

**“TRANSITIONING TO SCIENCE-BASED INVESTING”**

2019 Green Transition Scoreboard® Report: "Transitioning to Science-Based Investing"

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This report does not contain investment advice. For full disclosure: principals of Ethical Markets Media, LLC, are personal investors in green companies (see Appendix 1).

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## EXECUTIVE SUMMARY

Ethical Markets Green Transition Scoreboard® (GTS) annual tracking private green investments worldwide since 2009, now finds a cumulative USD \$10,387,278,576 trillion, as of May 2019. Our totals are as follows, with further breakdowns later in this Summary:

### 2019 Sector Totals

Sector	Amount US \$
Renewable Energy	\$ 4,419,326,835,848.63
Energy Efficiency	\$ 2,172,353,867,074.30
Life Systems	\$ 1,948,093,945,462.55
Green Construction	\$ 1,265,705,544,757.02
Corporate Green R&D	\$ 581,798,094,434.02
<b>Grand Total</b>	<b>\$ 10,387,278,287,576.50</b>

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Following our GTS 2018 report, “CAPTURING CO<sub>2</sub> WHILE IMPROVING HUMAN NUTRITION & HEALTH“, in this new report, “TRANSITIONING TO SCIENCE-BASED INVESTING: 2019-2020“, we update on the rapid expansion now well underway of the plant-protein food sector worldwide and the wave of new scientific studies behind this shift in our global food system which we saw as inevitable. We track how the growing evidence of climate change disruptions, long forecast by the Intergovernmental Panel on Climate Change (IPCC): floods, fires, droughts, hurricanes and species losses worldwide, have changed public opinion toward recognizing these life-threatening events affecting most countries and the global economy. Most strikingly, we uncovered the extent to which financial asset managers of mutual funds, pension funds, endowments and sovereign wealth funds are still largely operating on obsolete textbook models and algorithms ignoring today’s new risks to our living biosphere and life-support systems.

In this report, we reveal that today, the biggest unrecognized financial risk in all global markets is “science- denial”! This report is the first in-depth examination of this ubiquitous problem of science-denial, its roots in human cognitive biases, and the various financial risks it is imposing in markets worldwide. We reveal which sacred cow theories and so-called “economic laws” and accounting protocols have led asset managers, businesses and policy-makers astray.

Financial systems and global markets are still operating on anthropocentric textbook formulas, erroneous views of “human nature” and resulting obsolete models of risk, focusing on short-term monetary rewards. Since price data is always historic, they are often backing into the future looking through rearview mirrors. Some 3 million different indexes drive global markets, all encoded in various algorithms and using computer-driven high-frequency trading.<sup>1</sup> Today’s financial markets are largely driven by internal trading of secondary securities, ETFs, theme-based portfolios, robo-advisors based on anthropocentric concepts, rather than reflecting the latest real-world science, data and planetary trends.

We continue to urge financial advisors and asset managers, as well as private investors to shift their attention from this outdated theoretical “economism” to investing based in Earth systems science and the real-time information of over 120 Earth-observing satellites of many countries’ space programs, including NASA and ESA, the European Space Agency.<sup>2</sup> These satellites offer farmers information on weather patterns, agricultural conditions as well as information on planetary conditions of droughts, rainfall, pollution, ocean and atmospheric temperatures and specifics on sea-levels, fish stocks, tracking shipping. Financial groups use such information for just forecasting micro trends, like cars in retail parking lots for investors, businesses and portfolio managers.<sup>3</sup>

The GTS tracks Renewable Energy, Energy Efficiency, Life Systems, Green Construction and Corporate Green R&D, representing broad areas of investment in green technologies. Each sector covers an area of substantial capital investment in technologies which lead investigator Henderson’s years of research as a science advisor and the Ethical Markets Advisory Board expertise indicate are continuing to contribute to the growing green economy. Our Life Systems category tracks Fintech for sustainability, including peer-to-peer lending and crowdfunding, e-learning and social media in addition to other subsectors tracking the system-wide interconnections among food, agriculture, water, education and health. This 2019 GTS continues these systemic explorations and how investments can be redirected to address all 17 Sustainable Development Goals (SDGs) ratified by 195 member countries of the United Nations (UN) in 2015. In this report, we continue to explore the need to re-direct investments beyond the 3% of the planet’s freshwater on which too much of human food is currently dependent.

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<sup>1</sup> Henderson, H., “Perspectives on Reforming Electronic Markets and Trading” (2014), also see [www.unepinquiry.org](http://www.unepinquiry.org)

<sup>2</sup> Henderson, H., see for example, “Mapping the Global Transition to the Solar Age: From Economism to Earth Systems Science”, forward by NASA Chief Scientist Dennis Bushnell, London (2014)

<sup>3</sup> Bloomberg Businessweek, “Interrogating the Planet”, May 20, 2019, p. 20-21

We present new research on how natural systems: forests, wetlands, coastal ecosystems and indigenous farming can not only capture CO<sub>2</sub> from the atmosphere in growing a wide variety of overlooked food plants and trees to expand human food sources. We also offer additional evidence of the viability and necessity of shifting attention and investments toward agriculture based on the planet's 97% saltwater, using the 10,000 varieties of salt-loving (halophyte) plants for human nutrition that can grow on the degraded 40% scrub and desert lands worldwide. This halophyte agriculture has been practiced for millennia in 22 countries without fertilizers or pesticides and can also provide quality fuels from saltwater-grown algae. Some halophyte crops are now coming to market, including the complete protein grain quinoa, now in most super-markets, along with China's salt-tolerant rice.

The upward trend in investments since 2007 aligns with our recommendation to invest at least 10% of institutional portfolios directly in companies driving the global Green Transition, updating strategic asset allocation models both as opportunities and as risk mitigation. Excluding government investments to the extent possible, the \$10,387 trillion in private investments and commitments as of 2019 keeps private investors on track to continue in green sectors investments globally by 2020. NASA Chief Scientist Dennis Bushnell agrees with our contention that continuing all these investments could in a decade create new wealth ... and that we already have the technologies to solve food, water, and climate challenges.<sup>4</sup>

We strictly define 'green' by omitting technologies such as nuclear, clean coal and most biofuels (except algae grown on brackish or saltwater or biofuels sourced and used on small local farms). We assess rapidly advancing technologies such as artificial intelligence (AI) see "AI + Algorithms = Assumptions!", as well nanotech and IoT (Internet of Things), see "The Idiocy of Things Requires An Information Habeas Corpus". We follow global digitization trends, the future of the internet and the politicization of social media in the Overview. Sources of financial data are screened by rigorous social, environment and ethical auditing standards, also tracking the evolution of these standards worldwide. For example, the Climate Disclosure Standards Board (CDSB) now aligns its framework's 5-year strategy with the Taskforce on Climate-Related Financial Disclosures (TCFD).<sup>5</sup> The World Business Council for Sustainable Development (WBCSD) publishes its ESG Disclosure Handbook to guide asset managers, corporate officers and accountants.<sup>6</sup>

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<sup>4</sup> Bushnell, D. M., "Broadband Effective and Affordable Approaches to Climate", Chief Scientist, NASA Langley Research Center, Hampton, VA, Dec. 2018

<sup>5</sup> Climate Disclosure Standards Board, "CDSB" Framework", Apr. 9, 2018

<sup>6</sup> ESG Disclosure Handbook, Apr. 2019, WBCSD, [www.wbcsd.org](http://www.wbcsd.org)

## RENEWABLE ENERGY

Renewable Energy – Growing strongly, with our total of \$4.419 trillion as fossil fuels become “stranded assets”, with the rise of electrification in transport. Most commitments are from green bonds, along with banks including JP Morgan Chase, \$200 billion, HSBC, \$100 billion and Wells Fargo, \$30 billion. Cost parity of renewables, limiting carbon emissions are driving evolution to sustainable societies. For example, the research of CDP finds an eightfold increase in global companies now pricing carbon since 2013. These include 100 FORTUNE 500 corporations with collective annual revenues of \$7 trillion.<sup>7</sup> Such carbon pricing is recommended by the Taskforce on Climate Related Financial Disclosures (www.fsb-tcfd.org). Mexico's renewable energy grew toward the government's target of 13.9% of power to be green by 2022.<sup>8</sup>

Renewable Energy		US \$
Year		Amount US\$
2007	\$	170,200,000,000.00
2008	\$	224,200,000,000.00
2009	\$	209,500,000,000.00
2010	\$	267,300,000,000.00
2011	\$	334,700,000,000.00
2012	\$	282,100,000,000.00
2013	\$	281,000,000,000.00
2014	\$	322,200,000,000.00
2015	\$	397,000,000,000.00
2016	\$	375,000,000,000.00
2017	\$	417,800,000,000.00
2018	\$	432,000,000,000.00
Commitments	\$	706,326,835,848.63
<b>TOTAL</b>	<b>\$</b>	<b>4,419,326,835,848.63</b>

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<sup>7</sup> CDSB Framework, "Advancing and aligning disclosure of environmental information in mainstream Reports, Apr. 2018, [www.cdsb.net/framework](http://www.cdsb.net/framework)

<sup>8</sup> Sustainable Brands, Finance & Investment, Oct. 12, 2017

## ENERGY EFFICIENCY

Energy Efficiency –Grew to \$2,172 trillion, which reduces company costs and is the driver of the circular economy where many companies now compete to upcycle all kinds of previously ignored waste streams, e.g. TerraCycle and ECOR. Efficiency using all resources creates widespread ripple effects and as electrification and better storage advance in transport and other sectors. Such supply chain efficiency investments help suppliers become more energy efficient, as reported by CDP, the Carbon Disclosure Project. This positively impacts job creation, manufacturing and other metrics tracked by traditional GDP and is integral to transition management, quality of life metrics as reported in Life Systems. The fundamental underpinning of the circular economy now envisioned widely, rest on systemic energy and material efficiency and re-using, re-manufacturing, recycling and upcycling of all resources as we describe in our Overview.

Energy Efficiency	
Year	Amount US \$
2007	\$ 73,675,781,344
2008	\$ 81,140,728,352
2009	\$ 89,362,035,630
2010	\$ 98,416,338,800
2011	\$ 100,283,850,000
2012	\$ 113,653,500,000
2013	\$ 127,731,200,000
2014	\$ 152,830,000,000
2015	\$ 164,292,250,000
2016	\$ 176,614,168,750
2017	\$ 189,860,231,406
2018	\$ 204,099,748,762
Commitments	\$ 68,824,885,544
SMARTGRID	\$287,719,148,486
<a href="#">Supply Chain Efficiencies</a>	\$164,700,000,000
<b>TOTAL</b>	<b>\$2,172,353,867,074.30</b>



## Life Systems

water, land, remediation, waste and recycling, green infrastructure. Water is 60% discounted to assume mostly gov't spending. Community investments as defined by the Global Sustainable Investing Alliance as targeted investments aimed at solving social or environmental problems, and including community investing. Capital is specifically directed to traditionally underserved individuals or communities, as well as financing that is provided to businesses with a clear social or environmental purpose. Info-structure, education, community investing includes the myriad of digitization opportunities and risk in investments often overlooked as too small, such as the Fintech 100. Fintech was up due to investments in China. Plant-protein foods are a growing category.

Life Systems	
Subsector	Amount US \$
Water	\$988,903,046,811
Community Investments	\$44,426,000,000
E-Learning	\$49,425,354,652
Land & Water Remediation	\$426,390,000,000
Waste + Recycling	\$22,815,944,000
FinTech VC	\$152,994,000,000
Peer-to-Peer Lending	\$263,139,600,000
Plant Protein Foods	\$746,300,000
<b>TOTAL</b>	<b>\$1,948,093,945,463</b>

## Green Construction

Green Construction – This sector advanced strongly to \$1,265 trillion ranging from “low-tech” passive solar buildings to “high-tech” and new construction methods. For consistency, we omit labor, thus undercounting a form of capital which intrinsically increases the value of green construction. We also point to new trends, such as high-rise food-growing on urban skyscrapers, and startups in vertical urban agriculture in our Overview.

Green Construction	
Year	Amount US \$
2007	\$50,464,262,053
2008	\$56,701,418,037
2009	\$63,709,458,468
2010	\$71,583,661,200
2011	\$80,431,080,000
2012	\$90,372,000,000
2013	\$101,668,500,000
2014	\$108,375,000,000
2015	\$134,300,000,000
2016	\$148,750,000,000
2017	\$169,745,000,000
2018	\$189,605,165,000
<b>TOTAL</b>	<b>\$1,265,705,544,757</b>

## Corporate Green R&D

Corporate Green R&D – Grew strongly to \$581 billion, this sector is also heavily weighted in favor of automotive industries and their shift to electric vehicles, batteries, energy generation, conservation and distribution. Oil prices hovering between \$55-65 a barrel, even OPEC supply cuts have not cleaned backlogs. Saudi Arabia is re-shaping Aramco toward chemicals, feedstocks and renewables in anticipation of its IPO. Some companies have still not reported to 2018 investments. Commitments are mostly from car companies' R and D in electric vehicles and batteries.

Corporate Green R&D	
Year	Amount
2007	\$ 27,774,412,412
2008	\$ 29,530,269,669
2009	\$ 29,112,465,916
2010	\$ 31,336,733,011
2011	\$ 42,072,227,948
2012	\$ 52,199,705,541
2013	\$ 41,560,413,197
2014	\$ 48,426,581,813
2015	\$ 44,222,724,211
2016	\$ 51,913,189,529
2017	\$ 46,624,606,331
2018	\$ 40,135,907,361
Commitments	\$ 96,888,857,487
Total	\$ \$581,798,094,434.02

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# Overview

## **GREEN TRANSITION SCOREBOARD® 2019-2020** **“TRANSITIONING TO SCIENCE-BASED INVESTING”**

by Hazel Henderson

This final report confirms Ethical Markets annual projections with over \$10.387 trillion privately invested in green sectors worldwide detailed in our Executive Summary---since our initial report in 2009. Our forecast, based on our model's assumptions: that if renewably-resourced technologies continued to receive at least \$1 trillion of private investments annually worldwide, that these technologies would scale to compete price-wise with incumbent fossil-fueled industries and sectors and nuclear power. Today, in 2019 this price parity of renewables has been achieved and in many cases, solar and wind are now cheaper than fossil fuels, coal and oil as well as nuclear power --- while natural gas is still cheap (since the costs of fracking; e.g. water use, earthquakes) are still externalized. Further, our decade of reporting on this global green transition is now the subject of many mainstream financial media, hundreds of fossil fuel portfolios and daily news reporting. Happily, we are now passing the torch to these mainstream media. Daily headlines now report such news, as in the BBC's global news that the UK Parliament declared a climate change emergency<sup>9</sup> and US media's daily reporting on Congress and it's Green New Deal.<sup>10</sup> We expect that our decade of research on green technology choices can help steer more private investors and companies into participating in this new “moonshot”.

In 2009, we led by tracking the levels of these private investments in renewably-resourced energy and materials in more circular economies and detailed the evolution of these cleaner, less-polluting, lower-carbon technologies including those in: energy (solar, wind, geothermal, ocean, hydro, hydrogen), storage, transport, lighting, buildings, infrastructure, agriculture, food, freshwater, saltwater as well as overall efficiency improvements, information and community resilience, re-use, re-manufacturing, recycling and upcycling. We omitted nuclear power, as well as biofuels except those used locally on small farms and algae grown on saltwater. Our annual reports on this global transition from the earlier fossil-fueled Industrial era, disseminated the news on progress of these technologies scaling, as the global private investments steadily increased at over \$1 trillion in each of these successive years.

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<sup>9</sup> BBCTV “UK Parliament declares climate emergency”, May 2, 2019, [www.bbc.com/news/uk-politics-48126677](http://www.bbc.com/news/uk-politics-48126677)

<sup>10</sup> US 116<sup>th</sup> Congress, H. Res. 109, [www.congress.gov](http://www.congress.gov)

## Science-Denial Revealed as a Financial Risk

“These disruptive trends were also changing and being changed by socio-economic and political macro trends. We also noted the underlying shifts in paradigms, economic models and financial algorithms, as well as in accounting protocols toward ever more expansive views and multi-disciplinary, systems approaches to metrics and indicators used in public, private and civic sectors, as science-based

**Periodic Table of the Elements**

The periodic table includes the following elements and their atomic numbers:

- Group 1 (IA):** H (1), Li (3), Na (11), K (19), Rb (37), Cs (55), Fr (87)
- Group 2 (IIA):** Be (4), Mg (12), Ca (20), Sr (38), Ba (56), Ra (88)
- Groups 3-10 (VB-VIIB):** Sc (21), Ti (22), V (23), Cr (24), Mn (25), Fe (26), Co (27), Ni (28), Cu (29), Zn (30), Ga (31), Ge (32), As (33), Se (34), Br (35), Kr (36), Rb (37), Sr (38), Y (39), Zr (40), Nb (41), Mo (42), Tc (43), Ru (44), Rh (45), Pd (46), Ag (47), Cd (48), In (49), Sn (50), Sb (51), Te (52), I (53), Xe (54), Cs (55), Ba (56), La (57), Ce (58), Pr (59), Nd (60), Pm (61), Sm (62), Eu (63), Gd (64), Tb (65), Dy (66), Ho (67), Er (68), Tm (69), Yb (70), Lu (71), Fr (87), Ra (88), Ac (89), Th (90), Pa (91), U (92), Np (93), Pu (94), Am (95), Cm (96), Bk (97), Cf (98), Es (99), Fm (100), Md (101), No (102), Lr (103)
- Group 11 (IB):** Ag (47), Au (79), Hg (80)
- Group 12 (IIB):** Zn (30), Cd (48), Hg (80)
- Groups 13-18 (VIIA-VIIIA):** B (5), C (6), N (7), O (8), F (9), Ne (10), Al (13), Si (14), P (15), S (16), Cl (17), Ar (18), Ga (31), Ge (32), As (33), Se (34), Br (35), Kr (36), In (49), Sn (50), Sb (51), Te (52), I (53), Xe (54), Ba (56), La (57), Ce (58), Pr (59), Nd (60), Pm (61), Sm (62), Eu (63), Gd (64), Tb (65), Dy (66), Ho (67), Er (68), Tm (69), Yb (70), Lu (71), Fr (87), Ra (88), Ac (89), Th (90), Pa (91), U (92), Np (93), Pu (94), Am (95), Cm (96), Bk (97), Cf (98), Es (99), Fm (100), Md (101), No (102), Lr (103)

**Legend:**

- Alkali Metal
- Alkaline Earth
- Transition Metal
- Semimetal
- Nonmetal
- Basic Metal
- Halogen
- Noble Gas
- Lanthanide
- Actinide

Fig. 1: Periodic Table of the Elements-needed for science-based investing

investing became necessary. This shift can also be seen as transitioning from anthropocentric, conceptual investing formulas, benchmarks and textbook models to empirical science-based investing. Long-accepted norms and functions of central banks were re-examined, as well as the politics of money-creation and credit allocation (see our TV Special “The Money Fix”). This illuminated the role of money, as local and cryptocurrencies and fintech startups began invading legacy banking, insurance, lending, remittances, crowdfunding, based on blockchain and similar electronic platforms. We reported on these trends in GTS 2018. Globalization’s risks obscured by money-based GDP metrics became increasingly challenged after the 2008 financial meltdowns and bailouts of mainstream financial firms. The concept of shifting from today’s 3 million financial indexes, passive investing, theoretical formulas, benchmarks, financial algorithms and models to science-based investing seems appropriate in this 150th anniversary year of the Periodic Table of Elements. (Fig. 1) The risks of science-denial to the financial sector as the transition from fossil fuels continues is estimated by the coalition of central banks in the Network for

Greening the Financial System (NGFS) at losses of between \$1 trillion to \$4 trillion.<sup>11</sup> The Climate Action 100 group of 58 investors in BP (with under 10% of its shares) call for more progress toward the Paris climate targets, while Aviva's Steve Waygood says "The scientific consensus is crystal clear on the need for far-reaching action by corporates in limiting global warming to 1.5°C."<sup>12</sup>



Fig. 2: Sustainable Development Goals (SDGs)

Public outcries and civic organizations worldwide increased their demands for a global shift to ecologically-designed, circular, more equitable, inclusive and sustainable societies, all based on science, beyond the narrow economic metrics including GDP.<sup>13</sup> We followed these wider trends and the gradual shift toward science-based investing in each of our annual reports. By 2015, we saw an inflection point as the 195 member countries of the United Nations ratified the Sustainable Development Goals (SDGs) (Fig. 2) and signed on to the Global Climate accords and INDCs in Paris at the IPCC's COP 23. Earth systems science and planetary awareness were winning the paradigm battle! So-called "economic laws" gave way to the laws of physics and thermodynamics! Indeed the consortium of members of the World Business Council on Sustainable Development, the American Chemistry Council and investors

<sup>11</sup> Carbon Tracker, "Reporting for a Secure Climate", May 3, 2019

<sup>12</sup> GreenBiz, Holder, M. "Unprecedented: Why BP investors holding billions in shares are backing a climate Resolution", May 20, 2019, [www.greenbiz.com](http://www.greenbiz.com)

<sup>13</sup> Henderson, H., "Mapping the Global Transition to the Solar Age: from Economism to Earth Systems Science", London, 2014



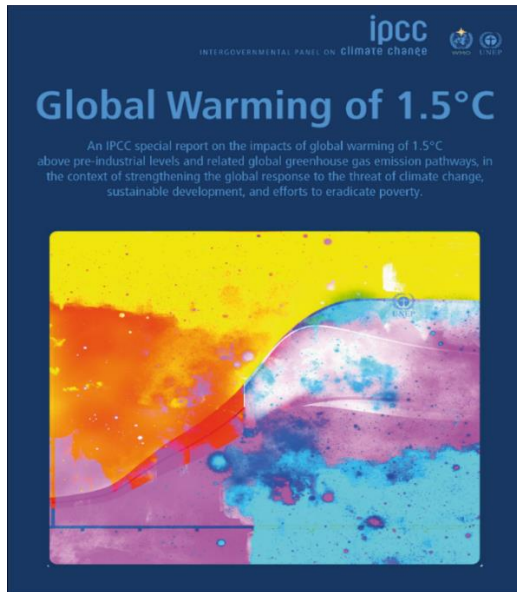


Fig. 3: IPCC Report, Oct. 2018

The SDG Compass provides companies with a framework and set of resources with five key steps for SDG integration as well as the SDG Survey on corporate priorities of SDG's goals and performance. The WBCSD's "CEO Guide to the SDGs" focus on four corporate implications 1) Risks of Inaction, 2) Capturing Opportunities, 3) Governance and Transparency, 4) The Need for Collaboration. Implications for business opportunities in achieving the SDGs could unlock US \$12 trillion a year of added value, (US \$2.3 trillion in food and agriculture; US \$3.7 trillion in cities and urban mobility; US \$4.3 trillion in energy and materials and US \$ 1.8 trillion in health and well-being). Similar benefit calculations underlie the Resolution for the

adopted the SDG model of integrated human development sustainable on planet Earth.<sup>14</sup> They endorsed the Trucost Evaluation Model of Corporate Performance<sup>15</sup> along with the SDG Compass.<sup>16</sup> The IPCC report (Fig. 3) finds that limiting global warming to 1.5°C requires "rapid and far-reaching" transitions in land, energy, industry, buildings, transport and cities --- "possible within the laws of chemistry and physics".<sup>17</sup> The report states that this will require unprecedented changes in all aspects of society and a five-fold increase in average annual investment in low-carbon energy technologies by 2050. The \$2.4 trillion needed annually through 2035 is an almost sevenfold increase over the \$333.5 billion in renewable energy over 2017.<sup>18</sup>



Fig. 4: Implications for Business-Opportunities WBCSD

<sup>14</sup> S&P Global Trucost ESG Analysis, "Aligning Business Value with the UN Sustainable Development Goals", Mar. 19, 2019

<sup>15</sup> SDG Evaluation Report [www.trucostspglobal.com](http://www.trucostspglobal.com)

<sup>16</sup> SDG Compass

<sup>17</sup> IPCC op. cit. Jim Skea, Co-Chair, IPCC Working Group III, Oct. 8, 2018

<sup>18</sup> Bloomberg New Energy Finance, "Climate Crisis Spurs UN Call for \$2.4 trillion Fossil Fuel Shift", Oct. 8, 2018

Green New Deal in the US Congress supported by over 100 members and many of the presidential candidates.<sup>19</sup>



Fig. 5: The Investment Integration Project (TIIP)

In this final report, we find these trends continuing and now show a cumulative \$10.387 trillion invested privately in these growing knowledge-rich, greener sectors of the global economy, as in our model. Thus, we can now finalize our Green Transition Scoreboard® annual reports, since so many other research and financial news groups, accounting and indicator firms are now producing similar reports. As we showed in our 2016, 2017 and 2018 reports, this global green transition would have proceeded much more rapidly if economic and financial models had kept up with the earth systems science and technological trends we followed. As we reported in GTS 2018, a comprehensive survey “Measuring Effectiveness: Roadmap to Assessing System-level and SDG Investing” (Fig. 5) has led the way in shifting asset managers toward the broader, empirical, science-based

focus.<sup>20</sup> China’s 14th Five Year Plan (covering 2021-25) will focus on accumulating four types of capital: human, social, physical and natural, envisioned by China’s Green Finance Committee launched in November 2018.<sup>21</sup> Increasingly, corporate performance was being judged by the extent to which companies enhanced or degraded all six forms of capital (finance, built, intellectual, social, human and natural) as in the International Integrated Reporting Council (IIRC).<sup>22</sup> Their survey of corporate executives found 89% agree on the need to focus on wider value considerations.<sup>23</sup> At last, investors were responding and forced to deal with costs of the global natural disasters and the scientific ecological

<sup>19</sup> US 116<sup>th</sup> Congress, H. Res. 109, 116<sup>th</sup> Congress, [www.congress.gov](http://www.congress.gov)

<sup>20</sup> Burckart, W., Lydenberg, S., Ziegler, J., “Measuring Effectiveness: Roadmap to Assessing System-Level and SDG Investing”, TIIP (The Investment Integration Project) and the Investor Responsibility Research Center Institute, Apr. 2019. [www.tiipproject.com](http://www.tiipproject.com)

<sup>21</sup> Ma Jun, former Chief Economist, Peoples Bank of China, co-chair, Green Finance Study Group, China & UK at G20, Progress Report, 2017, [www.unepinquiry.org](http://www.unepinquiry.org)

<sup>22</sup> IIRC Newsletter, Oct. 2018. [www.theiirc.org](http://www.theiirc.org)

<sup>23</sup> Integrated Reporting, Association of International Certified Professional Accountants, Black Sun, “Purpose and Profit, Value of Value: The new long-term horizon for business leaders”, May, 2019



data on climate disruption. The 2019 State of Green Business report by GreenBiz and Trucost-S&P Global sees 2019 as set to be a “transformative year for the sustainability agenda”, based on their 30 indicators of corporate sustainability performance.<sup>24</sup>



Fig. 6: Greta Thunberg

The world’s children, led by Sweden’s Greta Thunberg (Fig.6) staged school strikes, as well as the growing unrest of rising populations demanding social, political and cultural changes toward more sustainable human societies for our common future. Following the

global 350.org student campaign to disinvest university and other endowments from fossil fuels, the Sunrise Movement in the USA is campaigning for the Green New Deal, [www.sunrisemovement.org](http://www.sunrisemovement.org).

We reference IPCC’s comprehensive update “Global Warming of 1.5°C” (2018)<sup>25</sup> and note the extent to which it has activated governments, business and academics with other new warnings, including Bill McKibben’s “Falter: Has the Human Game Begun to Play Itself Out?”, (2019); David Wallace-Wells “The Uninhabitable Earth” (2019); Mike Berners Lee, “There is No Planet B” (2019); Yuval Harari “21 Lessons for the 21st Century” (2018) and more positive views by Hunter Lovins in “A Finer Future” (2018) and biologist John Todd in “Healing Earth”, (2018). Many of these echoed Joseph Tainter’s, “The Collapse of Complex Societies”, (1988). This IPCC report has also confirmed the many previous analyses of veteran investment pioneer, Jeremy Grantham.<sup>26</sup>

We are gratified to see the accelerating responses from business, financial and some political leaders around the world. The science-based, ecologically-literate, systemic models of human

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<sup>24</sup> “2019 State of Green Business” report, Makower, J. and Mattison, R. 2019, GreenBiz Group and Trucost-S&P Global, [www.greenbiz.com](http://www.greenbiz.com), [www.trucost.com](http://www.trucost.com)

<sup>25</sup> IPCC. Op cit. Mitigation Pathways Compatible With 1.5° C in the Context of Sustainable Development”, p. 93-174, [www.ipcc.ch](http://www.ipcc.ch)

<sup>26</sup> Grantham, J. News from the Grantham Research Institute, LSE, “The Race of Our Lives”, Aug. 2018

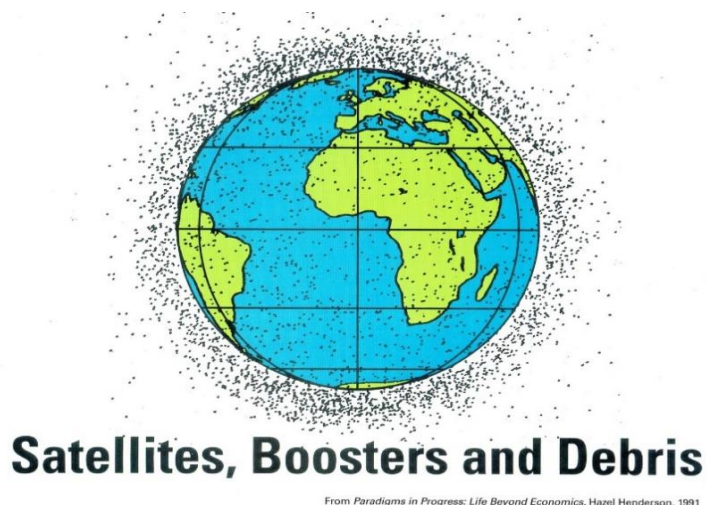



Fig. 7: Paradigms in Progress by Hazel Henderson, 1991

previously white-collar sectors, we are recognizing the shortcomings of algorithms based on our limited cognition as “bias in bias out”,<sup>28</sup> while advertising and profit-based social media companies are now recognized as a danger to our democracies, with many calls for breaking them up and the European Union’s new laws in their General Data Protection Regulation (GDPR) now widely adopted in other countries.<sup>29</sup>

Humans are learning that the planet itself is feeding back to us the results of our erroneous perceptions and short-term thinking and is now teaching us directly as our programmed learning environment. For example, human space debris from decades of careless satellite deployments now endangers future space exploration, (Fig. 7) as I noted in 1991.<sup>30</sup> As we face up to our self-inflicted crises, we are gradually growing up from our infantile stage to mature human

development now codified in the SDGs are also slowly entering political, social and financial debates and changing paradigms underlying single-focus siloed institutions. We are seeing the systemic, painful evolution of human societies, as well as recognition in brain sciences of our cognitive biases and emotional limitations.<sup>27</sup> As digital platforms continue to overtake so many traditional sectors of our societies, from media, retail, transport, to medical, legal, finance and other

Ethical Markets Media
www.ethicalmarkets.com www.ethicalmarkets.co



In the *Descent of Man* Charles Darwin wrote *only twice* of “survival of the fittest” — but *95 times* about love! 92 times about moral sensitivity. And 200 times about brain and mind.

Suppression over 100 years of the *real* Darwin has led to the social, political, economic, scientific, educational, moral and spiritual mess we are in today.

**Re-appraisals of Charles Darwin’s Origin of Species**

**Human species success based on:**

- ❖ **Evolution of Human Emotional Capacity for**
  - bonding (hormone: oxytocin)
  - cooperation
  - altruism

Source: The Darwin Project, [www.thedarwinproject.com](http://www.thedarwinproject.com)

Fig. 8: The Darwin Project

<sup>27</sup> Henderson, H., “[The Politics of Connectivity](#)”, CADMUS, May 2019

<sup>28</sup> Henderson H., “Let’s Train Humans Before We Train Machines”, [www.ethicalmarkets.com](http://www.ethicalmarkets.com)

<sup>29</sup> Henderson, H., “[The Future of Democracy Challenged in the Digital Age](#)”, CADMUS, Oct. 2018

<sup>30</sup> Henderson, H., “Paradigms in Progress”, Berrett-Koehler, 1991, 1996.

development, as described by political scientist/futurist William Halal.<sup>31</sup> We find that the many breakdowns we are experiencing also drive breakthrough and that stress has always been evolution's tool. Many deep thinkers are re-assessing the work of Charles Darwin (Fig. 8) and realizing that his theory of natural selection in no way translated into the convenient "social Darwinism" justified in Herbert Spencer's poisonous phrase "the survival of the fittest" by the winner-take-all, rapaciousness of power hungry elites. The theories of individualism, libertarianism and laissez-faire economics were shown as ideologies over-riding the wellbeing of the social groups of which we are all a part. Evolutionary biologist David Sloan Wilson described the despoliation of the environment and exploitation of weak and vulnerable populations due to such narrow ideologies.<sup>32</sup> The power of elites indifferent to injustice and inequalities was found to be the cause of the downfall of many states, as described by Acemoglu and Robinson in "Why Nations Fail" (2012).<sup>33</sup> The issues of justice and inequality were seen as exacerbating climate crises, as millions of climate refugees fled from climatic disasters:

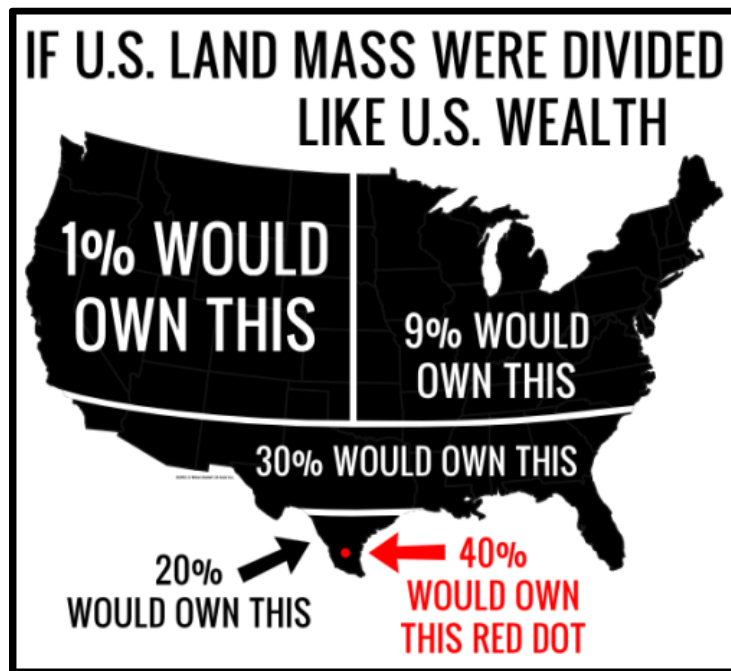


Fig. 9: Inequality in the USA

floods, droughts and hurricanes around the world. These refugees seeking asylum migrating to more fortunate countries began fueling "populist" politics among nativist groups. Many people surveyed by Pew Research are dissatisfied with how democracy is working.<sup>34</sup> Inequality is now accepted as a key social reform issue in most developed countries, with inequality at its highest level in the USA (Fig. 9) and Brazil. A comprehensive report "Inequality as a Systemic Risk" outlines how this gap between haves and have-nots is integral to democratic societies as well as their economies.<sup>35</sup> (Fig. 10)

<sup>31</sup> Halal, William, "The End of Knowledge", (2019)

<sup>32</sup> See for example, Sloan-Wilson, D., "The View of Life", (2019)

<sup>33</sup> Acemoglu, D., and Robinson, J. A., "Why Nations Fail", (2012)

<sup>34</sup> Pew Research Center, "Many Across the Globe Are Dissatisfied with How Democracy Is Working", May 13, 2019, [www.pewglobal.org](http://www.pewglobal.org)

<sup>35</sup> Green Alpha Advisors, "Inequality as a Systemic Risk", The threat, it causes and potential solutions", Jan. 25, 2019 [www.greenalphaadvisors.com](http://www.greenalphaadvisors.com)

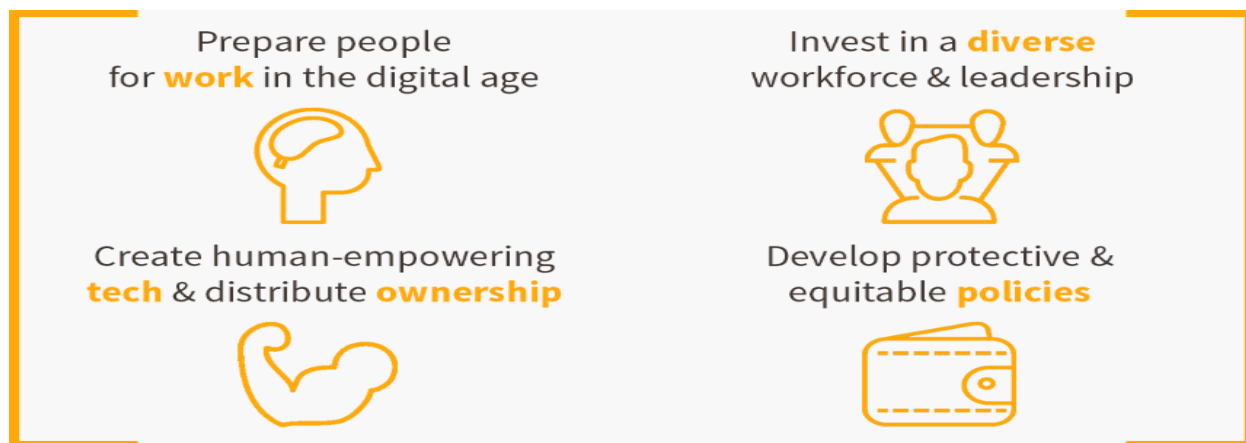


Fig. 10 Courtesy of Green Alpha Advisors

These asset managers also explore all the policy changes that might well close this growing gap. Cornerstone Capital Group's report, "Investing to Advance Racial Equity: Practical ways to tackle economic inequality" made the business and investing case for closing the gap.<sup>36</sup> The London School of Economics- Grantham Institute also calls for the global green transition to cleaner greener societies also be a "Just Transition" providing for all those tied to the dying fossilized sectors.<sup>37</sup> Former governor of India's Central Bank, Raghuram Rajan explains why capitalism needs populism in his critique of big business and big government elites.<sup>38</sup> Furthermore, IRENA the global institute promoting solar energy, sees solar as a democratized technology and advancing localism and decentralizing political power.<sup>39</sup> Others propose carbon taxes that are collected from polluters and then distributed back to the general public.<sup>40</sup> Democratizing investing so that individual clients can access their own portfolios and decision of their managers is becoming vital since many asset managers still follow routine algorithms that need updating on environmental risks. Cornerstone Capital now offers its "Access Impact Framework" enabling investors to measure the alignment of their portfolios to the issues that matter most to them.<sup>41</sup> Mainstream finance is boxed in on all sides. (Fig. 11) Scientists from many disciplines, such as those of The Darwin Project emphasized that Darwin had not used the phrase "the survival of the fittest", but rather this was coined by his contemporary, sociologist Herbert Spencer writing in the London-based journal The

<sup>36</sup> Cornerstone Capital Group, "Investing to Advance Racial Equity", Webinar on the report, Oct. 8, 2018, [www.cornerstonecapinc.com](http://www.cornerstonecapinc.com)

<sup>37</sup> Robins, N., Grantham Institute, London School of Economics and Political Science, "Investing in a Just Transition, June 1, 2018

<sup>38</sup> Project Syndicate, Rajan, R., "Why Capitalism Needs Populism", May 13, 2019, [www.project-syndicate.org](http://www.project-syndicate.org)

<sup>39</sup> Durden, T., "Energy Transition Will Upend Geopolitics", [www.zerohedge.com](http://www.zerohedge.com), IRENA, [www.irena.org](http://www.irena.org)

<sup>40</sup> Branson, Sir R., "Clean Energy Dividend", [www.looktothestars.org](http://www.looktothestars.org), Mar. 18, 2019

<sup>41</sup> Cornerstone Capital Group, "Introducing the access Impact Framework™", Apr. 23, 2019



Economist, for which the editors publicly apologized (Henderson, 2007). These scientists pointed out that in fact, Darwin had attributed the astounding success of the human species in colonizing the entire planet has been based on our genius for bonding, communicating, cooperating and sharing. Instead of economic models based on competition and private property to avoid “tragedies of the commons”, as echoed by biologist Garrett Hardin In his much-cited article in Science (1968), political scientist Elinor Ostrom showed with her research that communities often created rules for sharing their resources successfully.<sup>42</sup>



Fig. 11: Boxed-In Financial Markets, Hazel Henderson 2017

A recent example is research from the University of Michigan covering more than 18,000 community forests in Pakistan which found this shared management improved peoples wellbeing by 4.3% while reducing deforestation by 37%. Similar community forest management is practiced in Mexico, Madagascar, Tanzania and Indonesia.<sup>43</sup> This fact of cooperative sharing is evidenced by humanity's rise from roving bands of nomads to settled agriculture, then villages, towns, (Fig. 12) cities, global corporations, international agreements, global standards and protocols for commerce, trade and peace-keeping, as well as associations of those in science and professional societies, to the European Union and the United



Fig. 12: City Scene, Asia

Nations. Parliamentarians Jo Leinen and Andreas Brummel documented the history of human norms and standard setting in the succession of international agreements, treaties and protocols culminating in

<sup>42</sup> Ostrom, E., “Governing the Commons: The evolution of institutions for collective action”, Cambridge University Press, 1990

<sup>43</sup> ScienceDaily, “New research shows community forest management reduces both deforestation and poverty”, May 11, 2019

the founding of the United Nations and its continued development and future prospects.<sup>44</sup>

## **The Rise of Science-Based Investing**

As we tracked the evolution of our societies, cultures and economies, and the rise of science-based investing, we showed that humanity was slowly adapting to the new information societies based on “mediocracies and attention economies” (Henderson 1996) ... where the focus shifted from money to the value of time and attention.<sup>45</sup> Local and cryptocurrencies showed us that currencies are actually social protocols which depend on network effects of their various platforms and their prices depend on the extent to which people trust and use them.<sup>46</sup> Beyond money came deeper understanding of the various values which currency units represent and on which all budgets and priority statements were based. Indeed, we remembered that 25% of all world trade over the past years until today has been conducted in barter, as documented in “Countertrade, Barter & Offsets” (1985).<sup>47</sup> Mainstream, conventional finance became boxed in on all sides. (Fig. 11) Critiques grew even more systemic, including those by actuary Nick Silver, co-founder of green bonds in “Finance, Society and Sustainability”, (2018); economist Mariana Mazzucato’s “The Value of Everything” (2018) and “Collusion” by ex-Goldman Sachs executive Nomi Prins (2018). The Federal Reserve Bank of San Francisco produced a paper “Climate Change and the Federal Reserve”, a rare admission of how the real-world effects of climate change will affect the US economy.<sup>48</sup>

All this in our decade-long research is at last, culminating in evidence that mainstream metrics, indices and financial media gradually adopted these broader, scientific models capturing this systemic evolution of human societies ... now essential for our survival. An example is the now widespread adoption of green bonds (GTS 2014), pioneered by London-based Climate Bonds Initiative. After a slow start in



Fig. 13: Initiative Climate Bonds

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<sup>44</sup> Leinen, J., Brummel, A. “A World Parliament: Governance and Democracy in the 21<sup>st</sup> Century”, (2018)

<sup>45</sup> Henderson, H., “Mediocracies and Their Attention Economies”, (2017), [www.ethicalmarkets.com](http://www.ethicalmarkets.com)

<sup>46</sup> Gogerty, Nick, “The Nature of Value”, Columbia University Press (2012). Gogerty is CEO of Solar Coin, a rewards currency for verified solar-electricity producers and a partner of Ethical Markets, [www.solarcoin.org](http://www.solarcoin.org)

<sup>47</sup> Verzariu, P., “Countertrade, Barter & Offsets”, McGraw Hill, N.Y. (1985)

<sup>48</sup> Rudebusch, G., “Climate Change and the Federal Reserve”, FRBSF Economic Letter, Mar. 25, 2019.

this new century, they have now developed their own set of standards in cooperation with the Sustainable Accounting Standards Board (SASB) and robust auditing of the use of their proceeds. These bonds, first adopted by IFIs, are now routinely over-subscribed and mostly applied to new green infrastructure projects by municipalities, some countries and corporations.<sup>49</sup> While Blackrock's CEO Lawrence Fink continued issuing his letters to companies in their US \$6 trillion portfolio (97% unsustainable, and, still containing \$1 trillion of fossil liabilities)<sup>50</sup>, the more modest Gitterman Wealth Management firm had initiated the "NYC Sustainable Investment Conference for Financial Advisors", at the UN Headquarters as far back as October 19, 2017. Over 600 participant managers and institutions were introduced, many for the first time, to the opportunities as well as risks inherent in the SDGs. The Climate Policy Initiative reports on Global Climate Finance with details on public and private investments in many green sectors.<sup>51</sup> The IIRC's International Framework guides accounting for all six forms of capital. (Fig. 14)

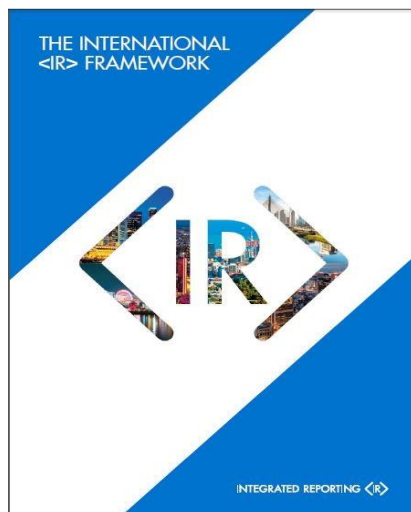


Fig. 14:  
The International Framework

In February 2019 a coalition, the "Climate Majority Project" was launched, led by New York City Comptroller Scott M. Stringer, representing \$1.8 trillion of 20 global pension funds demanding that the largest electric utilities commit to achieving net. Zero CO2 emissions by 2050.<sup>52</sup> The Climate Action 100+ a coalition of investors managing a total \$32 trillion is now confronting fossil companies directly --- and getting results, forcing Shell and BP to accelerate climate targets.<sup>53</sup> The group, NFGS, including 30 central banks, led by the Bank of France, the Bank of England and the People's Bank of China called for measures to spur green finance and better assessment of the risks from higher global temperatures. Insurers lost \$160 billion in 2018 from climate-related disasters.<sup>54</sup> Science-deniers Donald Trump and Brazil's Jair Bolsonaro and their central banks did not participate.<sup>55</sup> Carbon Tracker's "Reporting for

<sup>49</sup> Climate Bonds Initiative, Market Blog#22, Mar. 3, 2019 [info@crm.climatebonds.net](mailto:info@crm.climatebonds.net)

<sup>50</sup> World Resources Institute, "Serious about sustainability? Some progress but not yet persuaded by Blackrock's Efforts", Apr. 23, 2019

<sup>51</sup> Climate Policy Initiative, "Global Climate Finance: An Updated View, Nov. 2018, [www.climatepolicyinitiative.org](http://www.climatepolicyinitiative.org)

<sup>52</sup> Climate Majority Project, "Net-Zero by 5050", Feb. 28, 2019, [www.comptroller.nyc.gov](http://www.comptroller.nyc.gov)

<sup>53</sup> Bloomberg Businessweek, "Green, Rich and Intimidating", Apr. 15, 2019

<sup>54</sup> Bloomberg, "With Climate Losses Rising, Central Banks Push Greener Finance", May 13, 2019, [www.bloomberg.com/news](http://www.bloomberg.com/news)

<sup>55</sup> Ibid

a Secure Climate” is a model for upstream oil and gas companies to assess which of their fossil reserves may become “stranded”, identifying material risks to investors.<sup>56</sup> Science-denial in the USA is evident in the US Congress where members exhibit their ignorance at televised hearings. This led to efforts to revive its US Office of Technology Assessment (OTA) shut down in 1996 by science-denying members whose special interest supporters were opposed to OTA’s ground-breaking research.<sup>57</sup>

We have documented pioneering asset managers’ new models as they developed since the early 1980s, including screens developed by Alice Tepper-Marlin in the work of the Council on Economic Priorities since the mid-1960s. Mutual funds adopting these social and environmental screens include Calvert, Pax World, Parnassus, Alternative Energy, as well as Innovest which led in developing these screens for advising asset managers. We list such pioneer asset managers, credit unions and B corporations in our Ethical Money Directory as a free public service.<sup>58</sup> These new models began as “Socially-Responsible Investing”; “Double Bottom Line” then “Triple Bottom Line” and became known as “ESG (environment, social, governance)” funds and, as they became more mainstream, many took on the moniker as “Impact Investments”. This term enabled entry into mainstream finance circles, but with a loss of clarity, since, of course, all investments have impacts. Many pioneer asset managers preferred the earlier descriptions, and pointed out the confusion over “impacts”, since many investments blew the tops off mountains and polluted the environment. The Global Impact Investing Network (GIIN) launched its IRIS tool to measure impact in investments more precisely<sup>59</sup> which will be key in evaluating investments in forests.<sup>60</sup>



Fig. 15: Circular Economy

<sup>56</sup> Carbon Tracker, “Reporting for a Secure Climate”, May 2019

<sup>57</sup> Washington Post, “Why is Congress So Dumb?”, Jan. 11, 2019 (full disclosure: Hazel Henderson served on OTA’s Technology Assessment Advisory Council)

<sup>58</sup> Ethical Markets, “Ethical Money Directory”, [www.ethicalmarkets.com](http://www.ethicalmarkets.com)

<sup>59</sup> Global Impact Investing Network (GIIN), May 16, 2019, [www.theginn.org](http://www.theginn.org)

<sup>60</sup> Global Impact Investing Network (GIIN), “New Report: GIIN identifies compelling opportunities in the growing Forestry-focused impact investing space.”, Apr. 24, 2019





Fig.16:  
Ethical Biomimicry Finance®

This conceptual evolution is still proceeding, with the now widespread adoption of the “circular economy” (Fig. 15) adopted from the Ellen MacArthur Foundation and its founder, Ellen MacArthur, the first person to circumnavigate the world alone in a sailboat. This circular economy moniker embraces the entire economy and promotes re-use, re-manufacturing, repair, recycling and upcycling, i.e. running our economies scientifically, as Nature does. This science-based model is offered in our Principles of Ethical Biomimicry Finance®<sup>61</sup>. (Fig. 16) Janine Benyus and her Biomimicry Institute, teaches these Nature’s Principles to companies, cities and in their academic programs.<sup>62</sup>

It was all this prior re-conceptualizing and operationalizing of new financial and business models that laid the groundwork for the adoption in 2015 by 195 member countries of the United Nations of the SDGs. Thus, these SDGs are gradually displacing GDP and becoming the overarching framework for steering countries toward sustainable, inclusive forms of human development. Many of our TV programs including (“Steering Societies from GDP to the SDGs”) in our Series “Transforming Finance” explore with pioneer asset managers and investors the many reforms now adopted based on the 17 Goals of the SDGs. A glossy book “The Trillion Dollar Shift: Achieving the Sustainable Development Goals” by Marga Hoek, (Fig. 17) showcases 50 globally-concerned businesses and how each has contributed to implementing some of the various 17 Goals, with Forewords by Paul Polman, former CEO of Unilever and Feike Sijbesma, CEO-Chairman of DSM. The Global SDG Awards ten winners of its 2018 competition include young start-up companies in Australia, Britain, S. Africa, Afghanistan and the USA.<sup>63</sup>

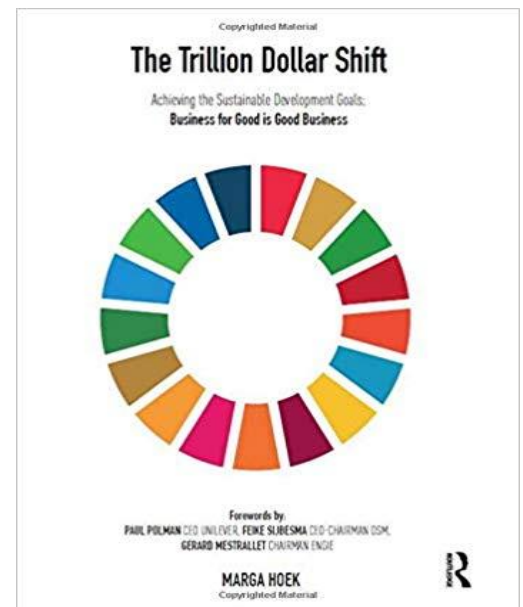


Fig. 17: The Trillion Dollar Shift

<sup>61</sup> Principles of Ethical Biomimicry Finance®, [www.ethicalbiomimicryfinance.com](http://www.ethicalbiomimicryfinance.com)

<sup>62</sup> See for example Green Transition Scoreboard® (2012) [www.ethicalmarkets.com](http://www.ethicalmarkets.com) and The Biomimicry Institute Missoula, MT, [www.biomimicry.net](http://www.biomimicry.net)

<sup>63</sup> CSRwire: “The Global SDG Awards Announces Winners of Its 2018 Sustainability Leadership Competition”, Mar. 25, 2019

Still, to be overcome are all the faulty assumptions and paradigms in economic textbooks still taught in too many business schools, and those lurking in all the ubiquitous algorithms that now govern our decisions. They still encode all our cognitive biases! Financial algorithms now dominate Wall Street and most public trading of securities, with the proliferation of some 3 million indexes, thousands of index funds, ETFs, and passive investing against benchmarks. Our report to the UN's Inquiry on Sustainable Finance "Perspectives on Reforming Electronic Markets and Trading" in 2014, examined high-frequency trading and the over 50% of all trading now automated and untouched by humans.<sup>64</sup> Ever more financial advisory firms offer investors portfolios based on algorithms. Since 2018 the EU's MiFID 2 rules now require such algorithms to be unpacked and monitored to catch biases, obsolete concepts and mis-trained machines.<sup>65</sup> The London-based New Economics Foundation goes further in holding the creators and users of algorithms legally accountable in their report, "Digital Self-Control", (2019).<sup>66</sup> Accounting firms are slowly adopting the IIRC's "six forms of capital" (finance, built, intellectual, social, human and natural)<sup>67</sup> and assessing corporate performance by the extent to which they enhance or degrade all six forms.(Fig. 14). However, many still allow "externalities" to be excluded from the balance sheets of too many companies and government accounts as we covered in our GTS 2016.<sup>68</sup>

As global connectivity increases through the explosion of information technologies, satellites, the internet, undersea fiber-optic cables, China's Belt & Road initiative, humans are required to re-examine their tribal past and "fight or flight" responses to potential threats from animals and competing bands of humans. This age old fear of "the other" will continue to drive many demagogues to seize power, until we realize that "the other" is now becoming a member of our family or our neighbor, as I discussed in "The Politics of Connectivity".<sup>69</sup> The IPCC expects another 200 million people driven by climate disasters will become refugees, while 1 billion will be newly exposed to dengue fever as temperatures rise, predicts Georgetown University Medical Center.<sup>70</sup> Growing backlashes caused by populations bypassed by narrow GDP-steered globalization and financialization are disrupting most mature developed OECD member countries in Europe and the Americas.

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<sup>64</sup> UNEP Inquiry on Sustainable Finance, Geneva, 2014, [www.unepinquiry.org](http://www.unepinquiry.org)

<sup>65</sup> Henderson, H., "Who's Afraid of MiFid2?", (2017) [www.ethicalmarkets.com](http://www.ethicalmarkets.com)

<sup>66</sup> New Economics Foundation, "Digital Self-Control", London [www.neweconomics.org](http://www.neweconomics.org), Feb. 2019

<sup>67</sup> IIRC, International Integrated Reporting Council, [www.iirc.org](http://www.iirc.org)

<sup>68</sup> Green Transition Scoreboard®, "Ending Externalities: Full-Spectrum Accounting Clarifies Transition Management", [www.ethicalmarkets.com](http://www.ethicalmarkets.com)

<sup>69</sup> Op cit.

<sup>70</sup> Science Daily, "A billion people will be exposed to diseases like dengue fever", March 28, 2019

These grassroots rebellions and so called “populist” revolts are understandable reactions to the inequality and injustices to those left behind by globe-trotting elites meeting in resorts and national capitals, convened at many Davos-type conferences. Broad-based, bottom-up coordinating of global policies leading to sustainable societies include “The Simultaneous Policy (SIMPOL) to buttress political leaders<sup>71</sup> and the annual FORUM 2000 conferences in Prague since 1995, convened by late Czech President Václav Havel.<sup>72</sup> Only



Fig. 18: Earth Charter 2019

broader human development which leaves no one behind and based on the SDGs and all the new quality of life metrics can steer humanity forward and help achieve climate stabilization. Such new forms of



Fig. 19: UN Principles of Responsible Investment

globalization based on new principles: such as the 16 Principles of Human Responsibility of the Earth Charter;<sup>73</sup> (Fig. 18) the UN-led 10 Principles for Responsible Investment<sup>74</sup>; (Fig. 19) the World Economic Forum’s 8 Principles of Climate Governance<sup>75</sup>, and those of the Global Compact of corporations, can provide the new global standards for investors and corporations. It is these more scientifically- based technologies, companies and

forms of global human development that our Green Transition Scoreboard® annual reports have tracked. Our science-based global standard recognizing that polluting, conflict-ridden gem mining is obsolete, is the EthicMarkGEMS ® certification only for gems not mined from the Earth ([www.ethicmarkgems.com](http://www.ethicmarkgems.com)).

<sup>71</sup> Bunzl, J., “The Simultaneous Policy (SIMPOL): An Insider’s Guide to Saving Humanity and the Planet”, New European Publications, London (2001)

<sup>72</sup> FORUM 2000, Prague, Czech Republic, [www.forum2000.cz](http://www.forum2000.cz), (Full disclosure: Hazel Henderson serves on the Content Committee of FORUM 2000)

<sup>73</sup> Earth Charter, San Jose, Costa Rica, [www.earthcharter.org](http://www.earthcharter.org)

<sup>74</sup> Principles of Responsible Investment, [www.pri.org](http://www.pri.org), (full disclosure, Ethical Markets has been a signatory member since its founding)

<sup>75</sup> World Economic Forum, [www.wef.org](http://www.wef.org)

Now our research will be distilled into a new textbook for financial and business school courses: "Mapping the Global Green Transition: 2010-2020" (forthcoming). An innovative consortium, the Science-Based Targets Initiative (Fig. 20) released updated criteria for companies to achieve the 1.5°C target in the IPCC special report mentioned earlier.<sup>76</sup>



Fig. 20: SBTi: Quantis, [www.quantis-intl.com](http://www.quantis-intl.com)

While the specific cognitive bias still at work with science-denial and climate-denial was identified as “theory-induced blindness” by Daniel Kahneman in *Thinking Fast and Slow* (2013), signs of reality-acceptance, abound in many fields. We identified this cognitive bias in GTS 2018, as preventing investments in saltwater agriculture and halophyte plant markets.

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<sup>76</sup> SBTi:-Quantis, “SBTi releases updates for well below 2°C and 1.5°C pathways”, Press Release, Apr. 4, 2019 [www.quantis-intl.com](http://www.quantis-intl.com)

# GLOBAL PRIORITIES THROUGH 2020-2050

## Nexus Between Energy, CO<sub>2</sub>, Food, Agriculture, Land Use, Water, Climate Change and Humanity's Responses

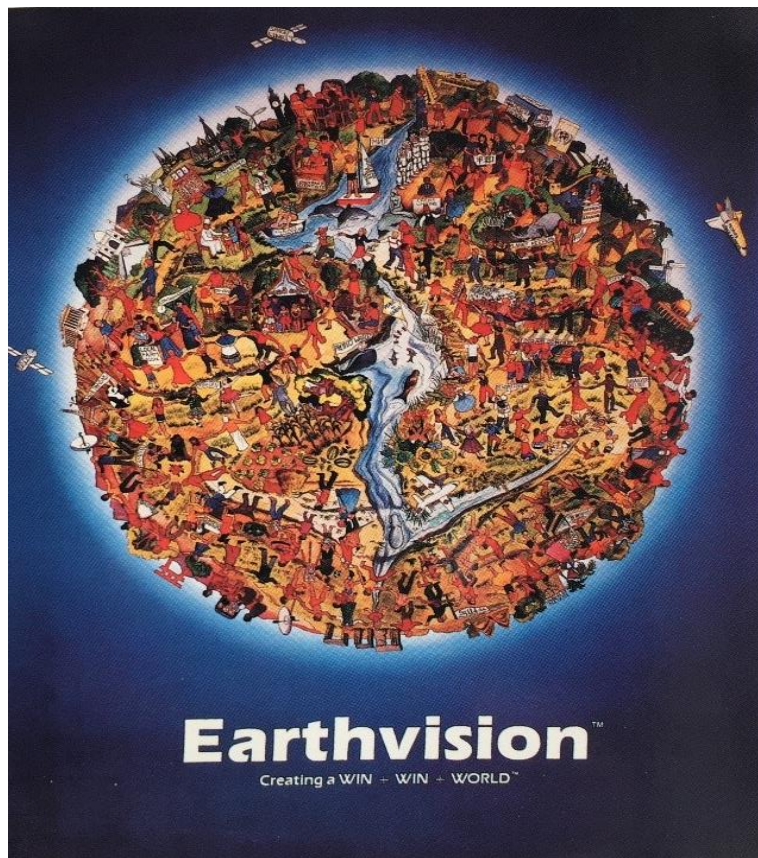


Fig. 21: Poster by Hazel Henderson and Barbara Marx Hubbard, 1987

The aforementioned IPCC report “Global Warming of 1.5°C” Summary for Policy Makers laid out the nexus between all these issues and priorities for all countries, those immediately urgent and those required before 2030 and the goal of complete ending of fossil-fueled production in all sections by 2050. The new imperative requires that CO<sub>2</sub> and other greenhouse gases (GHGs) be re-captured from the ambient atmosphere and to sequester at least 800 million tons of such CO<sub>2</sub> if we have any hope of keeping global warming below 1.5°C.<sup>77</sup> A new study by Australia’s University of Adelaide, published in Bioscience reveals that IPCC’s language is overly conservative and that threats are much greater.<sup>78</sup> In fact, many IPCC models miss

feedbacks and have assumed that ambient capture of CO<sub>2</sub> and reliable long-term sequestration was to be achieved, by technical processes i.e. (CCS) and by biological energy carbon and capture sequestration (BECCS). Unfortunately, this has not occurred! Alternative paths are emerging as economies shift to electrification based on renewable energy sources, particularly in electric transportation, including for ships and aircraft<sup>79</sup>. Research on how to store and distribute electricity more

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<sup>77</sup> IPCC “Global Warming of 1.5°C: “Summary for Policy Makers”, p 17-19

<sup>78</sup> Science Daily, “IPCC is underselling climate change”, Mar. 20, 2019

<sup>79</sup> Bushnell, D.M., “Enabling Electric Aircraft Applications and Approaches “, NASA Chief Scientist, Langley Research



efficiently, re-configuring large grids to local micro-grids and re-designing transmission lines to distribute direct current are changing the game for electric utilities. Technological advances in more efficient digital electrification are now making conservation into new expanded capacity.<sup>80</sup> This new research and machine-learning algorithms might well represent huge savings in electricity generation --- even obviating the need for some existing utilities' power plants.<sup>81</sup>

As mentioned, IPCC also assumes the need for a shift from fossil to low-carbon renewable energy will require \$2.4 trillion annually between 2016 and 2035.<sup>82</sup> Rapid cost reductions in solar and wind can reduce these estimates. The technical plans for bolting CCS facilities on to existing coal, gas & oil electricity generation power plants turned out to be too costly and reduced their efficiency by as much as 40%.<sup>83</sup> Furthermore, few safe reliable repositories of captured CO<sub>2</sub> were identified that would permanently store the CO<sub>2</sub> without dangerous unexpected "burping" back into the environment. Thus, the focus turned to new science, electrification and to Nature's way of securely sequestering CO<sub>2</sub>, by growing plants and trees, with the world's forests, lands, soil, peat, permafrost and plants, which turn CO<sub>2</sub> into carbohydrates and human foods through photosynthesis. Thus, our GTS report "Capturing CO<sub>2</sub> While Improving Human Nutrition and Health" turned to a deep examination of the nexus between related issues of food, agriculture, land use, water, energy and natural CO<sub>2</sub> sequestration in plants, trees, kelp and other salt-loving food crops (e.g. quinoa and China's salt-tolerant-rice, salicornia, etc.). This report tracks and embraces these connected SDG goals: 2. Zero hunger; 3.



Fig. 22: Wild plant roots v. agriculture

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Center, Hampton, VA, Aug 2018

<sup>80</sup> Roberts, D., "Digital Electrification: Less Waste, More Capacity", AltEnergy Stocks and Ethical Markets, May 17, 2019

<sup>81</sup> Vox, Roberts, D., "This technology could fundamentally change our relationship to electricity", June 20, 2018 [www.vox.com](http://www.vox.com)

<sup>82</sup> IPCC op cit.

<sup>83</sup> Green Transition Scoreboard®, 2014 "Plenty of Water", p. 16

Good health; 6. Clean water and sanitation; 7. Renewable energy; 8. Good jobs and economic growth; 9. Innovation and infrastructure; 12. Responsible consumption; 13. Climate action; 15. Life on land and 17. Partnerships for the Goals. We found that expanding the global food system beyond its perilous base on 3% of the planet's fresh water, using overlooked food plants including all the salt-loving halophytes, could save the 80% of freshwater currently used for irrigation in agriculture. This could save precious human drinking water as well as for other needs. We also found that halophytes, similar to many native plants with their deep roots, (Fig. 22) captured CO<sub>2</sub> from the air more efficiently than other methods --- and offered complete proteins for more nutritious human diets. Plants are already responding to rising CO<sub>2</sub> levels by increasing their rates of photosynthesis.<sup>84</sup> Scientists at the University of Birmingham, UK, have identified the first comprehensive network of wild crop species, a vast resource of genetic diversity for plant breeders to transfer to domestic crops.<sup>85</sup>

In our 2018 GTS report, we also discovered all the innovative companies offering these more nutritious, healthier foods and beverages: meat, fish, cheese and milk substitutes to cell-grown beef, insect-based snacks and trendy vegan and vegetarian restaurants all catering to the expanding global markets. Medical experts contributed the Lancet's EAT report on how human health can be improved by cutting 50% of meat from diets. They also stated that this would reduce methane gases from cows and sheep and the use of land for raising livestock and growing animal feed.<sup>86</sup>



Fig. 23: Community with smokestacks

We also discovered many companies capturing CO<sub>2</sub> from the air to re-use in manufacturing cement, plastics and fuels with zero-net carbon emissions. Clearly, fossil reserves (created over millions of years by generations of plants and animal remains) was seen as too valuable to be lifted out of the ground only to be burned!<sup>87</sup> Carbon was not the enemy --- but a useful asset for higher use than burning while polluting the Earth's

<sup>84</sup> ScienceDaily, "How plants are working hard for the planet", May 19, 2019

<sup>85</sup> ScienceDaily, "First comprehensive network of wild crop species will help breeders tackle food insecurity", May 24, 2019

<sup>86</sup> The Lancet, "Eat Plants, Save the Planet", Apr. 2, 2018

<sup>87</sup> Henderson, H. "Fossil Reserves: Are They Fuel or Feedstocks?", (2017)

atmosphere with CO<sub>2</sub> and soot<sup>88</sup> and costing millions of human deaths annually. Capturing CO<sub>2</sub> from the air to create useful feedstocks for chemicals could theoretically remove 3.5 gigatonnes of CO<sub>2</sub> and other GHGs by 2030, this would require enormous amounts of electricity.<sup>89</sup>

This new report updates the global news on the nexus between Energy, CO<sub>2</sub>, Food, Agriculture, Land Use, Water and Climate Change. Today, the search for all these new uses for carbon and ambient CO<sub>2</sub>, as well as expanding human foods and saltwater agriculture is a focus of many investment consortia, including the global FAIRR group with \$11 trillion of assets seeking a wide range of such innovative investments.<sup>90</sup> Following our updates on humanity's responses: in widespread acceptance of the SDGs, and science-based metrics for corporations, governments and finance beyond textbook economics, we turn to updating progress in related, but specific sectors. We begin with energy and CO<sub>2</sub> emissions now disrupting the global climate with increasingly dangerous weather events and their recognition as climate related. Even in the USA, surveys now show 59% cite global climate change as the top threat, below the public's views in 26 other countries, including Argentina 73%, Australia 60%, Brazil 72%, Canada 66%, France 83%, Germany 71%, Mexico 80%, Japan 75%, Netherlands 70%, Spain 81%, South Korea 86% and the UK 66%.<sup>91</sup> The Economist's Climate Risk Summit: Sink or Swim, July 2019 convening government and business leaders, attests to the new consensus.<sup>92</sup>

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<sup>88</sup> H. Henderson on NBC's Today, 1967.

<sup>89</sup> NewScientist, "Can we make our plastics from captured carbon?", May 18, 2019, p.8

<sup>90</sup> FAIRR, a Collier Initiative, May 9, 2019, and in Hazel Henderson presentation at Family Office Forum, Singapore, Mar. 5, 2018

<sup>91</sup> Pew Research Center, "Global Attitudes and Trends": Climate Change Still Seen as the Top Global Threat", Feb. 10, 2019

<sup>92</sup> The Economist, "Melting away", London, July 2, 2019, [www.climaterisk.economist.com](http://www.climaterisk.economist.com)



## **Energy and CO<sub>2</sub> Emissions**

We began with updating the various approaches to keep global warming below 1.5°C by shifting from fossilized energy to renewables and using methods of capturing and sequestering CO<sub>2</sub> emissions which the IPCC is assuming will remove 800 billion tons of ambient CO<sub>2</sub>. As we mentioned, we covered in previous GTS 2018, 2017, 2016, 2015, and 2014, we found no evidence that CCS equipment for power plants was in use, and that the few pilot projects were proving too expensive and reducing electricity generation efficiency by as much as 40%. Thus, we found that attention had turned to natural processes for CCS labeled BECCS (biomass energy carbon capture, sequestration). We now cite the hundreds of reports and scientific research to advance CCS following those in the IPCC report on “Land Use Transitional and Changes in the Agricultural Sector”, (AFOLU)<sup>93</sup> none of which mention expanding human foods with salt-loving, (halophyte) plants, but do reference the need to cut meat consumption. Methane

capture was an urgent new focus since this gas contributes 80 times more than CO<sub>2</sub> to global warming, and was already seeping from Arctic permafrost along with nitrous oxides (300 times more potent than CO<sub>2</sub>).<sup>94</sup> The International Institute for Applied Systems Analysis (IIASA) finds that comparing Arctic methane emissions with those caused by humans, that it is more effective to control human sources.<sup>95</sup>

Thus a spate of new reports examine alternative ways of capturing greenhouse gases, both CO<sub>2</sub> and methane. The US National Academies of Sciences, Engineering and Medicine published its “Gaseous Carbon Waste Streams Utilization: Status and Research Needs”<sup>96</sup> (Fig. 24) in 2019 which examines roadblocks to commercialization of CCS technologies. The report identifies “advances” that

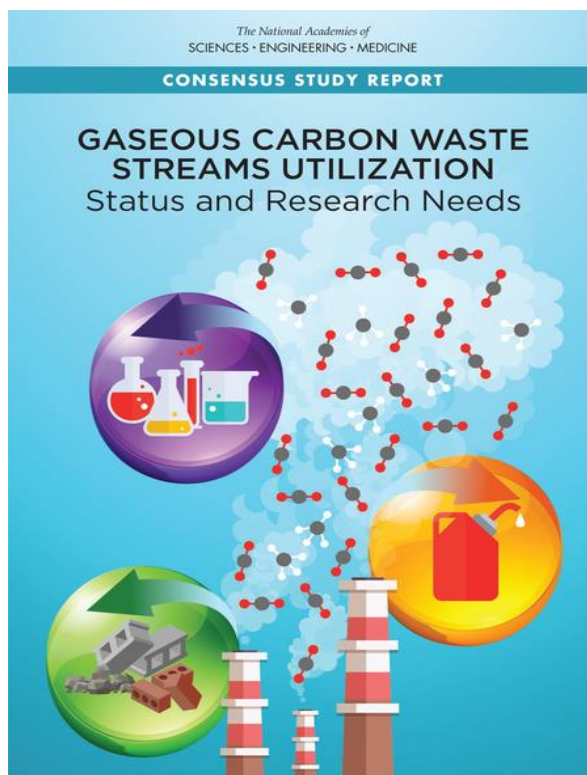


Fig. 24:

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<sup>93</sup> IPCC op. cit, Mitigation Pathways, p. 144-150

<sup>94</sup> ScienceDaily, “Warming Arctic Permafrost releasing large amounts of potential greenhouse gas”, Apr. 22, 2019, [www.sciencedaily.com](http://www.sciencedaily.com)

<sup>95</sup> ScienceDaily: “Diffusing the methane bomb: We can still make a difference”, Feb. 6, 2019

<sup>96</sup> National Academies Press, “Gaseous Carbon Waste Streams Utilization: Status and Research Needs”, (2019)

could enable much more extensive carbon utilization in biotechnology, cement and concrete production”.<sup>97</sup> Unfortunately, as is true of much science policy research in the market-oriented USA, the report’s authors, panels and reviewers were largely drawn from the incumbent corporate sectors and concluded “The report assumes that large volumes of gaseous carbon wastes, especially carbon dioxide will continue to be generated in the coming decades through continued use of fossil fuels!<sup>98</sup> There were few references to CO<sub>2</sub> utilization by plants, trees and natural foods and fuels, such as halophytes and algae we examined. A more useful report “Decarbonization of Industrial Sectors: the next frontier” looks at options for the cement industry, steel production, ammonia production and ethylene producers, most of which can be based on electricity from renewable sources while utilizing CO<sub>2</sub> emissions in production processes for creating useful products: cleaner cement, steel, fertilizers and fuels and using clean electrolysis of hydrogen as feedstocks, rather than using natural gas.<sup>99</sup> For example, StormFisher, in London, Ontario converts up to 100,000 tons of organic waste annually into renewable energy and fertilizer.<sup>100</sup>

The Ulsan National Institute of Science and Technology (UNIST) has found a catalyst to turn methane into formaldehyde with twice the current efficiency using nanomaterials.<sup>101</sup> Another Asian group at Tokyo Institute of Technology has designed a CO<sub>2</sub> reduction method of 57% using photocatalytic systems using abundant rather than rare earth metals.<sup>102</sup> Another group at Tokyo Institute of Technology is working on an additional method of directly utilizing CO<sub>2</sub> in exhaust gases from heavy industries.<sup>103</sup> Scientist at the University of Liverpool, UK have discovered a new process to make polymers out of sulfur, which could produce less-environmentally damaging plastics.<sup>104</sup> Since powerful global warming methane only remains in the atmosphere for a relatively short time, capturing it from “flaring” and fugitive emissions from oil-drilling operations is highly-desirable and 75% these captured emissions can be sold profitably.<sup>105</sup>

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<sup>97</sup> ibid

<sup>98</sup> ibid

<sup>99</sup> McKinsey & Company, “Decarbonization of industrial sectors: the next frontier”, June 2018

<sup>100</sup> StormFisher, company report, accessed May 20, 2019, [www.stormfisher.com](http://www.stormfisher.com)

<sup>101</sup> ScienceDaily, “New ways to harness wasted methane”, Jan. 18, 2019

<sup>102</sup> ScienceDaily, “Great strides for carbon capture using earth-abundant elements as photocatalytic system”, Nov. 30, 2018

<sup>103</sup> ScienceDaily, “Scientists achieve direct electrocatalytic reduction of carbon dioxide, raising hopes for smart carbon capture”, Nov. 28, 2019

<sup>104</sup> ScienceDaily, “A better way to make plastics out of sulfur”, Feb. 7, 2019

<sup>105</sup> Security and Sustainability Forum, “Profit from Capturing Methane Emissions”, Webinar, Apr. 9, 2019, [www.ssfonline.org](http://www.ssfonline.org)

Most often, CO<sub>2</sub> emission reductions come from shifting electric utilities from fossil fuels to accepting even larger sources from solar and wind generators, even though this requires tweaking their operating models to manage supplies from such intermittent sources. These reforms needed for obsolete business models are evident in South Africa where the costly, outdated coal-fired plants of Eskom, the nationalized electric utility are finally being forced to accept solar-supplied electricity through auctions. These auctions are now popular in many developing countries, where cheaper solar and wind farms can outcompete fossil fuels and win contracts.<sup>106</sup> The big debate on CO<sub>2</sub> capture is also over BECCS, which the IPCC and many energy industry groups still support, is a case of science-denial, where monoculture trees are grown in plantations and cut for fuel in electric generating plants on the theory that more trees can be re-grown ----- making this form of electricity “carbon-neutral”, as in Britain’s Drax plant.<sup>107</sup>

In GTS 2018, we cited many of the start-up companies and experimental efforts to capture CO<sub>2</sub> using various technologies. Updates include the US Department of Energy’s Oak Ridge National Laboratory (ORNL) which found that soda lime could capture CO<sub>2</sub> emissions from coal plants using 24% less energy. However, the ORNL admitted that “state-of-the-art carbon capture technologies come with major flaws”.<sup>108</sup> Furthermore, coal plants in the USA are being closed and phased out because they are too expensive and inefficient.<sup>109</sup> In Australia, TMIT University has developed a technique to efficiently turn CO<sub>2</sub> back into solid particles of carbon at room temperature.<sup>110</sup> Harvard scientists are researching turning CO<sub>2</sub> from power plants into industrial fuels and chemicals. Scientist at MIT are pursuing similar research.<sup>111</sup> A report from the Economist’s Technology Quarterly examines the global decarbonizing potential of shifting toward clean electric economies and widespread use of hydrogen.<sup>112</sup> Indeed, the global shift to electric cars (EV) continues to accelerate with over one hundred EV companies in China,

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<sup>106</sup> The Economist, “A glimmer of light’: Eskom threatens to destroy South Africa’s economy. There is a much cheaper, cleaner alternative”, Apr. 20, 2019, p. 46

<sup>107</sup> Drax Press Release, “Carbon dioxide now being captured in first of its kind BECCS pilot-Drax”, Feb. 7, 2019 [www.drax.com](http://www.drax.com)

<sup>108</sup> ScienceDaily, “Carbon-capture technology scrubs CO<sub>2</sub> from power plants like scuba-diving gear”, Jan. 31, 2019

<sup>109</sup> Carbon Tracker: “Powering Down Coal”, Dec. 21, 2018

<sup>110</sup> ScienceDaily, “Transforming carbon dioxide into industrial fuels”, Nov. 8, 2018

<sup>111</sup> Jones, B., “MIT Scientists Created a New Method of Turning CO<sub>2</sub> into Fuel”, Futurism, Nov. 28, 2017 [www.futurism.com](http://www.futurism.com)

<sup>112</sup> The Economist, Technology Review: “The Hydrogen Bombshell”, Dec. 1, 2018

with government subsidies and a planned investment worldwide of \$300 billion more.<sup>113</sup> A proprietary report forecasting the hydrogen generation market globally to 2030 sees increases in billions.<sup>114</sup> We covered progress in storing electricity and better batteries in GTS 2015 and new research continues. Ohio State University scientists have built a more reliable potassium-oxygen battery as a step toward



Fig. 25: Electric Cars in China

power-grid storage.<sup>115</sup> Rice University has demonstrated an environmentally-friendly way of extracting cobalt and lithium from spent lithium-ion batteries. This recycling of cobalt and lithium can conserve these key metals used in cellphones and electric cars.<sup>116</sup> Lithium-air batteries achieve 15 times the density of lithium-ion batteries, and one using lithium-metal may be on the horizon.<sup>117</sup> Colorado State University 's Next Generation Photovoltaics Center has a breakthrough in cadmium -telluride solar cell efficiency .<sup>118</sup>

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<sup>113</sup> The Economist, "Charging ahead, the future of cars", Apr. 20, 2019 and "China's Electric Car Showdown", Fortune, Apr. 1, 2019, p. 24

<sup>114</sup> ASDReports, "Hydrogen Generation Market-Global Forecast to 2030", [www.asdreports.com](http://www.asdreports.com)

<sup>115</sup> ScienceDaily, "A step for promising new battery to store clean energy". May 14, 2019

<sup>116</sup> ScienceDaily, "New 'blue-green' solution for recycling the world's batteries", Apr. 1, 2019

<sup>117</sup> NASA Chief Scientist Bushnell, op.cit.

<sup>118</sup> ScienceDaily, "Key insight into solar material's soaring efficiency", May 24, 2019





Fig. 26: Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES)

Thus, the whole idea of CO<sub>2</sub> capture from power plants, another case of politically-motivated science-denial, is becoming moot, along with the efforts to promote global geoengineering. These continue, promoted particularly by a group of scientists led by David Keith and his company, Carbon Engineering, backed by Bill Gates at a cost estimated by David Wallace-Wells at about \$3 trillion annually.<sup>119</sup> Critics of

BECCS ranged from specific objections raised by many scientists in the IPCC report, including that generating electricity from biomass fails to account for its competition for land, fresh water, food and loss of biodiversity.<sup>120</sup> Rates of deforestation are still unsustainable and growing trees to burn is less realistic than expanding forests and restoring damaged ecosystems, including peat lands, shoreline, mangroves and grasses while ending unsustainable land clearing for monoculture plantations for palm oil.<sup>121</sup> The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) in its 2018 report states “The loss of species, ecosystems and genetic diversity is already a global and generational threat to human well-being. Protecting the invaluable contributions of nature to people will be the defining challenge of decades to come”.<sup>122</sup> The case against BECCS was reinforced by the Nature Conservancy’s research finding that 21% of US greenhouse gas pollution could be removed through enhanced management of forest, grassland, agriculture and coastal areas.<sup>123</sup> The Brazilian state of Acre is preserving its forests by focusing on labor rights and distributes land to family farms.<sup>124</sup>

<sup>119</sup> Intelligencer, Wallace-Wells, D. “The Cautious Case for Climate Optimism”, Feb. 9, 2019

<sup>120</sup> IPCC op. cit, p. 148

<sup>121</sup> New York Times, “Palm Oil Was Supposed to Help Save the Planet. Instead It Unleashed a Catastrophe”, Nov. 20, 2018

<sup>122</sup> IPBES Media Information Alert, Nov. 19, 2018, [www.ipbes.net](http://www.ipbes.net)

<sup>123</sup> Nature Conservancy: “Natural solutions can reduce global warming”, ScienceDaily, Nov. 14, 2018

<sup>124</sup> ScienceDaily, “The carbon offset market: Leveraging forest carbon’s value in the Brazilian Amazon”, Apr. 6, 2019

Nitrogen may be able to be fixed by more plants beyond legumes, so as to reduce the need for nitrogen fertilizers. Yet the German Centre for Integrative Biodiversity Research warns that advances in agriculture are not a sufficient response and effective policies for nature conservation are needed.<sup>125</sup> The American Society for Horticulture Science stresses the importance of wetlands restoration in its experiments at the University of Florida.<sup>126</sup> The Australian National University finds that forest soils need up to 80 years to recover from fires and 30 years after logging, another argument against BECCS logging trees to burn for electricity.<sup>127</sup> The evidence grows that policy makers are overlooking the capacity of natural systems to store CO<sub>2</sub> and nitrogen,<sup>128</sup> in a study by Duke University of coastal waters. Another global campaign “Rewild the World” was launched in 2019 to allow ecosystems to recover on a massive scale to draw down CO<sub>2</sub> from the atmosphere.<sup>129</sup> Scientists at universities in the UK, Simon L. Lewis, Charlotte E. Wheeler, Edward T. A. Mitchard and Alexander Koch show that BECCS plans of the IPCC to triple the area of tree plantations for burning in electric power plants will not meet 1.5°C goals. They

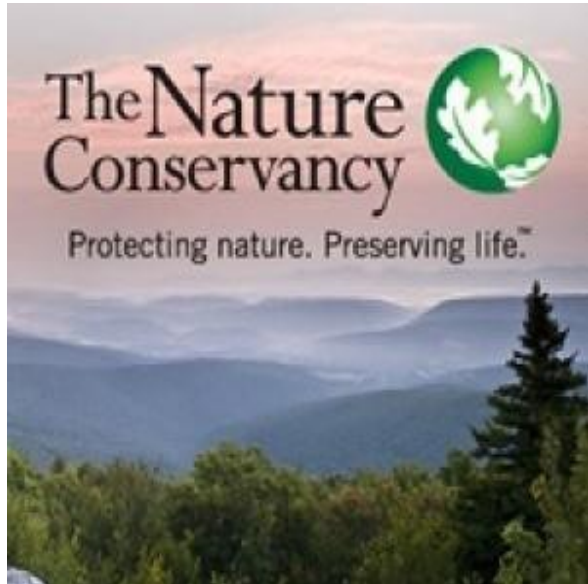


FIG. 27

show that restoring and protecting natural areas and planting trees in tropical and sub-tropical areas is a better approach.<sup>130</sup> The Archangel Ancient Tree Archive preserves the genetic heritage of many giant redwoods and other champion trees.<sup>131</sup>

Climate models continue to explore the complexities of our planet and more details on how human activities interact with ecosystems. A team of 29 scientists reported in Nature Climate Change on how the ways humans act will affect future climate change. This interdisciplinary study shows the potential of more integrated approaches.<sup>132</sup> These new methods can help scientists leverage their

<sup>125</sup> ScienceDaily, “Biodiversity crisis: Technological advances in agriculture are not a sufficient response”, Mar. 4, 2019

<sup>126</sup> ScienceDaily, “Improving ecosystems with aquatic plants”. Feb. 27, 2019

<sup>127</sup> ScienceDaily, “Forest soils need many decades to recover from fires and logging”, Jan. 22, 2019

<sup>128</sup> ScienceDaily, “Coastal waters are unexpected hotspots for nitrogen fixation”, Feb. 21, 2019

<sup>129</sup> The Guardian, Monbiot, G, “Rewild the World”, Apr. 7, 2019

<sup>130</sup> Nature: Comment: “Regenerate natural forests to store carbon”, vol. 568, Apr. 4, 2019

<sup>131</sup> Milarch, D., co-founder, Archangel Ancient Tree Archive, Copemish, MI, [www.ancienttreearchive.org](http://www.ancienttreearchive.org)

<sup>132</sup> ScienceDaily, “Climate model uncertainties ripe to be squeezed.”, Jan 7, 2019

impact on policy-making according to the Geological Society of America.<sup>133</sup> The Association for Psychological Science points out that few scientists are trained in interdisciplinary methods.<sup>134</sup> Thus, integrated systems-thinking, futures research and scenario-based forecasting are needed in finance, business and government. Sometimes, scientific groups can be misled, such as the Nature Conservancy's being a founding member of the Climate Leadership Council ([www.clcouncil.org](http://www.clcouncil.org)) a conservative group of large companies (many fossil-based) which lobbies for a \$40 carbon tax to be rebated to US taxpayers, much too low to shift markets. The hidden agenda is: in exchange for immunity to liability and lawsuits for recovering climate-related costs --- a very bad deal for the public interest!<sup>135</sup> The more publicly-motivated business group LEAD on carbon-pricing opposes the Climate Leadership Council's dubious proposal and calls for a meaningful price on carbon without waiving any liabilities for costs of climate-related damages to states and local governments. [www.leadoncarbonpricing.com](http://www.leadoncarbonpricing.com)

## Water

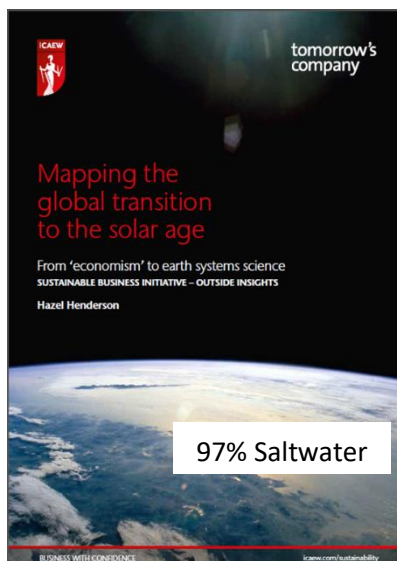


FIG. 28:

We first turn to the planet's 97% saltwater, and what we are learning about how oceans store and release CO<sub>2</sub>, as well as updating our GTS 2018 on the global crisis of the planet's 3% of freshwater. (Fig. 28) First, updating climate science, we learn from research at the University of California at Santa Barbara, USA more about exactly how the planet's oceans (its largest carbon sink) capture and

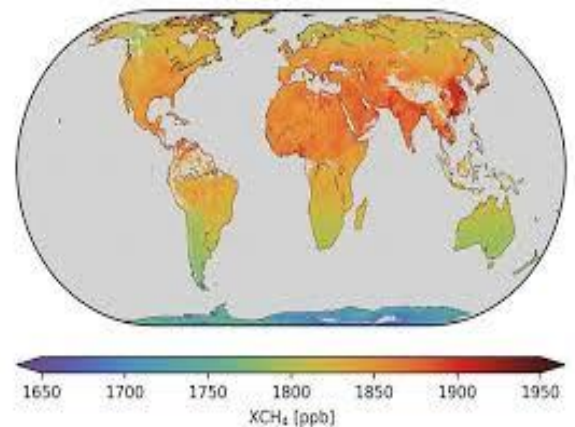


Fig. 29: Global Temperature, ESA

<sup>133</sup> ScienceDaily, "Leveraging scientists' perceptions for successful interactions with policy makers., Apr. 19, 2019

<sup>134</sup> ScienceDaily, "Solving 21<sup>st</sup>-century problems requires skills that few are trained in, scientists find". Dec. 3, 2018

<sup>135</sup> Savage, K. "Hearing Glosses Over Carbon Tax Proposal's Liability Waiver", [www.climateliability6news.org](http://www.climateliability6news.org) May 15, 2019

store carbon. The report's oceanographer Dave Siegal notes "the whole number is about 10 petagrams of carbon per year, which is about equal to how much carbon we spit out in fossil fuel emissions every year". The report, published in *Nature*<sup>136</sup> discusses lesser-known mechanisms: partial injection pumps (PIPs), three-dimensional circulation processes and vertically migrating animals that inject organic carbon in the deep ocean. Best-known is the biological gravitation pump (BGP) which is the sinking of biological debris (zooplankton, fecal matter, phytoplankton, etc.) that become food for bottom-dwelling creatures. There is vertical migration (DVM) by zooplankton's regular evening ascents to eat, thought to be the largest migration on Earth. This growing knowledge will be essential to science-based investing and is augmented by Earth-observing satellites and multi-disciplinary research by NASA and the European Space Agency, ESA, and the US National Science Foundation.

Another area of research on atmospheric climate science is how sunlight reacts with the particles of black carbon (soot), which scientists at Washington University-St. Louis in the USA find follows mathematical laws. Soot particles can heat surrounding air and are linked to urban air pollutions' death toll, as well as heart disease, cancer, and diabetes.<sup>137</sup> Scientist at the US Monterey Bay Aquarium Research Institute finds that many of the pulses of sinking carbon debris into the oceans are not fully captured in climate models.<sup>138</sup> These pulse events have become more prevalent since 2011 and have implications for the IPCC's global carbon budget. While oceans store heat and CO<sub>2</sub>, scientists report "burps" of CO<sub>2</sub> from the ocean around Antarctica.<sup>139</sup>

In GTS 2018, we examined the cognitive bias: theory-induced blindness together with the power of incumbent firms in today's unsustainable global agro-chemical industrial food complex. Even the comprehensive special report, *Water in The Economist* failed to mention the potentialities of expanding to use of the planet's 97% saltwater.<sup>140</sup> We cited evidence revealing this current global food system's reliance entirely on the planet's 3% of dwindling fresh water. This fresh water is fed by glaciers in mountainous areas, yet these glaciers are melting so fast that they could add 10 inches more to sea levels.<sup>141</sup>

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<sup>136</sup> ScienceDaily, "Balancing the ocean carbon budget", Apr. 17, 2019

<sup>137</sup> ScienceDaily, "Current climate models underestimate warming by black carbon aerosol", Nov. 19, 2018

<sup>138</sup> ScienceDaily, "Pulses of sinking carbon reaching the deep sea are not captured in global climate models", Dec. 3, 2018

<sup>139</sup> *NATURE*: "Massive ocean carbon sink spotted burping CO<sub>2</sub> on the sly", Dec. 14, 2018, [www.nature.com](http://www.nature.com)

<sup>140</sup> *The Economist*, "Thirsty Planet", March 2, 2019, pp. 5-14.

<sup>141</sup> ScienceDaily, "Melting small glaciers could add 10 inches to sea levels", May 24, 2019



We detailed all the current investments in freshwater-based uses for food, livestock and feeds, energy (fracking, power plant cooling), sanitation, sewage, wastage and pollution control. These investments focused totally on this 3% fresh water, rather than widening their lenses to see all the opportunities we cited in broadening our food choices and saving fresh water by shifting to these overlooked wild plants, halophytes, and indigenous ecological local farming methods. Updates on these opportunities are on covered later in this report.

Meanwhile, we examined the recent research on the global rush to create desalination plants, their costs, energy-use and brine pollution. Today, 16,000 desalination plants discharge 142m cubic meters of brine daily, 50% more than previously estimated.<sup>142</sup> Almost half this global desalination capacity is located in the Middle East (Saudi Arabia 15.5%), the United Arab Emirates (10.1%), Kuwait (3.7%). East Asia, Pacific, and North America regions produce 18.4% with the USA (11.2%) and China (7.5%). The researchers at the UNU's Institute for Water, Environment and Health in Canada; Wageningen University in Holland and Gwangju Institute of Science and Technology, S. Korea call for improved brine management strategies and disposal methods, since 80% of brine from plants near oceans discharge their untreated waste brine directly into marine environments with major risks to ocean life and ecosystems. Brine management represents up to 33% of the plant's costs, with additional costs of construction and energy, which needs better recovery methods and to shift to coupling with renewable

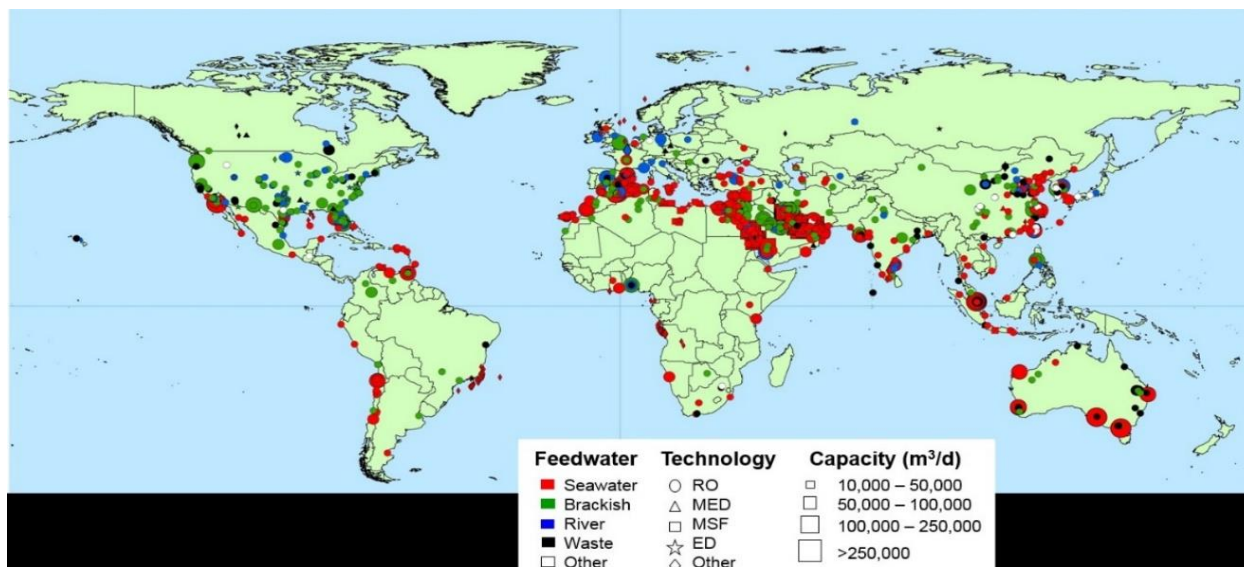


Fig. 30: UN University, Global Water Map, <http://bit.ly/2ReUuNA>

<sup>142</sup> UN University: “UN Warns of Rising Levels of Toxic Brine as Desalination Plants Meet Growing Water Needs”, Jan. 14, 2019

energy sources.<sup>143</sup> A University of Oklahoma study is focusing on microbes in sludge for wastewater treatment and reuse.<sup>144</sup>

The report also highlights the same opportunities that we cited in GTS 2018: to use treated brine to irrigate salt-tolerant (halophyte) species; algae, food crops and in aquaculture as well as to recover the salt and minerals in the brine (magnesium, gypsum, calcium, potassium, chlorine, bromine and lithium).<sup>145</sup>

A study by the University of California-Santa Cruz of brine discharge from the Carlsbad Desalination Plant which began operating in 2015 found that it raised the salinity level and the plume extended much farther offshore (beyond that permitted). So far, no significant changes in the organisms on the sea floor were found.<sup>146</sup> Other methods of desalination include using renewable solar, wind or the geothermal concept proposed by scientists of Florida Gulf Coast University and assessed by the Geological Society of America.<sup>147</sup> The US Department of Energy created a \$2.5 million prize to spur

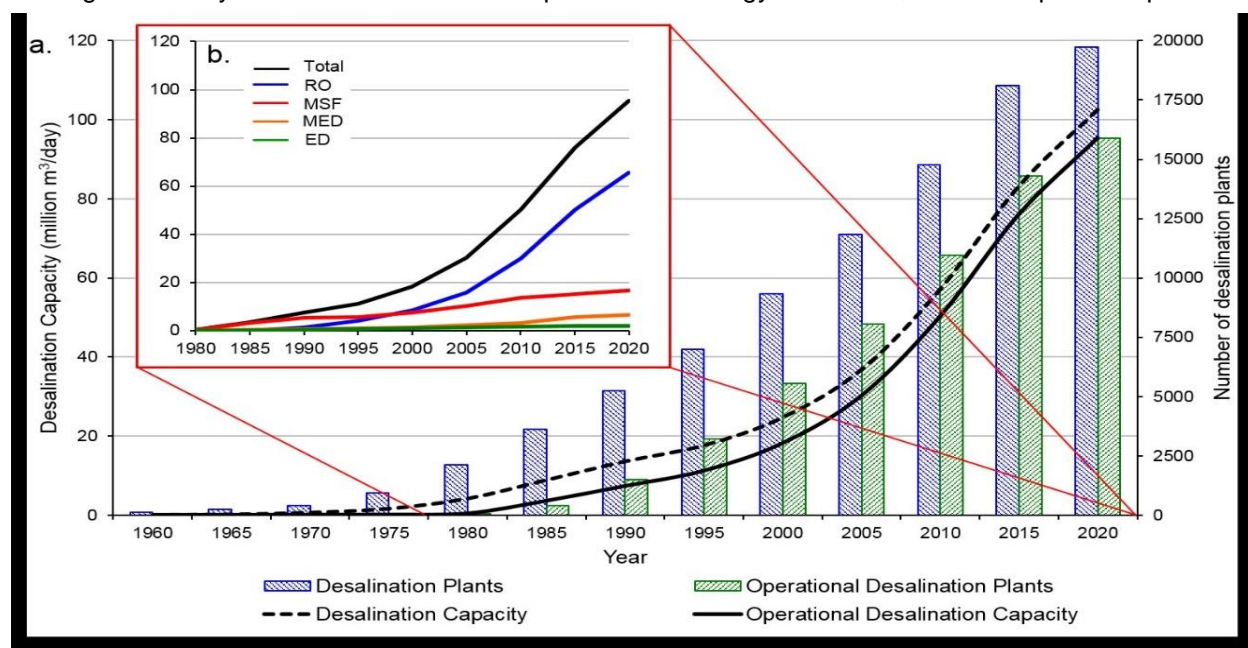


FIG. 31: Desalination Map, UN University, <http://bit.ly/2AysFoV>

<sup>143</sup> Ibid.

<sup>144</sup> ScienceDaily, "Bacteria communities for wastewater treatment system", May 14, 2019

<sup>145</sup> Ibid.

<sup>146</sup> ScienceDaily, "Study of brine discharge from desalination plant finds good news and bad news", Jan. 31, 2019

<sup>146</sup> ScienceDaily

<sup>147</sup> ScienceDaily, "A carbon neutral solution for desalination?", Nov 5, 2018

innovation in wave energy-powered desalination.<sup>148</sup> Engineers at Politecnico di Torino, Italy have developed a low-cost method of turning seawater into drinking water using solar energy. This passive approach inspired by nature is termed biomimicry.<sup>149</sup> Other approaches reclaim freshwater after human use for irrigation such as in Altamonte Springs, Florida which has won national and international awards.<sup>150</sup> Even more promising is the TSSE (temperature swing solvent extraction) method invented by a team led by Ngai Yin Yip at Columbia University Engineering which extracts 98% salts from brine and produces 50% of recovered water, using low-grade heat. TSSE is on track to commercial uses.<sup>151</sup> Molten salt is used as storage for solar energy-electricity at large-scale concentrated solar plants.<sup>152</sup>

But the question is, why is so much effort being invested in turning saltwater into freshwater, when there are so many human uses for seawater, including expanding the human food supply with saltwater agriculture of halophyte crops as well as sea crops like kelp and other nutritional seaweeds a staple in Japan? These options examined in GTS 2018 are updated later in this report and are seemingly still ignored due to the cognitive bias: theory-induced blindness, as well as resistance by incumbent interest groups.

## **Pollution Cleanups**

Meanwhile, much useful research and innovation proceeds on cleaning up pollution of both fresh and saltwater. Several efforts now trawl for the “islands” of plastic trash floating in oceans, including Ocean Cleanup funded by Dutch engineer Boyan Slat, while still a teenager.<sup>153</sup> Another focus



Fig. 32: Solar catamaran, Bora Bora, Tahiti

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<sup>148</sup> US Department of Energy” “DOE Announces Prize Competition for Wave Energy Water Desalination”, Feb. 25, 2019

<sup>149</sup> ScienceDaily. “Seawater turns into freshwater through solar energy”, Jan.7, 2019

<sup>150</sup> Meeting of the Minds, “A Safe & Cost-Effective Alternative Water Supply for Potable Reuse”, Jan. 9, 2019

<sup>151</sup> ScienceDaily, “Radical desalination approach may disrupt the water industry”, May 7, 2019

<sup>152</sup> National Renewable Energy Laboratory (NREL), Molten salt: uses, (NREL)

<sup>153</sup> WIRED, “Mop It Up”: Mark Benioff bets on Boyan Slat’s Ocean Cleanup”, Sept. 18, 2018

is on capturing algae blooms from coastal waters, including in Florida. Algae can be turned into high-quality aviation fuel and for many other uses, as promoted by the National Algae Association and in Algae Bloom Remediation workshops.<sup>154</sup> Purdue University scientists have developed a solar-powered method of purifying water used in oil refining and recover 95% of the oil.<sup>155</sup>

We certainly encourage all this useful innovation in the use of fresh and seawater, including the many innovations in the water-processing of hydrogen: electrolysis (which splits water  $H_2O$  into its two components: hydrogen and oxygen). Today, hydrogen, a valuable energy carrier widely used industrially, is still derived from using fossil fuels (mostly natural gas) for the electrolysis process. Thus all the new research efforts to split water using solar and other clean energy are valuable. They include Stanford University's harnessing seawater directly to generate hydrogen<sup>156</sup>; the University of Toronto's low-cost catalyst for clean-energy electrolysis of hydrogen<sup>157</sup>; Queensland University in Australia discovered another low-cost catalyst for solar electrolysis of hydrogen.<sup>158</sup> The Chalmers University of Technology has created new sensors for hydrogen used in hydrogen fuel cells powering vehicles.<sup>159</sup> Japan's Kyūshū Electric Power Company, which had suppressed solar-electricity due to lack of storage is now exploring storage in hydrogen.<sup>160</sup> Hydrogen, produced with solar splitting of water molecules can be produced at a much larger scale using concentrated solar cells, as demonstrated by Switzerland's École Polytechnique Fédérale de Lausanne, and are launching a new company, SoHHytec.<sup>161</sup> Meanwhile, an electric-powered solar catamaran delights guests in Tahiti's Bora Bora Resort. (Fig. 32)

Global freshwater continues to dwindle through pollution, climate change-caused droughts, glaciers melting and misuse. For example, Saudi Arabia owns the huge 5,000 acres Fondomonte Farms in drought-stricken Blythe, California, to grow alfalfa to feed its 93,000 cows, using water from the Colorado River system.<sup>162</sup> And pharmaceutical residues: the antibiotic ciprofloxacin, as well as other patent

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<sup>154</sup> National Algae Association, "Algae Bloom Remediation Workshop with Woods Hole Oceanographic, Ft. Lauderdale, FL, May21-22,2019. Many more scheduled for 2019 [www.algaeindustrymagazine.com](http://www.algaeindustrymagazine.com)

<sup>155</sup> ScienceDaily, "What oil leaves behind in 2.5 billion gallons of water every day in the US", Mar. 20, 2019

<sup>156</sup> ScienceDaily, "Researchers create hydrogen fuel from seawater", Mar. 18, 2019

<sup>157</sup> ScienceDaily, "Low-cost catalyst boosts hydrogen production from water", Dec. 12, 2018

<sup>158</sup> ScienceDaily, "New catalyst produces cheap hydrogen fuel", Nov. 29, 2018

<sup>159</sup> ScienceDaily, "World's fastest hydrogen sensor could pave the way for clean hydrogen energy", Apr. 11, 2019

<sup>160</sup> ScienceDaily, "Estimation of technology level required for low-cost renewable hydrogen production", Jan. 31, 2019

<sup>161</sup> ScienceDaily, "Record solar hydrogen production with concentrated sunlight", May 12, 2019

<sup>162</sup> The Guardian, "Who keeps buying California's scarce water?" Saudi Arabia" Lauren Markham,

medicines pollute rivers in the USA and Europe.<sup>163</sup> At the same time, predictions by the Virginia Institute of Marine Science of sea-level rise continue for 32 US coastal locations from Maine to Alaska<sup>164</sup>, while global warming has caused the disappearance of twice as many ocean-dwelling species as those on land.<sup>165</sup> Some good news includes the new water treatment system piloted in Singapore by Nanyang Technical University which reduces toxic waste in a semiconductor factor while extracting the metal waste for sale;<sup>166</sup> as well as a solar-powered moisture harvester of mist from the University of Texas, Austin.<sup>167</sup>

## **Food, Aquaculture & Agriculture**

We now link CO<sub>2</sub>, energy, and water with updates on food, aquaculture, and agriculture ---- all tightly coupled and dependent on the transition to science-based investing based on a systemic

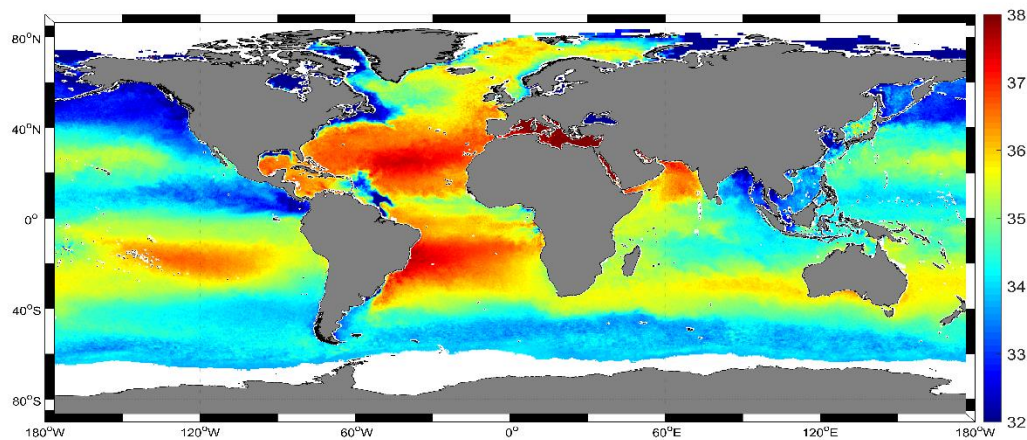


Fig. 33: European Space Agency (ESA) Salinity Levels

understanding of how our planet functions and is powered by the sun. The ESA satellite measures salinity levels in the world's oceans.<sup>168</sup> (FIG.:33) The World Economic Forum's Global Risks Report, now in its 14th edition for 2019 illustrates the gradual expansion of financial models and business plans from

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Mar. 25, 2019

<sup>163</sup> ScienceDaily, "Pharmaceutical residues in fresh water pose a growing environmental risk", Radboud University, Feb. 22, 2019

<sup>164</sup> ScienceDaily, "Continued sea-level rise on East and Gulf coasts detailed", Feb. 25, 2019

<sup>165</sup> ScienceDaily, "Global warming hits sea creatures hardest", Apr. 19, 2019

<sup>166</sup> ScienceDaily, "New membrane water treatment systems to reduce toxic waste by 90%", Feb. 25, 2019

<sup>167</sup> ScienceDaily, "Solar-powered moisture harvester collects and cleans water from air ", Mar. 14, 2019

<sup>168</sup> ESA, Salinity Levels, May 13, 2019, [www.esa.int](http://www.esa.int)



the anthropocentric world view of economic textbooks to this science-based approach to investing and acceptance of the SDG models of both risks and opportunities.<sup>169</sup> Mounting evidence of climate risks and public pressure are pulling scientists into both finance and public policy with the USA still lagging.<sup>170</sup> A UN report shows how citizen engagement and new business and financial models are driving mainstream incumbents toward climate-smart infrastructure.<sup>171</sup> Many successful partnerships between governments, scientific labs, investments, and investors are driving many green ventures and patented innovations.<sup>172</sup> This confirms research by economist Mariana Mazzucato in *The Entrepreneurial State* (2015).

Foods from the oceans, rivers, and aquaculture are threatened, many fish stocks are stressed while aquaculture as currently practiced is also unsustainable. Depletion of ocean species began decades ago with over-investment in excessively efficient fishing vessels and methods like trawling and large nets catching many species which are thrown away as “bycatch”.<sup>173</sup> The UN Food and Agriculture Organization (FAO) found 33% of marine stocks were overfished by 2015 with another 60% fished at maximum sustainable levels.<sup>174</sup> The World Bank found that world fishing efforts need to decline by 5% per year over a 10 year period just to allow fish stocks to rebuild.<sup>175</sup> The challenges are political and social although solutions to curb over-fishing are well-known and documented. Aquaculture presents many environmental problems: the use of wild-caught fish as feed; the harmful effects of escaped farmed fish on wild fish; greenhouse gas emissions similar to pork & and poultry productions; conversions of valuable wetlands, high demand for fresh water; pollution and increasing land use.<sup>176</sup> Aquaculture also destroys some of the 35% of coastal mangroves, cleared for shrimp cultivation and fish ponds. Mangroves are powerful ecosystem stabilizers and CO<sub>2</sub> capturers with their annual ecosystem services estimated at \$1.6 billion globally.<sup>177</sup> Underwater kelp forests and seaweeds not only provide nutrition but provide host ecosystems for many species. “If we lose kelp forests we also lose our biggest fisheries” according to Dr. Ziggy Marzinelli at the University of Sydney. Australia has 8000 kilometers of kelp

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<sup>169</sup> World Economic Forum, *The Global Risks Report 2019*, 14<sup>th</sup> Edition, Geneva. [www.wef.org](http://www.wef.org)

<sup>170</sup> ScienceDaily, “Leveraging scientists’ perceptions for successful interactions with policy makers”, Geological Society of America, Apr. 22, 2019

<sup>171</sup> UN Environment Program, “Digital Finance and Citizen Action”, Dec 2018, [www.unepinquiry.org](http://www.unepinquiry.org)

<sup>172</sup> ScienceDaily, “Green tech startups see boost in patents and investment when partnering with government”, Mar. 18, 2019

<sup>173</sup> Henderson, H. *Creating Alternative Futures. The End of Economics*, (1978, 1996, 2015 e-book), p. 126

<sup>174</sup> FAO, “The State of World Fishing and Aquaculture”, Rome, 2018, [www.fao.org](http://www.fao.org)

<sup>175</sup> World Bank, “The Sunken Billions Revisited: Progress and Challenges in Global Marine Fisheries”, Washington DC, 2017

<sup>176</sup> World Resources Institute, “Creating a Sustainable Food Future”, Dec. 2018, p. 41

<sup>177</sup> ScienceDaily, “Mangrove patches deserve greater recognition,” Zoological Society of London, Jan. 18, 2019



forests which host many species of fish, shellfish, lobster, and abalone.<sup>178</sup> Eelgrass, the most abundant seagrass in temperate waters, store 27.2 tons of organic carbon per hectare comparable to mangroves, macroalgae and salt marshes. In the past 50 years, at least one-third of these coastal ecosystems have been lost and we are losing another soccer-field size area every 30 minutes.<sup>179</sup> New research at the North Carolina State University finds that aquaculture or fish-farming does not help conserve wild fisheries.<sup>180</sup> Conserving wild catches under the Paris climate accords could net additional billions in fisheries revenues, according to the University of British Columbia.<sup>181</sup> Bloomberg Business week editorialized that tens of billions of subsidies for fishing fleets and fuels are harmful and should be curbed.<sup>182</sup> Illegal fishing is now being monitored using satellites, ranging from 11 to 26 million tons a year on top of officially permitted annual catches of 90 million tons.<sup>183</sup> Saltwater and ocean-grown plants (seaponics farming) contain the mineral profiles humans' need for optimal nutrition.<sup>184</sup>

Surface water is threatened in rivers and lakes as well as groundwater, which in the USA supplies primary freshwater to half of the population and 40% of all crop irrigation. The western US groundwater in the Basin and Range Province, freshwater extends to an average depth of 3,400 feet. Dropping off these freshwater tables in the USA, the University of Arizona finds the transition from fresh to brackish water in many states occurs at less than 1000 feet, where drilling deeper wells is not a solution.<sup>185</sup> The amount of fresh groundwater is available globally on which some 5 billion people in water-scarce areas rely, is less than previously thought, and water withdrawals exceed the recharge rate.<sup>186</sup> The University of Maryland scientist found the use of salt to de-ice roads was increasing salinity and liberating toxic metals in freshwater streams and rivers over the past 50 years.<sup>187</sup> This creates salt-evolved organisms: zooplankton unable to block salt-induced algae blooms, revealed by studies at Rensselaer Polytechnic Institute.<sup>188</sup> Charging for use of water is widely-advocated as a market-based solution to waste and

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<sup>178</sup> ScienceDaily, "Underwater forests threatened by future climate change", Feb. 6, 2019

<sup>179</sup> ScienceDaily, "Are we losing one of our biggest CO2 sinks?", Oct. 31, 2018

<sup>180</sup> ScienceDaily, "Aquaculture does little, if anything, to conserve wild fisheries", Feb. 11, 2019

<sup>181</sup> ScienceDaily, "Achieving Paris climate target could net additional billions in fisheries revenue", Feb. 11, 2019

<sup>182</sup> Bloomberg Businessweek, "The Perils of Overfishing", Apr. 22, 2019, p.10

<sup>183</sup> The Economist, "Netting the Crooks", Sept. 8, 2019

<sup>184</sup> Walters, C. "Fertility from the Ocean Deep": Nature's Perfect Nutrient Blend for the Farm", Acres USA, (2005, 2012)

<sup>185</sup> ScienceDaily, "US groundwater in peril: Potable supply less than thought", Nov. 28, 2018

<sup>186</sup> Ibid.

<sup>187</sup> ScienceDaily, "Saltier waterways are creating dangerous "chemical cocktails", Dec. 3, 2018

<sup>188</sup> ScienceDaily, "Salt-evolved zooplankton grow too slowly to block salt-induced algal blooms", Dec. 3, 2018

overuse, but cannot be applied widely since water is essential to life. However, pricing water uses by industry and large un-essential uses can be effective.<sup>189</sup> Sewage water is cleaned and treated by extracting its sludge for fertilizer, as in Milwaukee's familiar Milorganite, (see GTS 2018), as well as turned into bricks for construction to substitute for mining clay.<sup>190</sup>

## **Agriculture and Food**

We now update our GTS 2018 report with recent findings that also connect the dots linking agriculture and food, and an overview of current practices and continue to reveal their unsustainability. The conclusions in the World Resources Institute 2018 report, "Creating a Sustainable Food Future", synthesizes that while productivity gains in agriculture are critical, they must be linked to protecting carbon-rich ecosystems, biodiversity, restoring peatlands, large scale re-forestation --- and reduction in demand by changing consumer patterns. A 30% global shift from beef, sheep and goat meats to other foods would by itself, nearly close the land gap and halve greenhouse gases' mitigation gap.<sup>191</sup> Courageously, the report also calls for humans to move more rapidly to replacement-level fertility rate, by reducing poverty and improving women's access to education and healthcare.<sup>192</sup> This, in turn will require full recognition in all cultures and religions sects of "habeas corpus" rights to all women.<sup>193</sup> Another landmark report "Missing Pathways to 4.5° C" links food and agricultural sustainability to safeguarding the land rights of local indigenous peoples, biodiversity and food sovereignty.<sup>194</sup> This study links climate action with all these important, overlooked factors.

A definitive report from the European Academies Science Advisory Council (EASAC) takes an integrated view of food systems, resource-efficiency, environmental stability, resilience and public health agenda. The report calls for sweeping changes to agriculture's use of 40% of the Earth's land surface, 70% of the world's freshwater and 30% of all energy consumption.<sup>195</sup> While this vast, useful report covers opportunities for reform in all agricultural and food systems, it overlooks many of the under-utilized

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<sup>189</sup> See for example: Barbier, E. B., "The Water Paradox", (2019)

<sup>190</sup> ScienceDaily, "From toilet to brickyard: Recycling biosolids to make sustainable bricks", Jan. 22, 2019

<sup>191</sup> World Resource Institute, op. cit. p. 76

<sup>192</sup> Ibid. p. 2

<sup>193</sup> Henderson, H., "Politics of Connectivity", op. cit.

<sup>194</sup> CLARA (Climate Land Ambition and Rights Alliance), "Missing Pathways to 1.5° C", 2018

<sup>195</sup> EASAC: "Opportunities and challenges for research on food and nutrition security and agriculture in Europe", Dec. 2017, [www.easac.eu](http://www.easac.eu)

wild and halophyte species, local indigenous farming and saltwater agriculture.<sup>196</sup> Another report from the Boston Consulting Group outlines realistic reforms and calls on corporations to embrace sustainability more seriously.<sup>197</sup> The European Union's Real Time Delphi study<sup>198</sup> on the nexus between water, energy and food security expects the use of saltwater to increase in saline agriculture echoing the Millennium Project's Global Futures Intelligent System.<sup>199</sup> The Future Today Institute focuses on future agricultural technologies.<sup>200</sup> Britain's Committee on Climate Change (CCC) finds it feasible to reach zero GHGs emissions by 2050 with cost reductions now in renewable technologies and shifting farmland use, as well as tripling tree-planting.<sup>201</sup>

Perhaps the most influential report on sustainable food systems for the planet is The Lancet Commissions EAT study by its commissioners and 18 scientific authors from 16 countries on health, agriculture and environmental sciences. They developed global scientific target for healthy diets and sustainable agriculture, with a global set of indicators of planetary boundaries,<sup>202</sup> naming food production as among the largest drivers of global environmental and climate change, by contributing to biodiversity loss, freshwater use, interference with global nitrogen and phosphorous cycles, land-system change (and chemical pollution not assessed in the report).<sup>203</sup> The EASAC report also advises changing diets to mostly plant-based foods and cutting beef, sheep and goat meats by 50%. A deeper focus on diets follows on page 53 since meat from livestock adds almost 15% to global greenhouse gas emissions. The climate goals of the Paris accords focus on the impact of land use and the associated massive depletion of natural carbon sinks. However, a research team at the University of Karlsruhe Institute of Technology and the University of Edinburgh show that previous efforts to reduce GHGs through human land use are insufficient.<sup>204</sup> So far, 197 countries have prepared Nationally Determined Contributions (NDCs), most

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<sup>196</sup> Ibid., p. 33-41

<sup>197</sup> Boston Consulting Group, "It's Time to Plan the Seeds of Sustainable Growth in Agriculture", Sept. 2018, [www.bcg.com](http://www.bcg.com)

<sup>198</sup> European Commission, "Study on water, energy and food security, 2018, [www.europa.eu](http://www.europa.eu)

<sup>199</sup> Millennium Project, Global Futures Intelligent System", 2018 [www.millennium-project.org](http://www.millennium-project.org)

<sup>200</sup> Future Today Institute, "Agriculture Technologies", 2019, [www.futuretodayinstitute.com](http://www.futuretodayinstitute.com)

<sup>201</sup> NewScientist, "Time for a Green Revolution", May 11, 2019, p. 10

<sup>202</sup> The Lancet Commissions, "Food in the Anthropocene: The EAT-Lancet Commission on healthy diets from sustainable food systems", Jan. 16, 2019

<sup>203</sup> Ibid., p. 1

<sup>204</sup> ScienceDaily, "Climate goals of the Paris Agreement: Impact of land use", Feb. 19, 2019

aimed at reducing deforestation, afforesting large areas and reducing GHGs from agriculture. These plans could remove up to 25% of global GHGs every year --- but take decades --- far too long to slow climate change.<sup>205</sup> Deforestation is still continuing in Brazil (often for raising beef cattle), which could lead to local increases in temperature of up to 1.45° C, as found by scientists at Rio de Janeiro State University.<sup>206</sup> Worsening worldwide land degradation is now undermining the wellbeing of 3.2 billion people.<sup>207</sup> We humans are learning how

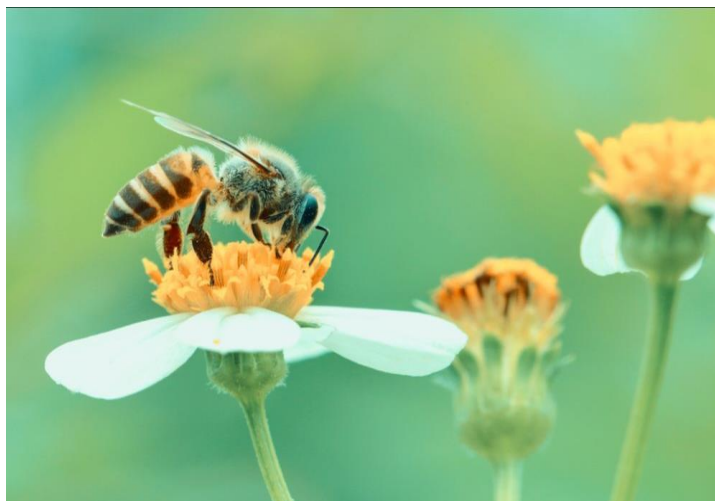


Fig. 34

forests are controlled by climate, measured by scientists at the University of Arizona and the Santa Fe Institute. They amassed a huge database which showed 9 functional traits: temperature, vapor, growth, weight, wood density, leaf areas, precipitation, wind speed, carbon, nitrogen and phosphorus, and hope to use this data to improve the accuracy of computer models predicting climate change.<sup>208</sup>

There is now broad agreement that protecting forests and enhancing agriculture and other lands are imperative, but may not be enough without policy mechanisms to accelerate shifts to renewable resources and incentives to support such natural climate solutions.<sup>209</sup> University of Edinburgh scientists criticized many countries' NDCs which instead of protecting and restoring natural forests, plan vast monocultures of commercial trees which are poor at storing carbon.<sup>210</sup> Pushing for higher agriculture yields by exploiting farmland often results in losses of biodiversity, found by scientist at Helmholtz Centre for Environmental Research-UFZ.<sup>211</sup> Russia, however, is benefitting from a warmer climate and has

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<sup>205</sup> Ibid.

<sup>206</sup> ScienceDaily, "Predicted deforestation in Brazil could lead to local temperature increase up to 1.45° C", Mar. 20, 2019

<sup>207</sup> IPBES, "Media Release: Worsening Worldwide Land Degradation Now 'Critical', Undermining Wellbeing of 3.2 Billion People", 3-year assessment report, Mar. 23, 2018

<sup>208</sup> ScienceDaily, "These nine measures reveal how forests are controlled by climate", Dec. 28, 2018

<sup>209</sup> ScienceDaily, "Forest, carbon sinks cannot make up for delays in decarbonizing the economy, experts argue", Feb. 28, 2019

<sup>210</sup> ScienceDaily, "Restore natural forest to meet global climate goals", Apr. 2, 2019

<sup>211</sup> ScienceDaily, "How much nature is lost due to high yields?", April 10, 2019

become a big wheat exporter.<sup>212</sup> Adverse climate conditions and conflicts have resulted in 226 food shocks across 134 nations over the past 53 years according to an international study led by the University of Tasmania, published in *Nature Sustainability*.<sup>213</sup> Crop residue burning in India and many countries accounts for up to 80% of fall and winter air pollution in New Delhi.<sup>214</sup> This practice is wasteful since rice straw can be upcycled into useful products by circular economy companies, including ECOR, and crop wastes are better plowed back into enriching soils.<sup>215</sup> Air pollution and environmental damage caused by corn production in the USA results in 4,300 premature deaths due to GHGs, fine particles, and ammonia according to a study by the University of Minnesota College of Food, Agriculture and Natural Resources Science.<sup>216</sup> Excessive use of phosphate fertilizers which often cause runoff pollution of waterways has now been found to also hurt plants by altering soil microbes.<sup>217</sup> Although one effect of increasing CO<sub>2</sub> in the atmosphere is more fuel for plants to photosynthesize increasing growth rate sometimes by as much as 40%, the bad news is how this may affect diseases to crops such as leaf disease and others affecting roots, according to research at Utrecht University in Holland.<sup>218</sup> Scientists' inventories of insect species found declined in insect life and health of 50-80% in areas in Germany, California and Borneo.<sup>219</sup> Famed biologist and entomologist E. O. Wilson reminds us that if insects were to vanish the environment would collapse into chaos.<sup>220</sup> As we learn about the role of bees (Fig. 34) in pollination our foods, we also know that many people and the world are using insects for food.<sup>221</sup>

While there has been little progress on investing in the huge opportunities of expanding global food supplies with halophyte plants and saltwater agriculture, we note that scientists at Oxford University have modified plants' ability to tolerate high salinity.<sup>222</sup> An interesting experiment in California took seawater from the ocean at Long Beach and mixed it with chemically-treated URB Water (which changes

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<sup>212</sup> The Economist, "Good Times in Grainville: Post Soviet farming", Dec. 1, 2018, p. 60

<sup>213</sup> ScienceDaily, "Extreme weather geopolitics major drivers of increasing food shocks", Jan. 28, 2019

<sup>214</sup> ScienceDaily, "Crop residue burning is a major contribution to air pollution in South Asia", Feb. 27, 2019

<sup>215</sup> World Affairs, "The Impact of Green manure and Soil Amendment", Jangir, R., Saini, L. K., Tajane, D. Winter 2018 (October-December) Vol. 22, No. 4, New Delhi, India

<sup>216</sup> ScienceDaily, "Air pollution caused by corn production increases mortality rate in US", Apr. 1, 2019

<sup>217</sup> ScienceDaily, "Excessive phosphate fertilizer use can reduce microbial functions critical to crop health", Mar. 18, 2019

<sup>218</sup> The Economist, "Climate change and crop disease", Apr. 20, 2019

<sup>219</sup> The Economist, "Nothing in the cry of cicadas", Mar. 23, 2019

<sup>220</sup> The Economist, "Plague without locusts", Mar. 23, 2019, p. 12

<sup>221</sup> Nature, "Globe to gut: Inside Big Food", Mar. 26, 2019

<sup>222</sup> ScienceDaily, "New Biochemical pathway that may develop more resilient crop varieties", Feb. 21, 2019



its molecular structure) and used to irrigate a patch of 100 bok choy plants at Joyful Farms in Hemet, California. The plants survived, grew and were eaten raw, as well as cooked. They tasted fine and no one had any negative side-effects.<sup>223</sup> As we reported (GTS 2018) experiments like these are welcome and many halophyte crops including quinoa, salt-tolerant rice, salicornia are enjoyed in the USA, Europe and China. Dr. Carl Hodges at the University of Arizona's Plan to restore and green California's Salton Sea may get a hearing.<sup>224</sup> Dr. John Todd of Ocean Arks International is also developing saltwater farming both kelp and coastal water and land,<sup>225</sup> discussed in his "Healing Earth" (2018).

Scientists, at the University of Illinois, have now engineered the photorespiration of plants to increase their efficiency by 40%, as reported in Science<sup>226</sup> Research Instituto Italiano di Tecnologia in Pisa, Italy have discovered that plants can generate 150 volts of electricity, enough to power 100 LED lightbulbs.<sup>227</sup> Research at the University of Sydney, Australia harvests wild plant genes that are disease-resistant and uses a new method, AgRenSeq to rapidly transfer these genes to currently-grown crops.<sup>228</sup> Often better tilling and mulching is effective, such as in China's dry plateau, increasing the staple potato crop.<sup>229</sup> Rice is not only now in salt-tolerant varieties, but can also be hybridized to contain more protein.<sup>230</sup> Rice can also filter pollutants from runoff water as discovered by the American Institute of Agronomy.<sup>231</sup> Scientists at Ohio State University have found that co-planting a native shrub alongside its millet crops can increase production 900% since the shrub's deep roots draw up water.<sup>232</sup> The state of Hawaii targets its food self-sufficiency by 2020 using native species and indigenous agricultural methods.<sup>233</sup>

Israel is transforming farming in many ways, including using drones and satellites for information, drip irrigation to save water and automating beehive maintenance, mostly innovated by commercial

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<sup>223</sup> Gammon, T., URB Water, LLC, Summary: "Growing Food with Seawater", May, 2019

<sup>224</sup> Saltwaterworks, Hodges, C., "Salton Sea Plan", [www.seawaterworks.com](http://www.seawaterworks.com)

<sup>225</sup> Ocean Arks International: Communication from Dr. John Todd (also on Ethical Markets global Advisory Board). Nov. 2018

<sup>226</sup> ScienceDaily, "Scientist engineer shortcut for photosynthetic glitch, boost crop growth 40%", Jan. 3, 2019

<sup>227</sup> ScienceDaily, "How plants can generate electricity to power LED light bulbs", Dec. 12, 2018

<sup>228</sup> ScienceDaily, "Harvesting wild genes give crops renewed resistance to disease", Feb. 4, 2019

<sup>229</sup> ScienceDaily, "Soil tilling, mulching key to China's potato crop", Nov. 29, 2018

<sup>230</sup> ScienceDaily, "High-protein rice brings value, nutrition", Jan. 23, 2019

<sup>231</sup> ScienceDaily, "Can rice filter water from agricultural fields?", Dec. 5, 2018

<sup>232</sup> ScienceDaily, "How one tough shrub could help fight hunger in Africa", Nov. 2, 2018

<sup>233</sup> ScienceDaily, "Indigenous agriculture has potential to contribute to food needs under climate change", Feb. 26, 2019

companies.<sup>234</sup> Other big agribusiness firms are fed with data from Climate Corp, collected from farmers (on yields, fertilizer use, crop rotation, rainfall, etc.) which is used by Syngenta, DowDupont and BASF. This data is then sold back to the farmers.<sup>235</sup> The seed bank in Svalbard, Norway is now threatened with melting permafrost.<sup>236</sup> Researchers at Britain's Royal Botanic Gardens Kew found that 36% of critically, endangered species produce seeds that cannot tolerate drying or freezing.<sup>237</sup> US farmers spent \$22 billion on seeds in 2018, many of which are patented by Monsanto (now part of Bayer AG) and DowDupont. The Farmers Business Network (FBN a 5 year old startup) sells non-GMO seeds developed directly with plant-breeders and cutting out the big middlemen.<sup>238</sup> Since our GTS 2018, little effort has been made to broaden global food from its over-reliance on a few monoculture crops: corn, wheat, soy, rice and alfalfa. Out of 30,000 global edible plants species only 30 are currently used to feed people.<sup>239</sup> A new natural farming strategy is rolling out in China, reported by Stanford University.<sup>240</sup> New plant-breeding goes beyond hybridization to use CRISPR/Cas gene-editing which if used responsibly can contribute to food supplies.<sup>241</sup> Tobacco plants contain protein, Interleukin 37 and anti-inflammatory substances useful in human health.<sup>242</sup> Israel-based Salicrop is breeding salt-tolerant seeds to increase food crops.<sup>243</sup>

Neusis Global plans to develop fully integrated farming, beginning with localizing food for Puerto Rico for autonomous development.<sup>244</sup> In Germany, an innovative effort to prevent continuing burning of lignite (brown coal) in power plants is to use ignite as a soil enhancer. Research and development by NOVIHUM Technologies in Dortmund has invested €20 million in trials in Germany, Canada, USA, Spain, Italy, Oman and Australia. NOVIHUM turns lignite into a stable humus for soil, indistinguishable from natural high-grade humus.<sup>245</sup> Another new company, Pearl's Premium, produces an ultra-low-

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<sup>234</sup> The Economist, "Agritech in Israel", Jan. 12, 2019, p. 41

<sup>235</sup> Bloomberg Businessweek, "A Bumper Crop of Information", Mar. 18, 2019

<sup>236</sup> The Economist, "Svalbard, Melting Away", Oct. 13, 2018, p. 53

<sup>237</sup> ScienceDaily, "Seed banking not an option for over a third of threatened species", Nov. 2, 2018

<sup>238</sup> Bloomberg Businessweek, Technology, Mar. 11, 2019, p. 9

<sup>239</sup> Ibid.

<sup>240</sup> ScienceDaily, "Farming for natural profits in China", Apr. 1, 2019

<sup>241</sup> ScienceDaily, "New plant breeding technologies for food security", Mar. 29, 2019

<sup>242</sup> ScienceDaily, "Tobacco plant transformed into 'green bioreactors' to benefit human health", Feb. 26, 2019

<sup>243</sup> Salicrop: Company Presentation "Overcoming the Salinity Barrier", Nov. 2018, [www.salicrop.com](http://www.salicrop.com)

<sup>244</sup> Neusis Global, LLC, company presentation, "An Unparalleled Holistic Agriculture solution", [www.neusisglobal.com](http://www.neusisglobal.com), personal communication with co-founders Kate Mulder and Michael Klein, May 17, 2019

<sup>245</sup> NOVIHUM Technologies GmbH: company presentation, "Grow Better Wherever You Are", Aug. 2018

maintenance lawn seed for suburban lawns, with deep roots, high salt-tolerance, requiring little watering or mowing.<sup>246</sup> Lastly, Wall Street's cannabis craze garnering millions from investors,<sup>247</sup> may be in for a surprise. Scientists at the University of California, Berkeley find that yeast can produce low-cost cannabinoids, in a more energy-efficient, environmentally friendly method than growing marijuana crops.<sup>248</sup>

## **Food Futures**



Salt tolerant rice



Bowl of Quinoa



Salicornia Fields, Eritrea, Africa  
Courtesy Elizabeth Hodges



Salicornia Field, Sonora, Mex  
Courtesy Elizabeth Hodges

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<sup>246</sup> Pearl's Premium: company presentation, "People, Pet and Plant Friendly Lawn Seed", 2018, [www.pearlspremium.com](http://www.pearlspremium.com), personal communication with founder, Jackson Madnick

<sup>247</sup> FORTUNE, "Wall Street's Contact High", Feb. 1, 2019, [www.fortune.com](http://www.fortune.com)

<sup>248</sup> ScienceDaily, "Yeast produce low-cost, high quality cannabinoids", Feb. 27, 2019

Following our GTS 2018 report on the reasons for the global rise of the plant-protein sector we covered startups including Beyond Meat, Impossible Foods and many others. On May 3, 2019, Beyond

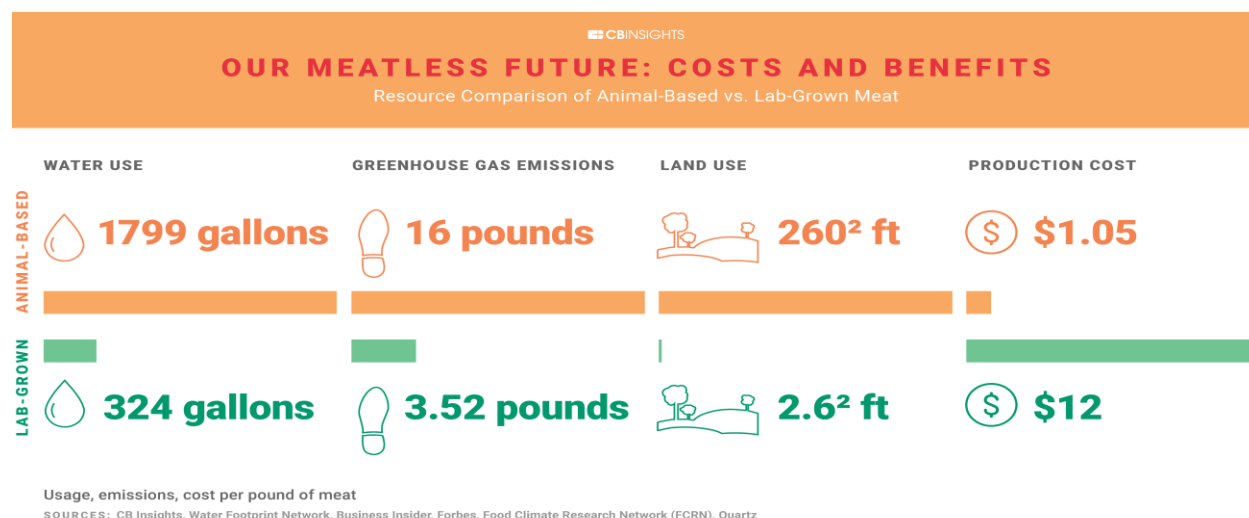


Fig. 35: ["Our Meatless Future, Traditional Meat Production vs. Lab Grown Value Chain"](http://www.cbinsights.com)  
[www.cbinsights.com](http://www.cbinsights.com)

Meat's IPO soared 163% on its first day trading on Nasdaq.<sup>249</sup> Our update "Greening Our Global Food System" had noted that the CEO of Tyson Foods, (the chicken livestock giant) had invested \$55 million into Beyond Meat saying "Meat is the new tobacco!"<sup>250</sup> (Fig. 35)

The speed with which the plant-protein food industry has grown since our 2018 reports involves many cultural shifts toward a new awareness of global responsibility for human effects on climate change. These include global movements of animal rights, vegetarian and vegan diets, health concerns and fashion fads, to TV, film and other celebrities calling for meatless diets. Increasing war chests of capital investing in plant-protein startups, include New Crop Capital, IndieBio Investments, Tyson New Ventures,<sup>251</sup> FAIRR and its consortium of investors.<sup>252</sup>

<sup>249</sup> MarketWatch, "Beyond Meat soars 163% in biggest-popping U.S. IPO since 2005", May 3, 2019, 9:26AM EST

<sup>250</sup> Ethical Markets: "Greening the Global Food System", (original quote in Bloomberg Businessweek), Aug. 2018, [www.ethicalmarkets.com](http://www.ethicalmarkets.com)

<sup>251</sup> CBInsights, "Our Meatless Future", January 2019, [www.cbinsights.com](http://www.cbinsights.com)

<sup>252</sup> FAIRR, "Plant-Based Profits", March 30, 2018, [www.fairr.org](http://www.fairr.org) and reported on p. 30 of GTS 2018



We update on FAIRR's research by referencing their Collier FAIRR Protein Producer Index Report which covers 9 of the risk factors for the 60 largest global companies with a combined market cap of close to \$300 billion in livestock and aquaculture and how they relate to the SDGs.<sup>253</sup> FAIRR's founder and Chief Investment Officer, Jeremy Collier, Principal of Collier Capital notes, "Investors need ESG data and transparency to enhance shareholder value, this index helps bridge the knowledge gap."<sup>254</sup> The 9 risk factors are: 1) GHGs, 2) Deforestation and Biodiversity Loss 3) Water scarcity and use 4) Antibiotics 5) Waste and water pollution 6) Working conditions 7) Food Safety 8) Sustainable proteins and 9) Animal



Fig. 36: Cornerstone Capital, "Sustainable Protein" report, Feb 2019

welfare. Another major financial innovator is Cornerstone Capital Group, a leader in this and other ESG research and investing. Their 2019 report on Sustainable Protein is comprehensive and highlights the many new investment opportunities.<sup>255</sup> (Fig. 36)

<sup>253</sup> Collier FAIRR Protein Producer Index Report; Summary Version, 2018 [www.fairr.org](http://www.fairr.org)

<sup>254</sup> Ibid.

<sup>255</sup> Cornerstone Capital Group, "Sustainable Protein: Investing for Impact at the Nexus of Environment, Human Health and Animal Welfare". Global thematic Research, Feb. 2019, [www.cornerstonecapinc.com](http://www.cornerstonecapinc.com)



While cows will survive as milk producers, consumers are embracing plant-based alternative beverages that substitute for the dairy milk and now equal a comparative 13% of the size of the market.<sup>256</sup> Non-dairy milks, made from soy, oatmeal, almonds, coconuts, cashews in 2017 captured \$2 billion in sales. (Fig. 37) This success incentivized the plant-protein food startups that now offer an alternative to beef, chicken, pork, sausages, hamburgers, as well as fish and cheeses. An influential article in New Scientist made consumers aware of how dairy-derived



Fig. 37: Plant Based Milks

cheeses were also bad for the planet<sup>257</sup> with world production to 22 million tons per year and expanding as traditionally-cheeseless (and often vegetarian) Asian cultures are mimicking western diets.<sup>258</sup> Demand for cheese has driven expansion of the dairy industry, with milk production at 800 million tons, much for cheese, from cows, goats or sheep, all are ruminant species with methane-belching digestive tracts.<sup>259</sup> This burgeoning plant-based global food industry is beginning to disrupt the giant incumbents hold on



Fig. 38: Organic Produce

global grain trading, Cargill, ADM, ConAgra, Bunge, Louis Dreyfus, and on agrochemicals: Monsanto (now part of DowDupont), Syngenta, as well as farm machinery giants, Caterpillar, Komatsu and Deere. This agro-chemical industrial complex is tightly-coupled with the big industrial food and beverage producers, Kraft-Heinz, Pepsi, Coke, as well as livestock meat companies, Tyson, Purdue, Hormel, McDonald's and other burger chains.<sup>260</sup>

<sup>256</sup> The Guardian, "White gold: the unstoppable rise of alternative milk", Oliver Franklin-Wallis, Jan. 19, 2019 [www.theguardian.com/news](http://www.theguardian.com/news)

<sup>257</sup> NewScientist, "Cheese Meltdown, Feb. 16, 2019 p. 30-35

<sup>258</sup> Ibid. pg. 35, "Alternative Cheese Put to the Test", (sampling vegan cheese products from) UK companies

<sup>259</sup> AltEnergy Stocks, "Does the Beyond Meat IPO Spell the End Of The Cow?", Nov. 22, 2018

<sup>260</sup> Henderson, H. "Investing in halophytes: The next big thing", Green Money Journal 2014, 2017 and GTS, 2018



Fig. 39: Plant protein-based burgers

This disruption of such a huge global industrial complex emerged with growing consumer awareness of climate change, environmental destruction and personal health and aesthetic concerns. Animal rights activist coalesced with environmentalists, vegetarians and anti-corporate movements in many developed countries and these joined forces with many reform groups concerned with poverty, hunger and deprivation in developing countries.<sup>261</sup> In the USA nearly half of all shoppers now add plant milk to their carts.<sup>262</sup> Ecovia Intelligence found that in

2018 worldwide organic food and drink sales had increased 6% to \$106 billion. North America and Europe comprise 90% of this market. Countries traditionally exporting their organic crops, China, India and Brazil are now developing strong markets for these crops internally.<sup>263</sup> Rising consumer awareness and widening availability are cited, as well growing number of restaurants and food service groups, chains including McDonald's and Pret A Manger offer organic foods. Burger King now offers plant-based Impossible Foods, veggie-burgers.<sup>264</sup> Scientists at the National University of Singapore found that eating mushrooms may reduce the risk of cognitive decline.<sup>265</sup> A restaurant chain, Potato Head in Singapore hosted Pat Brown, M.D. founder and CEO of Impossible Foods to launch their range of plant-based meat and says his mission backed by Temasek Holdings is to completely remove animals from the human food chain by 2035.<sup>266</sup> Impossible food is now valued at \$2 billion and the brand is now in 5,000 restaurants worldwide.<sup>267</sup> New food start-ups, Beyond Meat, Impossible Foods, Mosa Meat, Aleph Farms, Alpha Foods, Fora Foods, emerged from animal-rights activist Chris Kerr, founder of New Crop Capital, along

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<sup>261</sup> Bloomberg Businessweek: The Good Business Issue, "New Crops Portfolio", Dec. 24, 2018, p. 65-67

<sup>262</sup> The Guardian, "White gold, opt.cit, [www.theguardian.com/news](http://www.theguardian.com/news)

<sup>263</sup> Ecovia Intelligence: Press Release, "Global Organic Food Sales Break USD 100 Billion Barrier", Apr. 26, 2019

<sup>264</sup> Global Citizen, "Burger King will start selling meat-free Impossible Burgers across the USA, Apr. 29, 2019

<sup>265</sup> ScienceDaily, "Eating mushrooms may reduce the risk of cognitive decline". Mar. 12, 2019

<sup>266</sup> Eco-Business, "Meat from plants-Does Asia have an appetite for Impossible Foods?", Mar. 13, 2019

<sup>267</sup> CNet, "Impossible Burger 2.0 tastes like beef. Really", Dara Kerr, Jan. 7, 2019, [www.cnet.com/news](http://www.cnet.com/news)

with other venture funds.<sup>268</sup> The Organic Trade Association reports that sales hit a new milestone of \$47.9 billion in 2019, pushed by millennials.<sup>269</sup>

The rise of the plant-food sector and the host of new companies is matched by the rise of cool vegan, vegetarian and environmentally aware restaurants. For example WIRED covers the venture capital pouring into such new chains; Sweetgreen became the first restaurant “unicorn” raising \$200 million; Cold-pressed Joe and the Juice is planning an IPO at \$1.5 billion; Kitchen Fund and Enlightened Hospitality Investments, (run by Shake Shack’s founder) are pumping over a \$100 million into “early-stage scalable restaurant concepts. One such concept is to use 23andMe DNA results to customize food to your microbiome.<sup>270</sup> A cautionary look at the rush for foods and beverages fortified with extra protein finds these fashionable foods advertised as providing extra energy or building muscle are unnecessary for most western consumers.<sup>271</sup> All these issues are covered in Raise Vegan and other magazines.



Fig. 40: Vegan Restaurants



Fig. 41: Raise Vegan

<sup>268</sup> Bloomberg Businessweek: The Good Business Issue, “New Crops Portfolio”, Dec. 24, 2018, p. 65-67

<sup>269</sup> FoodPrint, May 24, 2019 [www.foodprint.org](http://www.foodprint.org)

<sup>270</sup> WIRED, “Green Giants: The Rise of Fast-Casual Food Platforms”, Mar. 2019

<sup>271</sup> NewScientist, “Protein Mania”, Apr. 20, 2019





Fig. 42: Seaweed Farming

Shifting to ocean-raised kelp and other seaweeds is both healthy and good for the planet. This form of ocean farming helps protect over-fished species and is described in “Eat Like A Fish” by former commercial fisher Bren Smith.<sup>272</sup>

Eating insects is taking off in western countries as another nutritious, healthy and superior diet for the planet, following the 80% of people on Earth who consume insects<sup>273</sup> The BBC TV series “Grubs Up: Would You Eat Insects to Save the Planet?” aired in April 2019 covers all these issues while showing all the foods available in stores and restaurants.



Fig. 43: Insect food for people

<sup>272</sup> Smith, B., “Eat Like a Fish”, Penguin Random House, (2019)

<sup>273</sup> Bloomberg Businessweek, “Hopping to a Menu Near You”. Apr. 15, 2019, p. 71



Fig. 44:

Protifarm, the Dutch company is the world's largest producer of buffalo worms for human foods.<sup>274</sup> Insects contain 60-70% protein and are rich in iron, zinc and other nutrients. A US startup, Bugs for Birds partners with a Canadian firm that diverts food wastes from landfills, which are used to grow larvae of black soldier flies, which in turn, becomes feed for livestock.<sup>275</sup>

However, as mentioned, and in the IPBES report warns, insects too, especially bees, are endangered by human practices, pesticides, etc. and are the pollinators on which we rely for many of our crops.<sup>276</sup> Insect protein is also used in pet foods, with many products on the market, as a new study by



Fig. 45: Insect-based foods packaged for pets

scientists at Britain's University of Nottingham finds. One company, Yora, compares its insect-based pet foods as far superior to the land and water requirements and GHGs emissions of beef.<sup>277</sup>

<sup>274</sup> BBC-TV, [www.bbc.co.uk/programmes/n3ct6l9t](http://www.bbc.co.uk/programmes/n3ct6l9t) , Apr. 2019

<sup>275</sup> Natural Capital Solutions, "How A Boulder Startups' Innovative Business Mode Is Fighting Climate Change, Preserving Land and Improving Livestock Health", [www.natcapsolutions.org](http://www.natcapsolutions.org), May 9, 2019

<sup>276</sup> IPBES, op. cit., also FAO: "State of the World's Biodiversity for Food and Agriculture", Rome, Feb. 22, 2019

<sup>277</sup> The Conversation, Gardner, D.S., Salter, A., Welham, S., "Insect Protein: dish of the day for your environmentally friendly pet", Feb. 21, 2019, [www.theconversation.com](http://www.theconversation.com)





Fig. 46: Factory Livestock Farming

One area where plant-based cultured meat and insect-based foods are clearly superior to livestock-raised meat is their freedom from antibiotics --- both the huge quantities used in raising livestock and the residues (Fig. 46) consumed in the meat products. These uses of antibiotics are leading to a new global health crisis as they engender mutating new strains of antibiotic-resistant diseases which

already kill 700,000 people annually worldwide and could kill 10 million by 2050.<sup>278</sup> Worse, global pharmaceutical research and drug markets fail to address this crisis, since selling antibiotics is a low-profit business so new drugs to combat resistant diseases are not being developed. A key developer, Achaogen, Inc. filed for bankruptcy even as it had produced a new antibiotic to target a superbug CRE which kills patients in hospitals.<sup>279</sup> The industrial factory-farming model requires the use of antibiotics since the animals are in such crowded, unhealthy factory-like facilities. US Senator Bernie Sanders election platform included ending this factory-farming model, along with similar proposal by Senator Elizabeth Warren. Both call for breaking up the giant food and agriculture firms and fostering more organic local farming.<sup>280</sup>

The revolution in medicine as research on the human biome---particularly the millions of microbiota in the human gut, has led to new approaches, including fecal transplants to combat antibiotic-resistant bacteria.<sup>281</sup> Almost 2,000 unknown bacteria have been identified in the human gut.<sup>282</sup> Such fecal transplants are found safe and effective in children.<sup>283</sup>

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<sup>278</sup> The Economist, "Netflix and pills" and "A tough sell", May 4, 2019 p. 12, p. 57

<sup>279</sup> Bloomberg Businessweek, "When a Drug is Too Effective to Succeed", May 6, 2019, p. 13

<sup>280</sup> Common Dreams, "Sanders Proposes Major Change to Food Production System", May 7, 2019

<sup>281</sup> ScienceDaily, "Fecal transplants may be best answer to antibiotic-resistant treatment: Non-pharmaceutical Treatment combats recurring Clostridium Difficile infections", May 12, 2019

<sup>282</sup> ScienceDaily, "Almost 2,000 unknown bacteria discovered in the human gut", Feb. 13, 2019

<sup>283</sup> ScienceDaily, "Fecal microbiota transplant found safe and effective in children with C. difficile", May 19, 2019

All this research we access in this report from scientists around the world may illustrate why we are naming science-denial as the newest financial risk. Without exploring these underlying planetary conditions --- all tightly, interlinked, asset managers will continue making misguided investments and risking more kinds of stranded assets beyond those recognized in fossil fuels. New research is often brought to light by NGOs and the role of citizen scientists who over-ride efforts by corporations to mislead the public.<sup>284</sup>

Another new risk is in the adoption of unhealthy western fast food diets in many developing countries. One in five deaths worldwide are linked to such unhealthy diets as burgers and soda drinks replaced traditional diets. The UN's Food and Agricultural Organization (FAO) head, José Graziano da Silva says "We cannot only focus on tackling hunger anymore. We are witnessing the globalization of obesity".<sup>285</sup> A study by the US-based



Fig. 47: Fast foods in developing countries

"Institute for Health Metrics and Evaluation" finds that unhealthy eating is killing 11 million people a year-up from 8 million in 1990. While smoking kills 8 million people a year. Diet-related stroke, cancer, diabetes and heart disease will cost the world more than \$30 trillion.<sup>286</sup> (Fig. 47). Some startups are experimenting with affordable, healthy alternatives, including NamZ in Singapore.<sup>287</sup>

Now for a review of the global counter-trends likely to block the shift to healthier, environmental-friendlier food systems. Globally, the consumption of meat and animal products is rising. In China, between 1961 and 2013 the average Chinese person went from eating 4 kilograms of meat per year to 62 kilograms, consuming half of the world's pork.<sup>288</sup> In the decade to 2017 global meat consumption rose by

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<sup>284</sup> Citizen Science, editors Cavalier, D. and Kennedy, E. B., Consortium for Science, Policy and Outcomes, Tempe, AZ and Washington, D.C., (2016)

<sup>285</sup> FAO, "FAO chief says trade has a key role", Apr. 23, 2019, Rome

<sup>286</sup> Institute for Health Metrics and Evaluation. [www.healthdata.org](http://www.healthdata.org)  
Thomson-Reuters Foundation, [www.thomson-reuters.com](http://www.thomson-reuters.com)

<sup>287</sup> Eco-Business, "The Nutrition Paradox: what does it mean for business?", May 26, 2019, [www.eco-business.com](http://www.eco-business.com)

<sup>288</sup> The Economist, "A meaty planet". May 4, 2019, pp. 50-53

an average of 1.9% a year and dairy consumption by 2.1%.<sup>289</sup> While US consumption of beef peaked in 1976, Chinese and consumers in many African countries are eating more beef, as well as dairy and chickens. Africa imports more meat each year than China and their chickens will quadruple to 7 billion birds. While many poor undernourished people will benefit, the overall health costs will escalate due to fast foods, sugary sodas, fat and salt as we noted, China is buying farmland in 30 countries to feed its 1.4 billion people, while also buying lab-grown beef from Israeli companies.<sup>290</sup> China is battling an epidemic of African swine fever in 2019, their Year of the Pig. Already 1 million hogs have been culled from their 440 million pigs.<sup>291</sup> Livestock meat producers are pushing back. University of California's Prof. Frank Mitloehner lays out the case for business as usual, challenging the position of the many studies we cite in this report.<sup>292</sup> Associations of cattle breeders and other livestock producers join the chorus. Smaller scale farmers like W. M. Harris of White Oak Pastures<sup>293</sup> echoes the FAO report on ways that 30% of the GHG emissions from livestock could be reduced.<sup>294</sup> Unfortunately, these efforts to improve the health and diet of the animals, and other better methods are not widely adopted and mitigation seems likely to be marginal.<sup>295</sup> Other kinds of pushback include Sustainability advisor Erica Hauver's critique of the US dietary 1980 Guidelines, which advised low fat-higher carb diets and seem to have increased obesity and diabetes.<sup>296</sup> Attacks on vegetarians and vegans, were reported in Britain when a food editor recommended "Killing Vegans" --- hopefully in a tasteless jest, for which he resigned!<sup>297</sup>

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<sup>289</sup> Ibid.

<sup>290</sup> The Economist, "Feeding the Dragon", Feb. 2, 2019, p. 53

<sup>291</sup> Bloomberg Businessweek, "Year of the Pig Apocalypse", May 13, 2019, p. 28-9

<sup>292</sup> The Conversation, reprinted in EcoBusiness: "Yes, eating meat affects the environment, but cows are not killing the climate". Oct. 31, 2018

<sup>293</sup> Triple Pundit, "Enlisting Cows in the Struggle to Reverse Climate Change", May 6, 2019

<sup>294</sup> FAO, "Tackling Climate Change Through Livestock", 2013, Rome

<sup>295</sup> Ibid

<sup>296</sup> GreenBiz, "The inconvenient truths behind the 'Planetary Health' diet, Feb. 6, 2019, [www.greenbiz.com](http://www.greenbiz.com)

<sup>297</sup> EcoWatch, "Food Editor Resigns After Writing 'Killing Vegans' Comment

The pushback to plant-based meat foods has begun, after Beyond Meat's IPO made headlines on May 5th, 2019. Wisconsin-based hedge fund investor Dane Bowler, who also holds a B.S. in dietetics from the University of Wisconsin in Madison analyses the ingredients in Beyond Meat's burger patties and



Fig. 48: Waste food to alcoholic drinks

finds unsubstantiated claims and excessive fat.<sup>298</sup>

However, other nutritionists, including Jillian Kubala, M.S. RD, find Impossible Food's burger a good choice for vegans and vegetarians, but she adds that healthier plant-based burgers can be made at home.<sup>299</sup> Another criticism of lab-grown meats by researchers at Oxford Martin School published in *Frontiers in Sustainable Food Systems* concluded that unless renewable energy is used, lab-grown meat on fossil fuels could be worse than farm raised beef, according to Dr. John Lynch, lead author.<sup>300</sup> Foodtank researchers survey many companies turning food wastes into alcoholic beverages, distilling whiskey, beer, wine, vodka, as well as a sake-like drink.<sup>301</sup> (Fig. 48)

To summarize, the entire current global food system is also being disrupted by a host of external forces: climate change, (more droughts, floods heat waves and hurricane catastrophes), freshwater shortage, land shortage and degradation, soil depletion, pollution, biodiversity loss, (particularly of insect pollinators), human dietary-related sickness and death, antibiotic-resistant diseases, as well as over-reliance on corporate concentration, too few monocultured crops, vulnerability to global economic and commodity market volatility, as well as trade wars, such as those today affecting growers worldwide. The U.S. National Academy of Sciences, in a report on sea-level rise, finds the IPCC's October 2018 report may understate this risk, assessing the possibility of twice their levels.<sup>302</sup> The 2018 National Climate

<sup>298</sup> SeekingAlpha, "Beyond Meat: Unhealthy for The Heart and The Portfolio", [www.seekingalpha.com](http://www.seekingalpha.com), May 9, 2019

<sup>299</sup> EcoWatch, "What Is the Impossible Burger and Is It Healthy?", May 5, 2019

<sup>300</sup> EcoWatch, "Lab-Grown Meat Could Be Worse for The Climate Than Farm-Raised Beef: Oxford Study", Feb. 20, 2019

<sup>301</sup> Foodtank, "Creating Boozy Beverages from Food Waste: 10 Brewers Doing it Right", Mar. 28, 2019

<sup>302</sup> National Academy of Sciences, "Ice sheet contributing to future sea-level rise from structured expert judgement", May 21, 2019, [www.pnas.org](http://www.pnas.org)

Assessment which forecast such scenarios in the USA through 2100 is being curtailed to only 2040 by the Trump administrations.<sup>303</sup>

All these forces are affecting countries and regions differently. For example, in our home state, Florida USA, it has been customary to raise herds of cattle which are sent all over the USA for slaughter. Today, due to climate change, the weather is now hotter and these warmer temperatures cause cows' immune systems to falter, making them more vulnerable to parasites and diseases, while they eat less and produce fewer calves. Southeastern Florida has more of these large cattle ranches than any other part of the country, since its prized grass for grazing herds grows year-round.<sup>304</sup> The University of Florida's scientists are researching how to cross-breed Angus cows with Indian Brahman cows more used to hot climates. But this is expensive and take decades while the US Department of Agriculture's Research Service staff has been cut by a third, with more cuts in the budget's 2019 request.<sup>305</sup> Meanwhile Florida's hurricanes, floods and droughts will continue to drive cattle-rearing northwards, and its coastal cities are bracing for rising sea levels. Governor Ron DeSantis has named the state's first chief science officer: Tom Frazer, Director of the University of Florida School of Natural Resources and the Environment.<sup>306</sup>

So far, nothing has caught the attention of incumbent food industry producers like the disrupters we cover in the exploding plant-protein food and beverage sectors. As we have documented for a decade, the writing has been on the wall. Examples include research funded by the Bill and Melinda Gates Foundation in 2017 which found 11 million deaths and 255 million disability-adjusted life years (DALYs) were attributable to dietary risk factors, including high intake of salt with low intakes of whole grains, fruits and vegetables.<sup>307</sup>

Thus we forecast over the next decade the continued acceleration of the current shifts in our global climate and food system along with the further expansion of alternative plant-based foods and beverages. However, we continue to forecast, as we have over the past 5 years that the lowest hanging,

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<sup>303</sup> Washington Post, May 28, 2019 and [www.globalchange.gov](http://www.globalchange.gov)

<sup>304</sup> Bloomberg Businessweek, "Fried Steak", Apr. 29, 2019, p. 53-57

<sup>305</sup> Ibid

<sup>306</sup> Florida Trend, Northeast News, June 2019 p.37, [www.floridatrend.com](http://www.floridatrend.com)

<sup>307</sup> The Lancet, "Health effects of dietary risks in 195 countries, 1990-2017: a systematic analysis for the Global Burden of Disease Study", 2017 and Elsevier Ltd., online, Apr. 3, 2019, [www.thelancet.com](http://www.thelancet.com)



most viable shift will be toward salt-loving halophyte foods which can thrive on the planet's 40% of degraded, desert land and 97% saltwater. We have been presenting these opportunities for addressing this multi-faceted and viable path in our many presentations, reports, articles and TV programs.

Humanity can over the next decade expand these options and help secure global food supplies, save precious freshwater, store CO<sub>2</sub> emissions safely in these plant roots and soils while improving human nutrition and health. Since April 2017, we have presented the findings of our GTS report "Capturing CO<sub>2</sub> While Improving Human Nutrition and Health" before many global meetings on climate change, global freshwater crises, scientific and academic societies with little effect. Our best audiences have been individual investors and small foundations at a series for Family Office Forums.<sup>308</sup> With this updated report and the new disruptive startup and investment leaders, we still expect the next big thing will be saltwater agriculture and desert-greening. While Silicon Valley investors remain dazzled by their social media and platform monopolies, fighting rearguard battles with regulators, we see science-based investors and independent researchers focusing on real-world priorities for our common human future on planet Earth.



Fig. 49: Review of plant-based food sector, 2019

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<sup>308</sup> See for example, in Singapore, London, Zurich, Wiesbaden and San Francisco hosted by Family Office Forums Convened by Prestel & Partner, London



## APPENDIX 1- POSITIONS HELD BY PRINCIPALS OF ETHICAL MARKETS MEDIA

For full disclosure: members of the GTS research team of Ethical Markets Media, LLC, are invested in companies supporting the green transition or mentioned in this report, many of which are privately held, early stage, pre-IPO companies.

### **As of May 2019**

Apple (AAPL)  
Brookfield (BEP.UN)  
Boralex (BLX)  
Centre for Social Innovation Community Bonds  
ECOR  
EnvisionSolar (EVSJ)  
Environmental Services (EVX)  
Equal Exchange  
First Trust Nasdaq Clean Edge Green Energy Index (QCLN)  
Generate Capital  
Google (GOOGL)  
GrainPro  
Green Garmento  
iShares Global Real Estate Index Fund (CGR)  
iShares Global Telecom ETF (IXP)  
iShares 1-10 Year Laddered Government Bond Index ETF (CLG)  
LightPath Technologies (LPTH)  
Munich Re (MURGY)  
Natcore Technology (NXT)  
Philips (PHG)  
PowerShares Cleantech Portfolio (PZD)  
S&P Global Water Index Fund (CWW)  
S&P Global Healthcare Index Fund CAD-Hedged (XHC)  
S&P Global Consumer Discretionary Index Fund CAD-Hedged (XHC)  
SolarShare Community Bonds  
TD Bank (TD)  
Technology Select Sector SPDR® Fund (XLK)  
3M (MMM)

## **APPENDIX 2 – RESEARCH TEAM**

### **Research and Writing**

Hazel Henderson, D.Sc.Hon., FRSA, founder and president of Ethical Markets Media (USA and Brazil), chair of the Advisory Board, is a futurist, evolutionary economist, author of Mapping the Global Transition to the Solar Age, of award-winning Ethical Markets: Growing the Green Economy and many other books. She founded the EthicMark® Awards for Advertising, created the Green Transition Scoreboard®, co-developed with Calvert the Ethical Markets Quality of Life Indicators and with Biomimicry 3.8 developed the Principles of Ethical Biomimicry Finance®. In 2012, she received the Award for Outstanding Contribution to ESG & Investing at TBLI Europe; was inducted into the International Society of Sustainability Professionals Hall of Fame in 2013, and in 2014 was again honored as a "Top 100 Thought Leader in Trustworthy Business Behavior" by Trust Across America. She is a Fellow of the World Academy of Art and Science, an Honorary Member of the Club of Rome, holds many honorary doctorates and is listed in Who's Who in the World. She has served as a science policy advisor to the US Office of Technology Assessment, the National Science Foundation and the National Academy of Engineering.

LaRae Long, Executive Director of Ethical Markets Media. LaRae began her career in the financial services industry 1981. She gained extensive client service and administrative experience during 33 years by holding positions in many customer oriented and administrative roles. Her administrative experience was enhanced as an Executive Assistant for a major financial brokerage firm. Graduated in 2004 with a Business Administration Degree from North Florida Community College.

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Popovich, Ph.D., Mila, World Academy of Art and Science, Chair Global Women in Blockchain

Robin, Vicki, author “Your Money Or Your Life” and “Blessing The Hands That Feed Us”

Saltzberg, Edward, Security and Sustainability Forums

Schneider, Claudine, former US Congressmember, R, Rhode Island

White, Professor Jerry, University of Virginia

Ethical Markets is grateful for the expertise of our reviewers, while accepting full responsibility for the content of this report.

**Praise for the Green Transition Scoreboard®**

“Over twenty years ago, Hazel Henderson talked of a most implausible goal: to both encourage Green investing and to track its growth worldwide. The remarkable \$5.3 trillion [2014] now invested in Green still challenges the imagination. The world needs to know of this triumph and its significance to all our futures.” – Carson E. Beadle, former Director, Mercer; Executive Committee Chairman, Security Mutual Life Insurance of NY

“No leader, from the CEO of the smallest of corporations to the president of the largest of nations, could do better than internalizing the principles of Ethical Markets and always keeping a sharp eye on the Green Transition Scoreboard.” — Ashok Khosla, Chairman, Development Alternatives and pioneer social entrepreneur.

“The GTS adopts a much more comprehensive and therefore effective working definition of a green economy than is usually the case, and provides a robust and consistent framework for

measuring our progress towards it.” — Matthew Kiernan, founder, Innovest; CEO, Inflection Point Capital Management; author, Investing in a Sustainable World

“We usually do manage what we measure; so the GTS is an important contribution from Ethical Markets Media in getting to the future our polling suggests people intend for their children.” — Doug Miller, Chairman, GlobeScan Inc.; President, GlobeScan Foundation

“Wonderful initiative. Finally, an overview of the amount of private money invested and committed to Impact Investing.” – Robert Rubinstein, CEO, TBLI GROUP™

“Because it enables tracking of the global macro-shift from the Industrial Era to the emerging sustainable economies of the 21st century the GREEN TRANSITION SCOREBOARD® is an important innovation. Check it out!” Don Tapscott, author of the bestsellers Wikinomics and Macrowikinomics

“Since 1987, we have guided our investors towards companies leading the growing green economy: the Sustainability Sector. The GTS is an important milestone in measuring the increasing economic viability of this CleanTech universe.” – Stuart Valentine, Founder, Centered Wealth, Fairfield, Iowa

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