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Theory of Bioenergy Accumulation and Transformation: Application to Evolution, Energy, Sustainable Development, Climate Change, Manufacturing, Agriculture, Military Activity and Pandemic Challenges

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Our theory includes generalized explanations of how nature works, confirmed by pieces of evidence, cover predictions for further technological developments towards economically and environmentally sustainable industrial processes as well as provides the role of bioenergy accumulation and transformation for improved understanding about evolution, influences of anthropogenic activity, decision-makers errors, technological choices, pandemics prevention and the necessary skills toward the innovation algae-based system. The possibility of origination and evolution of the landforms of life were the results of bioenergy accumulation by microalgae and at present, the contribution of algae remains dominant in reducing CO_2 *and maintaining* O_2 *level in the atmosphere. Population growth stimulates the accumulation of air carbon and bioenergy. The production and application of fertilizers originated large GHG emissions and it is a big conceptual need to shift on organic agriculture including algae fertilization of soil to contribute long-term sustainability. The used technologies for 1G biofuels production, as well as microalgae to biofuel based on biomass phototrophic growth by the use of fertilizers, are induced aggressively increasing GHG emission instead of their mitigation. Microalgae biofuel has big potential in case the use of wastewaters and food waste for biomass growth. The priority strategy for dealing with future pandemics treats such as COVID-19, etc. must be increasing the stability of immunity system of humans and animals to infections and due to a high concentration of physiologically active compounds in microalgae they application can be the best decision. Analyses of the Kyoto Protocol, Paris Climate Agreement, etc. results provide that their application has many disadvantages. The New policy must be founded on the admitting of the Life Conserve industry as the new part of the production.*

Keywords: *bioenergy, biofuel, environmental policy evaluation, evolution, climate change, Malthusian theory, microalgae, agriculture, pandemics, waste*

Abbreviations: CCS – carbon capture and storage, CO_2e – carbon dioxide equivalent for a gas, dw – dry weight, GHG – greenhouse gases, GDP – global gross domestic product, GDP - gross domestic product, GHG – greenhouse gases, ha – hectare, L – liter, LCA – Life Cycle Assessment, MJ – megajoule, NDS – National Determined Contributions, NO_x – oxides of nitrogen, ppmv – parts per million by volume, ppb – part per billion by volume, t – ton, UV – ultraviolet light

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Introduction

According to the First law of thermodynamics, energy cannot be created or destroyed and only changed from separate specific form to another and applies to biological (Roach et al. 2018). The Sun is the largest reservoir of energy received by the planet (Ashok 2020). Energy is the capacity for doing work as with the following differentiation by types: Stored (potential) energy and Working (kinetic) energy (EIA 2019, Encyclopaedia 2020). It exists as heat, light, motion (kinetic), electrical, chemical, nuclear and gravitational energies. Humans and animals eat the food contained accumulated bioenergy in the form of chemical energy and then it is used as kinetic energy.

Atmospheric oxygen (O_2) increased in stages, at first through photolysis, and then the major impact on the growth of its content has been originated by the accumulation of bioenergy in algae photosynthesis which reduced the CO_2 content of the atmosphere (Albany University 2020, Berkowit 2014, Samson 2018, Sayre 2010). At the first stage, the free O_2 reacted with iron dissolved in the oceans, and only after saturation of its oxidizable rock it spread in Earth's atmosphere 2.3 billion years ago (Berkowit 2014). Plants complete converting the energy of sunlight into the biomass true bioenergy which has stored in the form of chemical energy. O_2 level had archived a rate of 35% and later declined to 14% during a period of 120 million years and then (the Cambrian period) reached to current 21% (if the O_2 share of 15% – fires would not burn, 25% – the wet organic matter would burn freely) (Samson 2018). Under the sun's ultraviolet rays (UV) form single oxygen atoms from O_2 which with O_2 generate ozone molecules (O_3). Due to absorbing Sun UV rays O_3 layer of the atmosphere protecting the life forms from harsh and biologically lethal UV radiation (wavelengths of 200–300 nanometers). Earth's atmosphere and clouds absorb or scatter about 54% of the received sunlight energy and the other part reaches the planet surface (Ashok 2020). Stabilization of O_2 to current 21% as well as formed stratospheric O_3 layer allowed the rapid evolution of the life landforms and large animals which has evolved 600 million years ago (HHMI 2020). The total Sun energy captured by photosynthesis in green plants is around 2×10^{23} joules/year or 4% of the total energy of sunlight (Akihiko and Oikawa 2004). Hence, processes were lead to the capture and storage of solar energy and chemical elements in living matter that are generalized explanations of how Life works.

The Second law on the production of entropy is not respected for life forms as they are hierarchical networks of informed energy flows and have the ability of homeostatic and environmental regulation as well as to reproduce by building an own energy transformation for evolution by natural selection (Roach et al. 2018). Natural selection and random mutation are the main arguments of Darwin's theory of evolution which is mainly the overcome scientific awareness (Burkeman 2010). However, the most past of Earth life has been the history of microorganisms which through the horizontal transfer can get 10% of its genes from other organisms and more than 200 of identified human genes is looked as the result of the horizontal transference of the bacteria genes (without evolution natural selection transition process) that was arguments for the initial foundation of the theory named the

Conditional Evolution of Life. Simultaneously, Darwin never claimed that natural selection was the exceptional mechanism of evolution and its theory more applicable to the most modern complex forms of life. Besides, modern Neo-Darwinism still has not demonstrated specific statistical distribution follow random mutations but under certain allowances, the method of evolution using random mutations or modifications can be admissible. Thus, Darwin's theory cannot describe all uncertainties.

Influenza pandemic includes the dissemination of a new strain of the virus which may infect humans when their most parts have no immunity and which can transmit efficiently from person to person around the world. Infectious diseases have repossessed as the leading cause of death compared to non-communicable diseases such as cardiovascular diseases or mental illness (WEF 2020a). The past (WHO 2020) and new virus COVID-19 pandemic affecting societies and economies at a high scale and humans face the hard challenges that require new managing and technological decisions (UN 2020). The vaccines versus pandemics are not always effective (Avagyan 2010a). Therefore, the priority strategy for dealing with future pandemics treats must be increasing the immunity system of humans and animals to infections.

On the other hand, the UN Secretary-General António Guterres in the UN's 75th anniversary year indicated "four horsemen" (Geopolitical tensions (devastating conflicts continue to cause widespread misery, the nuclear menace is growing), The climate crisis (rising temperatures continue to melt records, the world is edging closer to the point of no return, etc.), Global mistrust, and The dark side of technology which are estimated as looming threats and imperils of 21st-century possibilities (Guterres 2020). So, the world is meeting a growing number of complex and interconnected challenges (Guterres 2020) and humans come to the future with considerable uncertainty about its ability to curb well-being and sustainable development. However, science is constantly evolving with expanding our understanding of life's important issues. Our theory provides the role of bioenergy accumulation and transformation for improved understanding about evolution, influences of anthropogenic activity, decision-makers errors, technological choices, and the necessary skills toward the innovation algae-based system addressed to the circular and green economy and pandemics challenges.

Discussion

Where we stand regarding Global Challenges and Climate Change

In the Archean Eon (4.0 billion to 2.5 billion years ago), hydrocarbon-containing fossil fuels (coal, petroleum, natural gas, oil shales, bitumens, tar sands, and heavy oils) were arises as an effect of geologic developments acting on the remains of organic matter produced by photosynthesis (most parts formed before the Devonian Period (back 419.2 million to 358.9 million years) from algae and bacteria (Kopp 2020, Nunez 2019). Thus, fossil fuels are a result of a former accumulation of Sun energy in living organisms and its future transformation.

Yearly, more than 80% of the produced energy is generated through the combustion of fossil fuels (Koop 2020, Sayre 2010). The fossil coal had been used as a fuel since 1,000 B.C., but only since the Industrial Revolution began to replace biomass as the primary source of energy and a large consumption of oil and natural gas started in the late 1800s and early 1900s and at large scale the rice of theirs utilizing promoted greenhouse gases (GHG) emission with a growing speed (EPA 2018, Kopp 2020, Theodoropoulos 2011). GHG absorb infrared radiation and reradiates it back to the surface that causing planet warmer and Climate change (EPA 2016, 2018, Kopp 2020, UNEP 2019). As a result of anthropogenic activity connected with the combustion of fossil fuel and land-use change atmospheric CO_2 vacillated from 275 to 290 parts per million by volume (ppmv) of dry air between the 10^{th} century and at the late increased up to 416 ppmv by 2020, CH_4 concentration (sources: incorporate natural gas and petroleum systems, agricultural activities, land use, land-use change and forestry, landfills, coal mining, wastewater treatment, stationary and mobile combustion, and certain industrial processes) increase from 722 parts per billion (ppb) from 1750 to 1,859 ppb by 2018, N_2O atmospheric concentration has risen by approximately 22% (sources: biological processes in soil and water and a variety of anthropogenic activities in the agricultural, energy, industrial, and waste management fields) (CO_2.Earth 2020, EPA, 2016, 2018, Kopp 2020, WEF 2020a). Currently, total GHG emissions by shares of the economic activities are the following: Industry – 32.1%, Agriculture – 26.8% (mostly from agriculture and deforestation), Heat and Electricity Production – 25% (burning of coal, natural gas, and oil for electricity), and other – 23.5% (WEF 2020b). Oil is the world's leading fuel and in 2018 oil production and consumption increased by 159 million liters (L)/day, natural gas consumption rose by 195 billion cubic meters, coal consumption – by 1.4%, double its 10-year average growth, electricity generation - above 3.7% and GHG emission archived maximal level for 7 years British Petroleum 2019). In 2018, total energy investment was nearly $1.85 trillion, shares of oil and gas were $477 billion and transport biofuel – $6 billion (80% from ethanol production) (IEA 2019a). On whole, fossil energy-related emissions from energy use and industry, which prevail in total GHG emissions, reaching a historical maximum of 37.5 $GtCO_2e$ in 2018 (IEA 2019a). GHG emission growing stimulates also subsidies to fossil fuels which were $4.9 trillion or 6.5% of global gross domestic product (GDP) in 2013 and later increased to $5.3 trillion in 2015 (Cody et al. 2015). Governments subsidizing fossil fuel have several objectives such as declining the cost of fossil fuel energy production and raise/declining the price of energy producers (Avagyan 2018a). Two-thirds of subsidies are realized in the forms of tax expenditures (tax reduction or exemption), accelerated depreciation and capital allowances as well as royalty concessions. The detrimental consequence of fossil fuel subsidies induces the decreasing necessary other expenses such as health, social spending, clean energy, energy access for the poor, etc. Eliminating fossil fuel harmful subsidies will promote the expansion of a green economy and all recognize also that government support should be limited by the WTO Agreement on Subsidies and Countervailing Measures. On the other hand, it will be an arduous agreement as the world oil demand from approximately 14.3 billion L/day in 2014 will increase to 16.5–19.1 billion L/day by 2040 but continuing extraction and combustion of fossil fuels will generate serious environmental threats (Avagyan 2018a). Thus, the record consumption of previously accumulated bioenergy transformed into fossil fuel is the main driver causing Global warming.

The current global land area is 13.2 billion hectares (ha), which only 1.6 billion ha (12%) is used for cultivation of crops, 3.7 billion ha (28–30%) – under forest, and 4.6 billion ha (35%) – comprises grasslands and woodland ecosystems, another part – unsuitable for agriculture (FAO 2011). Agricultural land (includes arable land and pastures) more than 50% is located in 10 countries and the largest areas are in China, the US, and Australia (OECD-FAO 2017). In 2015, the OECD countries used agricultural land by 34.3% of their total land (FAO 2018a). Nonetheless, global agricultural land usage decreased by 62 Mha over the past 10 years, which as expected will continue in the followed decade (about 24 Mha) (FAO 2018a). Decreasing of organics, excessive irrigation, exploitation of low-quality water, abuse of synthetic fertilizers, and pesticides are resulting in a reduction of agricultural soil fertility, its dirtying, and reduction. Fertilizer consumption leads also to water pollution and an increase in GHG emissions from chemicals (Avagyan 2018a, WEF 2020b). Due to soil erosion and desertification global suitable land is lost by 19–23 ha per minute (FAO 2011, 2017, 2018a, Zabel et al. 2014). Each year soil erosion and other forms of farming land degradation rate reach capacity of 5–7 million ha, and the application of current technologies could lead to the reduction of 95% of the agricultural land by 2050 (WEF 2020b). Simultaneously, agriculture and food systems are generated 25–27% of GHG emissions, 70% of freshwater exiting (water consumption should double by 2050), and 60–70% of biodiversity deprivation (FAO 2017, 2018a). On the other hand, a third of global food manufacturing is wasted with the economy lost at $936 billion annually and generates 4.4 $GtCO_2e$ or about 8% of total anthropogenic GHG emissions (FAO 2015, WEF 2020b, 2020c). Simultaneously, Food systems must adapt to a rising global population (Table 1) which can reach around 10 billion by 2050 (FAO 2017).

Table 1. *World Population by Year*

Year	World Population
2020	7,794,798,739
2010	6,958,169,159
2000	6,145,006,989
1990	5,330,943,460
1980	4,458,411,534
1970	3,700,577,650
1960	3,033,212,527
1927	2,000,000,000
1900	1,600,000,000
1850	1,200,000,000
1760	770,000,000
1700	610,000,000

1600	500,000,000
1500	450,000,000
1400	350,000,000
1200	360,000,000
1100	320,000,000
1000	275,000,000
900	240,000,000
800	220,000,000
700	210,000,000
600	200,000,000
200	190,000,000
-200	150,000,000
-500	100,000,000
-1000	50,000,000
-2000	27,000,000
-3000	14,000,000
-4000	7,000,000
-5000	5,000,000

Source: Worldometers 2020.

Malthusian theory predicted the geometric growth of a population and arithmetic rise in food supply (the size of a population is determined by the availability of food) (Agarwal 2020, Chand 2011, Seth 2018, Shermer 2016). However, technological successes have made an important breakthrough and will allow contributing to further overcoming problems to address current food challenges (Dupont 2019, FAO 2018b, USDA 2016a). From 1960 to 2008, the world population has more than doubled (Table 1) but over the last 40 years the production of cereals, oil crops, sugar, horticulture, eggs, and meat increase more than the population growth rate (food consumption per capita increased from an average of 2280 kcal/person/day at the 1960s to 2800 kcal/person/day) in case that cultivated land area was increased only on 30% (Wik et al. 2008). From 1960 up to 2015 agricultural production was raised 3 times due to boosting productivity and a substantial increasing in the use of land, water, and other natural resources for agricultural goals (FAO 2015). So, it allows concluding that population growth contributes to a decrease in Global warming due to the accumulation of bioenergy in agricultural products which leads to the capture and storage of carbon in living matter. In most of the economic articles was shown that population growth promotes overall GDP growth and leads to its growth per person (Peterson 2017). In low-income countries, accelerated population increasing is predisposed to be adverse in the short and medium period as can reduce well-being but in the longer period, it can be a positive as an augmenting population will make an effective contribution in economic progress. In the emerging Asian economies, the high grown rate of the population is archive significant advancement in GDP per capita. The Chinese government was introduced the one-child policy as an action to raising the economy and multiplying living standards but as a consequences, since

1970, 400 million births were prevented (sex-selective abortion) which originated a deficit of 40 million female babies as well as the acceleration of the aging of the population which potentially treat for their economy with a far-ranging global scale (Fifield 2019, Kuo and Wang 2019). On the other hand, a small population reproduction in high-income countries is also to generate social and economic obstacles (Peterson 2017). Migration from low-income countries helps to adjust these imbalances but is opposed by some socioeconomic uncertainties (Peterson 2017). However, economic researches on the relationship between population and economic growth (Peterson 2017) have generated often contradictory results. Therefore, this relationship required description through the direct analysis of the carbon cycle to take in attention that Earths carbon moves between the following reservoirs (Table 2).

Table 2. *Amount of Carbon Stored in Different Reservoirs*

Carbon Reservoir	Amount in Gt
Atmosphere	720
Ocean (surface layer)	670
Ocean (deep layer)	36,730
Lithosphere (sedimentary rocks)	> 60,000,000
Lithosphere (kerogens)	15,000,000
Biosphere (living)	600–1,000
Biosphere (dead)	1,200
Fossil fuels (coal)	3,510
Fossil fuels (oil)	230
Fossil fuels (gas)	140
Fossil fuels (other)	250

Source: Falkowski et al. 2000.

Human body includes roughly 18% of carbon by dry weight (dw) (Helmenstine 2019, IPFS 2016, Singer 2012), animals body: 18–25% (Johnstone 1932), higher plants: 35.8–47.9% (Ma et al. 2018, Mroczek et al. 2011) and microalgae: 45–70% (Avagyan 2012, Raja et al. 2014, Schlesinger and Bernhardt 2020). Consequently, any growth of living biomass with the accumulation of bioenergy is a contribution to air carbon removal.

The G20 countries add 78% of global GHG emissions (UNEP 2019). Their military sectors are one of the sources for these emissions. So, the GHG emission of the US military sector is too many than other developed countries (Ketchell 2019, McCarthy 2019). The military protection of supertankers in the Persian Gulf was contributed 34.4 $MtCO_2e$ per year, the Iraq war result was 43.3 $MtCO_2e$ annually (Bannerman 2018, Liska and Perrin 2010). From 2003 to 2007, the war generated at least 141 $MtCO_2e$ (Liska and Perrin 2010). The conventional and nuclear, etc. warms escalation is one of a top threat as can cause significant short- and long-term decreasing accumulation of bioenergy and conservation of carbon in a living matter as well as the growth of military sectors will stimulating the rising of GHG emissions. Simultaneously, the use of a 15-kilotonne nuclear bomb will result in 17 million deaths and the GHG emission of 690 $MtCO_2e$ (Jacobson 2019). Therefore, world politics must take steps against approaches of present or future such warms escalations which are in some doctrines (Tannenwald et al. 2018). Such escalations will influence on the bioenergy accumulation and living standards of current and future populations through the boomerang effect based on Climate change around the world.

Analysis Traces on Formation and Application of Policy and Financial Tools for Mitigation of GHG Emission

The world community must make a Systems analysis to look by all aspects of the policy adopted tools, financial investments, and subsidies as well as priorities of R&D to define its goals or purposes and discover operations/tools for accomplishing Natural (formed by Nature) and anthropogenic activity systems (Avagyan 2017, 2018a, b, c, 2019). The Kyoto Protocol fixed objectives and obligations of countries that have mandatory legal force but a blunder in environmental results. The Paris Climate Agreement was established only on the accord of countries based on voluntary nationally determined contributions (NDCs). It does not implement any new fundamental global instrument to GHG emission reduction and leaves the choice of measures to national policy-makers. In realness, the Paris Climate Agreement promotes, mostly, instruments of the Kyoto Protocol without well-understood problems and did not give the crucial policy ability to cut down on pollution (expectations of favorable scenarios have a small probability of 50–66% that can be estimated as an equal probability of arising/no arising). Analyses by results of the Kyoto Protocol and Paris Climate Agreement provide global ineffective management as at their period of action GHG emission was increased by about 52 billion tCO_2e/year or up to 58% from 1990 to 2018 (Avagyan 2017, 2018a, Rogelj et al. 2016). Investigation of environmental policy tools such as Carbon pricing, Emissions Trading System, etc. showed that their application has many disadvantages that discourage significantly decreasing pollution (Avagyan 2018a). In 2017, total GHG emission was estimated at 51.9 $GtCO_2e$/year and for the 2°C emissions gap full implementation required 11–13.5 $GtCO_2e$ mitigation by 2030 but in 2018 it reached a record of 55.3 $GtCO_2e$ as well as in case of the current policies it will be 60 $GtCO_2e$ by 2030 (UNEP 2019). In case of the full fulfillment of both unconditional and conditional NDCs, the GHG emission gap will be reduced by about only on 2–3 $GtCO_2e$, and presented forecast provide that global GHG emissions of 2020 are likely to be at the high rate by the scenarios for the 2°C and 1.5°C which makes problematic to archive the 2030 and end of the century emission goals (UNEP 2019, WEF 2020a). In such circumstances, the deterioration actions and the Global environmental risks will be growing as the Paris Climate Agreement can only some reduce than eliminate severe Climate change impacts (Avagyan 2018a). If the current GHG emission movement will continue, in the future it expected further upward pressure of emission, and Global temperature would increase between 3 and 4°C (Rogelj et al. 2016) as well as the advancing degradation of the global environment (WEF 2020a). In order to restrict global temperature growth to 1.5°C GHG emissions necessary drop rapidly to 25 $GtCO_2e$ in 2030 (UNEP 2019).

Adaptive System responds to the change must be an improvement for human well-being (Avagyan 2018a). The UNEP hoped for big investments for climate action, predominantly from the private sector in case that their investments were only \$81 billion in 2016 (UNEP 2016) and its approach is not business sound (Avagyan 2017, 2018a). The main attention of investors is on short-term business results prevailing on long-term decarbonization targets (WEF 2020c). According to the ISO/TS 14067 product is any goods or service and, consequently, mitigation of pollution is a product which has high demand from the public (Avagyan 2017, 2018a). For such circumstances, the relation ought on the economic Law of Supply and Demand. Any company, which actions decrease pollution, must get cash for its Life Conserve product. The New policy must admit the Life Conserve industry as the sovereign branch of production (Avagyan 2011, 2017, 2018a). Starting fund of disbursements for Life Conserve results can be created from the incomes of environmental taxes, programs, etc. (Avagyan 2017, 2018a). For this goal, compliance of the common rules and norms will promote rising initiatives and investments in the Global Life Conserve industry, supporting overcome market barriers, developing new environmental business strategies and originating jobs, etc. The indexes for payments can be set by the UNEP data (UNEP 2016) for emission reduction cost of \$100/tCO_2e, elimination of N, P, etc. from wastewaters - the equivalent cost for their removal of a Water treatment plant, for solid waste – costs of anaerobic digestion, etc. that can promote the practicality of such production and draw investments (Avagyan 2017, 2018a). Thus, only the new design of environmental policy to promote an alliance between the economics and environmental policy and applicable innovative financial instruments that can archive adequate investments for GHG reduction (Avagyan 2018a). Hence, the world meets insufficiency and critical governance errors in the development of efficient legislation based on the common guidelines, laws, etc. for the development Live Conserve industry (Avagyan 2017, 2018a).

Policy was formed but can its Tools Fundamentally Reduce GHG Emission? How do we succeed in Circular and Green Economy?

The Paris Climate Agreement as branches for GHG mitigation was noted agriculture, buildings, energy, forestry, industry through stopping deforestation & forest restoration, restoration of degraded lands, soil carbon enhancement, biochar application, efficient appliances, and passenger cars, solar and wind energy with emission reduction potential up to 22 GtCO_2e/year (UNEP 2016). Improving forest management was its bio-carbon capture and storage (CCS) approach which potential has been estimated at 3 GtCO_2e/year in 2030 (UNEP 2016). The forest is one of the important drivers for the accumulation of bioenergy but the average contribution of forests for the accumulation of air carbon has fallen from 2.8 annually by the 1990s to 1.8 GtCO_2e in 2014 (FAO 2017). Many states, along with lion's share of G20 members, have declared the goal of net-zero deforestation but often were not maintained intangible works (UNEP 2019). Simultaneously, weighing between this CCS with population growth, effectively land use and food insecurity was not analyzed (Avagyan 2018a). The Paris Climate Agreement CCS application of forest developments is inexperienced and could be dubious for the arguments as public acceptance based on forest competition with food production by land and water (Rogelj et al. 2016, Boysen et al. 2017). Terrestrial plants have fixed 500 billion tCO_2/year, but the CO_2 capture by planting forests and such capture in agriculture is an insufficient solution as their contribution equals around 3–6% of fossil fuel GHG emissions (Skjanes et al. 2007). The forests have low photosynthetic efficiency and harvest small power densities (Smil 2016). Thus, the hope on the air CO_2 sequestration model by using forest plantations is not an essential workable (Avagyan 2018a, Boysen et al. 2017) that provides also above-listed small forest CCS potential compared with the aggressive growth of GHG emission of various branches as above listed. On the other hand, the fast growth of wind and solar energy generation for electricity cannot have also an essential influence on the indicator of Global sustainable energy as electricity represents only 20% of energy consumption (IBRD-WB-IEA 2017). In these circumstances, innovation applications to environmental goals have remained passive, and long-term incentives are needed (UNEP 2019). Hence, primary objectives are short-term actions by above listed new market-based policy aimed to create incentives for pollution mitigation (Avagyan 2017, 2018a) and a revolution in technologies directs (Avagyan 2011).

The anthropogenic excess of CO_2 in the atmosphere mitigated from the atmosphere by carbon sinks in land and ocean (algal) ecosystems (Stocker et al. 2013). The first photosynthetic prokaryotes *Cyanobacteria* by the morphological structure are not classically algae as having no nucleus and chloroplasts but they are tolerance to various stresses factors such as UV radiation, desiccation, high or low temperatures, and high concentration of salty (Avagyan 2012, 2018a, Pathak et al. 2018) that promoted its bioenergy accumulation and production of O_2 in the condition of harsh and biologically lethal UV radiation at start of life evolution. Eukaryotic green algae evolved from *Cyanobacteria* metabolism which can be only if the level of O_2 was archive about 0.2–1.0% of its present ampleness that occurred by 2.5–1.0 billion years ago (Avagyan 2012, 2018a, Samson 2018, Stocker et al. 2013). Microalgae activity provides 1/3 of total biomass around Earth and more than 50% of atmospheric O_2 (Avagyan 2012, 2018a). They have prevailed as the most effective tool for the primary accumulation of bioenergy compared with higher plants and have the following benefits (Avagyan 2012, 2018a): 1) more efficient accumulating bioenergy (yield/ha) (terrestrial crops have much lesser photosynthetic conversion efficiency (microalgae: 0.25–0.75%, sugarcane: 0.16%, wheat: 0.024–0.03%, rapeseed: 0.034% and palm: 0.15%), originate large quantities of proteins and lipids and have harvesting cycles of days, 2) can absorb CO_2 by 450 t/acre and historically approved by the ability to fix CO_2 with efficiency at 10–50 times more compared to terrestrial plants. Due to an advanced tolerance to high CO_2 concentrations up to 20% in the flue gases (CO_2 part in the atmosphere is around 0.03%), the exhaust gases may be applicable for aeration, heating and as nutrients source with a reduction of CO_2 share as well as for prolongation (also exhaust steam) of the industrial period. It is a widespread vision that some industrial companies such as cement, steel, etc. have barriers for a transition to low- or zero-carbon technologies (WEF 2020c). Simultaneously, it was offered diversification strategy to the growth of the sales for cement, thermoelectric power, and chemical industry as well as for Canadian oil sands operators through the coherent policy of microalgae production aimed to prevent environmental air pollution and improvement of economic indicators of companies (Avagyan 2008a, 2017, 2018a). The US emitted annually more than 6.7 billion metric tons of CO_2 and natural gas-fired plants share is 2.1 billion t/year (US Department of Energy 2016). Thus, 1.4 billion tons of algal biomass could be produced by the use of their total CO_2 amount of exhaust gas (Langholtz et al. 2016), 3) water demand of open ponds per unit area is analogous to cotton or wheat requirements but less compared to corn. Species can grow in phototrophic, heterotrophic or mixotrophic conditions. Microalgae water consumption and the use of fertilizers can be decreased by the cleaning and reuse of wastewaters and polluted groundwater. Also, the influence of water evaporation as a limiting factor for microalgae commercial manufacturing must be exaggerated (Avagyan 2018a), 4) microalgae cultivation out of agricultural land, farms, and forests allow exclude land limitation for their production (Avagyan 2018a), 5) production is an environmentally preferable process with a low waste content in comparison with other microorganisms and plants. The use of pesticides is eliminated, 6) uniform cell structures allowing more efficient and easier to extract value-added products from biomass.

Biofuels producing based on the transformation accumulated bioenergy of biomass to various fuels (Avagyan 2018a, Avagyan and Singh 2019). At vesicle, combustion liquid biofuels do not produce any sulfur oxides or nitrous oxides as well as CO emission, polycyclic aromatic hydrocarbons, and particulate matter is less compared with diesel and petrol (Avagyan 2010a, 2012, 2018a). Their market is growing fast (Avagyan 2012, 2018a). In 2018, the biofuels market reached 154.4 billion L or 3.7% of transport fuel demand (share of bioethanol is 74.5%, biodiesel, and hydrotreated vegetable oil: 27.6%, and other: 0.9%) with forecast to boost 25% to 2024 (IEA 2019b). Currently, the production of the first-generation (1G) biofuel based on using the following main raw material: for ethanol - maize (17%), sugarcane (19%), and for biodiesel production – vegetable oils accounts a considerable share (13%) of demand (Avagyan 2018a, Avagyan and Singh 2019, OECD-FAO 2017). EU ethanol is originated in general from wheat, maize, and sugar beet, biodiesel - from rapeseed oil (over 50%) (EC 2017). Biofuel production targets have been subsidized through market price support mechanisms and more 50 countries have its mandated demand (only Brazil is no used such policy as in the main states condition favor to hydrous ethanol production) as well as mixed with other instruments such as tax incentives, etc. (Avagyan 2018a). For energy crops, the US established many support-programs (Avagyan 2018a, TCS 2014). The US taxpayers payments are about $ 0.62 for every dollar of a producer-selected crop insurance premiums (Federal Crop Insurance Premium program). 80% of federal crop insurance premium subsidies allocated to the production 3 major crops – corn, soybeans, and wheat for biofuels of the US and accounted 0.12 cent/L subsidies for the mature corn directed to the ethanol industry. The EU member states in 2018 allowed the continuation of subsidies to crop-based biofuels for later 12 years (Keating 2018). In contrast, algae biofuel have not adequate support and subsidies similar to oil and crop biofuels as well as committees lobbyists and government actions to modify the risk (Avagyan 2008b, 2017, 2018a). As obstacles for commercialization of algae biofuel are marked the large capital investment, operation costs of biomass production (fertilizers, energy, and freshwater) and technological problems (Avagyan 2008b, 2017, 2018a) (Avagyan 2018a). However, 1) there is an analytical error as compared to the outlay of microalgal biofuel production with the subsided price of oil fuel and 1G biofuel, 2) macro- and microalgae biomass to biofuels transformation technologies have developed substantially over the past 1–2 decades. Simultaneously, analysis of proposed main approaches to "overcome supposed" economic challenges of algae to biofuels such as nitrogen or phosphate starvation/depletion, genetic engineering, polycultures, and biorefinery showed many uncertainties that arise from the lack of practical application (Avagyan 2018a). On the other hand, many analyzed big data programs and Life Cycle Assessments (LCA) are established on the application of fertilizers for the cultivation of microalgae (Avagyan 2018a). Our analysis of the more well-designed project of US National Renewable Energy Laboratory by the microalgae to biofuel based on phototrophic growth of in open unlined pond of 2,020 ha by the use of anhydrous ammonia (NH_3, 10 t/day) and diammonium phosphate $(NH_4)_2HPO_4$, 5 t/day) and with the 10-acre pond annual average productivity of 25 g/m^2/day (biomass yield of 38 ton/acre/year) (Davis et al. 2016). Leaning on the ISO/TS 14067, we evaluated the product full Life cycle by daily GHG emission values due to the use of nitrogen fertilizers (Avagyan 2018a). The result showed that only their production realized 63.56 kgCO_2e for each kg of biotechnologically originated microalgae biomass that exceeding sum of mitigation by algae cultivation CCS – 1.83 kgCO_2e per kg biomass, differences between gasoline and diesel emissions by combustion in motor vehicles (gasoline is realized 2.29, biofuel E10 – 2.21 and E85 – 1.61 kgCO_2/L, diesel – 2.7 kgCO_2/L, biodiesel B5 – 2.65 and B20 – 2.62 kgCO_2/L) as well as the amount of crude oils extraction-to-refining (4 to 50 gCO_2e/megajoule (MJ) and combustion in motor vehicle emissions of 73 gCO_2e/MJ). Our evaluation confirms - nitrogen fertilizers in which production is consumed a large volume of natural gas should not be used in the production of microalgae biomass, as well as commercial biomass phototrophic growth technology based on the application of only fertilizers, cannot provide GHG emission mitigation (Avagyan 2018a). Unfortunately, this NPEL design originates also the uncertainties connected with the planned productivity of microalgae, construction of unlined ponds, and the probability of polluting groundwater by fertilizers as well as the safety of staff and environment. Simultaneously, our research on the many wastewater contents, food waste, etc. was shown that their microalgae bioremediation conjugate with their profitable biomass manufacturing has a high unrestricted potential which unaccustomed (Avagyan 2008b, c, 2010a, 2011, 2012, 2013, 2018a). Besides, the use of food waste as a nutrient for microalgae biomass producing may originate GHG emission reduction equal to 3.3 GtCO_2e/year or 8% of overall emissions as a result of reducing its origin (Avagyan 2018a).

In total, the manufacturing of fertilizers, food storage, and packaging make 1/3 of wholly anthropogenic GHG emissions (whole food system: 9,800–16,900

$MtCO_2e$; fertilizer manufacturing: 575 $MtCO_2e$, and refrigeration: 490 $MtCO_2e$) (Gilbert 2012) as well as consumes 1% of the world's energy and for soil fertilization, the US farmers expend 3 kcal of fossil energy or on a par with 20.8 L of fossil fuels/acre/year to produce 1 kcal of food energy (Connelly 2011). The fertilizers using promote progressive degradation of soil organic matter, and water (Avagyan 2018a, European Environment Agency 2018, Gilbert 2012, Xie et al. 2017). It is well known that nitrogen fertilizers production originates large GHG emission of 3.6–3.7 tCO_2e to each ton of nitrogen amount, potash fertilizer production creates GHG emission at 0.095–0.161 tCO_2e per ton, as well as an emission factor of phosphate fertilizer plants equal 0.57 kg CO_2e/kg P_2O_5 (Avagyan 2018a, Avagyan and Singh 2019). Our stressed issue (Avagyan 2018a) is the fact that in 2016, 1G biofuel production promoted expansion of fertilizer industry and nitrogen fertilizer consumption directed to biofuels manufacturing was the following: in the US - maize to ethanol – 2.2, Europe – rapeseed to biodiesel – 0.6, Brazil – sugarcane to ethanol – 0.3 and other countries – 0.4 million tons (Yara 2018) corresponding to about 3.2% of global nitrogen fertilizer consumption (Yara 2020). To address this challenge, we recommended that manufacturers of IG biofuel must make displacement to the use of feedstock originating by the Principles of Organic Agriculture (Avagyan 2018a) with avoiding the use of fertilizers, pesticides, etc. (EC 2020a, IFOAM 2020, USDA 2016b). Simultaneously, microalgae *Chlorella* suspension watering of the agricultural plant (wheat, rice, etc.) improve the soil's mineral and organic composition, increase the content of O_2, water binding, etc. in soil with producing of good environmental impact and was caused 10–20% growth of the various crops yields in large scale field trials (Avagyan 2010a, 2012, 2018a) fertilization of dried *Chlorella* biomass improves crop production compared to a commercially available inorganic fertilizer: increase 21% taller and yielded 25% more (Connelly 2011) as well as it was recommended the application of microalgae in the hydroponic system as biostimulants and biofertilizers (Ronga et al. 2019).

At the same time, the UK Royal Academy of Engineering and 181 Holland scientists concluded that manufacturing of several biofuels from food crops such as biodiesel, etc. originated more GHG emissions and have much an unfavorable impact on climate, nature, and peoples compared to diesel arisen from fossil fuels (Lane 2017, UK Royal Academy of Engineering 2017). Their analyses were based on the estimations of the Direct and Indirect Land Use Change. However, the published researches of Land Use Changes have a weighty fluctuation in the results (UK Royal Academy of Engineering 2017). Therefore, we evaluated direct agro-chemicals influence on rapeseed biodiesel production (Avagyan and Singh 2019). From rapeseed feedstock, it can be produced biodiesel of about 1000 L/ha (Avagyan and Singh 2019, EC 2020b, Farm Energy 2019, Nickel 2011). Nitrogen requirements for rapeseed feedstock range from 135–183 kg/ha (EU) to 112–168 kg/ha (US), phosphorus fertilizer: 29–69 kg/ha and potassium fertilizer: 110–160 kg/ha (Avagyan and Singh 2019). The summary production of these fertilizers creates GHG emission of 0.9–1.2 $kgCO_2e$/L biodiesel. Moreover, it was indicated that using fertilizers originates an additional emission, exceeding the emission of their production at 2.0–5.5 times (Fertilizers Europe 2015). GHG emission of land-use changes (for fossil diesel is 0.13 kgCO_2e/GJ and for rapeseed biodiesel is 0.016 kgCO_2e/GJ (HHV) (IEA 2015). Fossil diesel combustion emission is 2.7 and biodiesel B100 is 2.5 kg CO_2e/L (Anderson 2011, Avagyan and Singh 2019, British Columbia Ministry of Environment 2014, IEA 2015). Hence, the manufacturing and use of fertilizers for the growth of rapeseed feedstock intended for biodiesel manufacturing generate more GHG emission compared with GHG emission mitigation by biodiesel at motor combustion.

The principal dilemma in the use of 1G biofuels is their influence on the food security, challengers of land and water accessibility as well as the impact on the food and feed prices (Avagyan 2008b, 2010a, 2012, 2018a, UK Royal Academy of Engineering 2017). In 2013, for producing of 86 million tons of 1G biofuels were used area of about 41.3 Mha or 4% of the global arable area and 216 billion cubic meters of water or 3% of the worldwide water uptake for food production (Rulli et al. 2016). The placement of policy for bioenergy crop for growth of biofuel production could require up to 54 Mha by 2030 or up to 3.8% of available arable land as well as 1.5 billion ha could be under biofuel crops by 2050, equivalent to current total global farmland (FAO 2020) as well as 700 Mha by the end of the century and converting such massive area of land to monocultures has clear unfavorable consequences for food production and nature (WEF 2020a). Currently, for producing 1G biofuels it has consumed 5.5% of world cereals and 8% of world vegetables (Searchinger 2020). It follows that the above-listed data are required a mandatory downward revision of planning volume and technology of producing 1G biofuel.

It was offered a conglomerate diversification strategy for Canadian oil sand operators including also microalgae biofuel manufacturing based on the use of their effluent gases as well as food waste (Avagyan 2017). Microalgae biomass has great market potential in many niches that allow a firm to add related products or markets in addition to biofuel. At present, about 9,200–13,600 tons dw of microalgae are annually produced worldwide (almost exclusively in open ponds) in general as additives for human consumption, perfumery, and aquaculture (Avagyan 2018a). The microalgae market was estimated at €3.5–5 billion in 2014 (Chy 2017) and is expected to achieve $44.6 billion in 2023 (García et al. 2017). Macro– and microalgae commercial installations are worldwide: Europe has 430 micro- and 132 macroalgae companies with an economic value of more than €1.69 billion/year), North America: 105, Asia: 26, Oceania: 2 and Middle East: 7), macroalgae production is 19–23 million ton dw and their market are estimated at $5–6 billion (Avagyan 2018a).

Presently, fruits and vegetables incorporate little key nutrients such as proteins (on 6%), vitamin B_2 (on 38%), vitamin C, phosphorus, calcium, iron, etc. compared to past (Avagyan 2008d, 2012, 2018a, Davis et al. 2004). This can also have its contribution on registered non-communicable diseases such as cardiovascular or mental illness substitution by infectious illnesses which currently the leading cause of death (WEF 2020a) as well as increase probability of pandemics linked to low-quality diets (Avagyan 2008d, 2010b). For increasing the immunity system of humans and animals to infections, long-term priorities must be the use of microalgae bioenergy in diets as they have high quantities of proteins

(50–70%, 15–17% in wheat, and up to 50% in meat), amino acids, a fairly big quantities of vitamins B_1, B_2, B_3, B_6, B_{12}, E, K, D, up to 30% lipids, 8–10% carotene, macro- and microelements, etc., in comparison with other plants or animals and algae applied in the human diet for thousands of years (Avagyan 2010a, b, 2012, 2018a). Their biomass is used also for at large scale production of carotenoids and astaxanthin as well as microalgae biomass can be used for a variety Biopharma product developments such as omega-3-fatty acids, arachidonic, eicosapentaenoic acids, stimulator of T-cells which largely improving the protecting ability of the immune system toward diseases like cancer, hypoglycemia, and bacteria, etc. (Avagyan 2010b, 2012, 2018a). Researches of the epidemiology of influenza and COVID-19 showed that vitamins B, C, D, zinc, etc. which may have influences on how people immune system works to fight off infections can be a useful tool to reduce risk (CDC 2020, Grant et al. 2020, Maghbooli et al. 2020, MedicineNet 2020, Narayanan and Nai 2020). Hence, microalgae have a high potential for present and future food security and human health.

In 2015–2017 the worldwide demand for feed was 1.6 billion tons and is supposed to increase up to 1.9 billion tons in 2027 with an annual growth rate of around 1.7% (OECD-FAO 2018). Throughout past years, the commercial goal of farmers was to gain the feed high assimilability which mainly was achieved by supplementation of cellulose hydrolysis enzymes as well as using small concentrations of powdered activated carbon (Avagyan 2008d, 2012). This unilateral formulation promotes decreasing product quality and the ability of animals immune system toward diseases. As a result growth of the mass epidemics amid animals and poultries in many states were evidenced. Since the 1970s, the former USSR established the industrial cultivation of microalgae (more than five hundred installations) for the production of microalgal feed additives (Avagyan 2008d, 2012, 2018a). On a large scale, it was shown that *Chlorella* suspension, pasta, and powder act as excellent feed supplements and boost the middle daily weight of cattle, sheep, poultry, fish, etc. on 11–20%; cow milk production on 17–20%; and poultry egg-laying on 10–20%. The account showed that producing of microalgae biomass of 417,659 t/year for addition like 1% feed additive can cost-effectively satisfy the demand of Top 6 high feed consumed countries for total feed additive by China at 23.2%, the US – at 21.1%, Russia – at 143.5%, Germany – at 174.8%, Japan – at 178.5%, and France – at 417.7% or they total feed additive demand of broiler branch – at 32.3% as well as common feed additive demand of aquaculture at 216.4% (Avagyan 2017, 2018a). Simultaneously, the expected fishmeal demand in 2025 will be 5.1 Mt and in case of fishmeal substitution by microalgae, it will allow mitigation of 9.33 $MtCO_2et$/year (Avagyan 2018a, WEF 2018). On the other hand, up to 2030, the global animal protein consumption replacement by alternative proteins (such as microalgae) on 10–15% will have the consequence of GHG emission reducing up to 550–950 $MtCO_2e$/year (WEF 2018). At the same time, antibiotics use in animal production results in arisen antibiotic-resistant bacteria that are pathogenic to humans and animals, and therefore many countries removed antibiotic growth promoters from animal diets (Avagyan 2008d, 2010a, 2012, 2018a). As an antibiotic alternative, it was offered organic acids and the use of essential or botanical oils. In this context, the use of microalgae *Chlorella* additive may be the better decision as incorporate natural organic acids: hexadecatetraenoic ($C_{16}H_{24}O_2$) up to 7–8% of total fatty acid content and octadecatetrienoic ($C_{18}H_{30}O_2$) acid together with oxy, aldehyde, and keto acids (Avagyan 2008d, 2012, 2018a). Due to the content of these acids, *Chlorella* has applied also for feed storage.

Conclusions

The possibility of origination and evolution of the life landforms were the results of bioenergy accumulation by microalgae which promoted decreasing CO_2 and the growth of O_2 contents (up to 35%) in the atmosphere that facilitates also creating stratospheric O_3 layer protecting the life from biologically lethal Sun UV radiation. In the Archean Eon, bioenergy accumulation by plants and its biomass further geologic transformation to fossil fuel which consumption in energy, industry, and agriculture since the late 1800s and early 1900s increase with a growing speed GHG emission inducing Climate change. Simultaneously, as a result of anthropogenic activities fixed lost forests and their role in accumulation air carbon and bioenergy, degradation of agricultural land, and water resource. What is the most hopeful and conceptual tool for sustainable development and move to the circular economy? Our former theory (Avagyan 2008b, 2012) is modeled from reality which has a history of some million years of implementation and devoted to life existence and solving problems of anthropogenic activity with the transition toward a bioeconomy and must the use in decision-making as algorithms to build the future. At present, the contribution of algae remains dominant in reducing CO_2 and maintaining O_2 level in the atmosphere. Historically, microalgae are the better organisms for the active accumulation of bioenergy compared with higher plants, have a high potential for the present and future food security and human health, can be cultivated away from agricultural land, for cleaning wastewaters and groundwater, improve the soil's mineral composition through increase content of organics, oxygen, water binding, etc. with the shift towards the elimination of the use of fertilizers, can cost-effectively satisfy the demand in high-quality feed additives and increasing product yields of agricultural animals as well as serving as feed antibiotic alternative and means against pandemics. Population growth and its needs in foods stimulate the accumulation of air carbon and bioenergy. However, the application of fertilizers, certainly, was promoted to a growing volume of agricultural production and population but their production and use originated large GHG emissions. Consequently, there is a big conceptual need to shift on organic agriculture including algae fertilization of soil to contribute to decreasing environmental degradation and long-term sustainability.

In the Energy branch, the current situation is unwanted in the area of biofuels policy as the collected data provides that currently used technology for 1G biofuels production as well as microalgae to commercial biofuel technology based on biomass phototrophic growth by the use of fertilizers is induced aggressive increasing GHG emission instead of their mitigation. Any decision-makers, experts, or journalists can account and get the obvious results that the governments subsided oil and 1G biofuel technologies which are increased GHG emissions. Microalgae biofuel has big potential in case the use of wastewaters and food waste for biomass growth towards sustainable system configuration. Such an approach will be the best solution for mitigation GHG emissions, restoration of water resources, and reuse materials as well as engage a diversification strategy as a way for boosting the companies' growth rate. Decision-makers need better verification and inventory data by the production of raw material to the final product such as 1G biofuel, to set measurable targets, design, and monitor implementation by ISO 14064 for biofuels and food security initiatives. System analyses provide that the main obstacle to the implementation of algae biofuel potential is unproductive policies that make complications in the connection of the goals of economic development and environmental activity.

In this context, the conventional and nuclear warms escalation is one of a top threat as can cause decreasing accumulation of bioenergy and conservation of carbon in organisms as well as the development of military sectors to move to the rising of GHG emissions.

Analyses of the Kyoto Protocol, Paris Climate Agreement, Emissions Trading system, carbon prices, etc. results provide that their application has many disadvantages which discourage significantly decrease pollution and environmental failures. It was fixed that the world is edging closer to the point of no return (Guterres 2020) but the member-parties of the Paris Climate Agreement unlearning lessons from the low effectiveness by solving large-scale environmental problems. The UNEP hoped to attract enough private investment for climate action, but its offered approach is not business sound. A philanthropic approach to environmental issues can take place, but the severity of the challenges requires the creation of economic incentives to ensure the preservation of life conditions. For such circumstances, the relation ought on the economic Law of Supply and Demand. The New policy must be founded on the acceptance of the Life Conserve industry that will allow mobilizing private finance to climate actions. Summarizing the issues described above, the world community must start preparing a tougher new arrangement with a change in organizational, political, financial, and technological choices.

Our theory includes generalized explanations of how nature works, confirmed by pieces of evidence, cover predictions for further technological developments towards economically and environmentally sustainable industrial processes as well as provides the role of bioenergy accumulation and transformation for improved understanding about evolution, influences of anthropogenic activity, decision-makers errors, technological choices, pandemics prevention, and the necessary skills toward the innovation algae-based system. Microalgae are the most optimal and productive means for accumulating excess solar radiation, transforming it into bioenergy with a direct effect on mitigation of global warming and Climate change, removal of GHG emission as well as promoting food, feed, and energy security and human health. Therefore, the conceptual shift of the world community must be the advancement of algae system technologies worldwide application for fostering sustainable development.

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