the nearest future would be the most important Risk factors in the Global World and World Economy, that can provide the world economic crisis and massive losses due to flooding of the coastal and low land areas of the Earth's land.

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