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Executive Summary

The 2017 Green Transition Scoreboard® (GTS) explores the deepening of green finance worldwide, following our 2016 GTS focused on transition management's top priority: “externalities”. Since 2007, companies tracked by the GTS are those avoiding negative externalities and focused on transition management in the context of the UN Sustainable Development Goals (SDGs) and COP21-22. For 2017, the GTS totals $8,133,456,730,370 in non-government investments and commitments in the green transition. All numbers on these totals are cumulative and global since 2007.

<table>
<thead>
<tr>
<th>Sector</th>
<th>Amount US $</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renewable Energy</td>
<td>$3,427,534,992,202</td>
</tr>
<tr>
<td>Energy Efficiency</td>
<td>$1,748,904,490,919</td>
</tr>
<tr>
<td>Life Systems</td>
<td>$1,660,880,346,366</td>
</tr>
<tr>
<td>Green Construction</td>
<td>$914,736,379,757</td>
</tr>
<tr>
<td>Corporate Green R&amp;D</td>
<td>$381,400,521,125</td>
</tr>
</tbody>
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Grand Total $8,133,456,730,370

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 Hazel Henderson's years of research as a science advisor and which the Ethical Markets Advisory Board expertise indicate are continuing to contribute to the growing green economy. Life Systems gained a new category for Fintech for sustainability, including peer-to-peer lending and crowdfunding, in addition to other subsectors tracking the system-wide interconnections among information and digitization, water, food, education and health.

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 $8.13 trillion in private investments and commitments as of 2017 puts private investors on track to reach $10 trillion in green sectors investments by 2020.

We strictly define 'green' by omitting technologies such as nuclear, clean coal and most biofuels while carefully assessing rapidly advancing technologies such as nanotech and IoT (Internet of Things), see "The Idiocy of Things Requires An Information Habeas Corpus". Sources of financial data are screened by rigorous social, environment and ethical auditing standards.
**Renewable Energy** – Growing strongly, at our total of $3.4 trillion as fossil fuel becomes less appealing in light of cost parity of renewables, limiting carbon emissions and driving evolution to sustainable societies.

**Energy Efficiency** – Grew to $1.7 trillion, as widespread ripple effects positively impact jobs creation, manufacturing and other metrics tracked by traditional GDP and integral to transition management, quality of life metrics reported in Life Systems.

**Life Systems** – Grew to $1.6 trillion encompassing broad areas systemically linked, including water, remediation, waste and recycling, green infrastructure and info-structure, education, community investing and the myriad of digitization opportunities and obstacles, investments often overlooked as too small, such as the Fintech 100.

**Green Construction** – This sector grew to $914.7 billion ranging from “low-tech” passive solar buildings to “high-tech” flow 3D printing. For consistency, we omit labor, thus undercounting a form of capital which intrinsically increases the value of green construction.

**Corporate Green R&D** – Grew to $381 billion, this sector is also heavily weighted in favor of automotive industries, energy generation, conservation and distribution with a precipitous decline in fossil fuels P&E.
Deepening Green Finance

As we reported in our last Green Transition Scoreboard® (GTS) “Ending Externalities: Full-Spectrum Accounting Clarifies Transition Management” (2016), the global transition away from fossil fuels was already unstoppable. (FIG 1: Annual Solar Radiation to Earth.) Yet while 195 nations had agreed on their UN Sustainable Development Goals (SDGs) and ratified the Paris Accords in 1995, mainstream financial markets were still stuck in obsolete models and had become global laggards. As reported in Business Week, April 10-23, 2017, thousands of new indexes, ETF and smart-beta funds compete for investors with ever more exotic "factors" they sell as leading to outperformance. Yet they still miss the biggest global trend: to low-carbon renewable-resourced, efficient circular economies. Meanwhile a GlobeScan Survey of 500 experts assess global progress toward meeting the UN’s 17 goals in the SDGs, finding that NGOs and social entrepreneurs have led the way.

By mid-2016, the Task Force on Climate-related Financial Disclosure (TCFD) co-chaired by Michael Bloomberg and Mark Carney, head of the Bank of England, reported that this lag in financial markets was creating a log jam to the expansion of green investing. Anxious asset managers, instead of

1 Business Week “Lies, Damned Lies and Financial Statistics” Peter Coy, April 10-23, 2017
2 “Evaluating Progress Toward the Sustainable Development Goals”. GlobeScan/Sustainability. 2017
3 Phase 1 Report of TCFD to the Financial Stability Board, March 31, 2016
re-tooling their models and portfolios, were risking another financial crisis as the value of the fossilized assets on their books continued to decline according to research by CDP and 2°Investing). Similarly, electric utilities were still dragging their heels in managing the increasing supplies of solar, wind and efficiency upgrades which were lowering demand. Instead of changing their traditional business models of demand management and slowing up their building more central base-load generation, most fought rearguard actions. They still lobby state legislatures, fight their consumers over net-metering and continue mounting advertising campaigns and ballot initiatives to retain their dwindling markets. A turnaround by laggard Florida Power and Light in 2017 was their announced sites for 8 new solar projects, each adding 75.5 mw by December 2017.5

FIG: 2

These battles continue, with energy consumers and businesses leaving grids and generating their own renewable energy. The world's renewable energy potential is a vast 11,941 exajoules---more than enough for future human needs, as estimated by REN21.6 On March 11, 2017 solar-generated electricity in California peaked in providing more than half of all supply for the entire state ---briefly plunging wholesale energy prices negative. (FIG: 2)

4 CDP, formerly the Carbon Disclosure Project as well as 2° Investing Initiative "Asset-Level Data and Climate-Related Financial Analysis: A Market Survey". Jan 2017
5 Power Engineering "FPL Announces Sites for Eight Solar Plants", Mar 2, 2017
This cost-saving by millions with efficiency in lighting, heating, cooling and building upgrades continued through 2016 and is still accelerating in 2017. This massive shift to renewables driven by cost reductions, technological innovation, public awareness of climate risks and adoption by corporations of sustainability goals has now placed financial markets in the crosshairs, boxed-in by these socio-technical trends.

FIG: 3

(FIG 3: "Boxed-in Financial Markets: Pressures From All Sides for Reform").

Today, the focus of business leaders, politicians, the private investors we track on GTS, as well as voters and consumers has shifted toward reforming financial markets and their obsolete textbook models. ("Fossilized Asset Allocation"). Finance was targeted first by socially-responsible, ethical investors. Since the 1980s, mutual funds: Calvert, Domini, Pax World, Parnassus, and ever increasing fund offerings and asset managers drove increasing trillions of investments as measured by the Social Investment Forum. As environmental pollution including CO2 and climate change concerns grew, financial markets were targeted on a second side, by the divestment movements, such at 350.org. State and city pension funds led by New York City’s pension fund, CALPERS and TIAA CREF began to respond joined by foundations in a shift to fossil-free portfolios. By 2015, finance became boxed-in on a third side: from the top: by those 195 countries of the UN, and their SDG’s 17 goals and their Intended National Development Plans (INDCs) for phasing out fossil fuel subsidies and targeting other so-called "externalities" ignoring pollution, environmental and social costs

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7 "Fossilized Asset Allocation", Nov. 30, 2008 (www.ethicalmarkets.com)
8 Social Investment Forum, www.socialinvestmentforum.com
on balance sheets of companies and government agencies. The new accounting standards are promulgated by IIRC, IRRC, SASB, CIMA, ICAEW, CDSB).

The fourth side of the boxed-in financial sector came from below: where upstart innovations emerged from Silicon Valley. The FINTECH 100 and increasing numbers of electronic platforms for peer-to-peer lending; crowdfunding, local and crypto-currencies, began bypassing legacy finance and traditional banking. For example, Kenya's M-Pesa pioneered cellphone-based banking, now accounting for over 50% of its GDP—with other countries in Africa following suit. Pure information-based trading no longer requires any currency, (Fig 4: “Two Ways of Transacting”) such as barter and swap sites, free recycling and secondhand goods, all facilitating sharing and community-exchange. This internet-based revival of barter is not to be confused with the hybrid “gig economy” of Task Rabbit, Mechanical Turk, UBER, Lyft, Airbnb and others highly-prized by traditional Wall Street. Such winner-take-all Silicon Valley investors hype these “unicorn” companies, which are little more than part-time labor markets of desperate unemployed people (often displaced by digitization) as the “sharing economy” critiqued by Douglas Rushkoff in Throwing Rocks at the Google Bus (2015).

This digitization of ever more sectors of industrial societies has produced:
1.) backlashes by civic groups and NGOs calling for guaranteed basic incomes for those replaced by robots and, 2.) efforts by elites and central banks to institute similar universal basic income (UBI) schemes to provide purchasing power to those displaced by automation or austerity cuts. As rounds of quantitative easing (QE) became less effective, central banks resorted to negative interest rates which crushed savers and pension funds. As I reported, these central banks then began embracing UBI schemes as economic stimulus so as to maintain aggregated demand. Clearly, the logic of the current economic growth model has broken down, as I described in “Bernanke and Friedman Were Right”.9 The march of digitization and automation now has prompted even Bill Gates to call for taxing robots!10

9 “Bernanke and Friedman Were Right: Helicopter Money or Qualitative Easing?” Just Means, June 8, 2016, www.ethicalmarkets.com
10 FORTUNE, Bill Gates, Feb. 22, 2017
The Rise of "Impact Investing"

The contentious battles over jobs drove populist politics in the USA and Europe---scapegoating immigrants and focusing on trade deals, as well as automation. Fossil fuel jobs declined to less than 100,000 in the US, while more than 3 million work in clean energy\(^\text{11}\) and REN21 estimates 8.1 million worldwide (FIG: 5)

Thus, we explore herein the reforms now occurring in finance itself, now it is boxed-in by all these global forces and trends. The task of redesigning financial models, new metrics ---- pioneered in the 1980’s-- is now producing many more of the actual paradigm shifts in investing that are sorely needed. A spate of important books appeared over the past 20 years (see www.ethicalmarkets.com/books and reviews ) formerly ignored by mainstream asset allocators. These books are finally producing the new models and platforms appearing under the recent re-branding and marketing rubric: “Impact Investing”. We highly recommend Sustainable Investing (2017) by pioneers Cary Krosinsky and Sophie Purdom including many case studies. Many retail investors and especially family offices and their young Millennial heirs, have been asking their asset managers to shift their portfolios toward clean, renewable companies, green infrastructure, green bonds, and young “pure play”, privately-held companies. Frequently, those using traditional asset managers, consultants or trustees are told that such new investments are “too risky” --- overlooking the facts that their fossil assets may even more risky and become “stranded” and turning into liabilities! Trillions in pension funds, retirees’ 401Ks and philanthropic portfolios whose beneficiaries are most concerned with climate change and support the phasing out fossil fuel, learn to their dismay, the extent to which their nest eggs are still in the fossilized sectors! And many major oil companies are still over-investing in new reserves or in shale oil and gas fracking operations, as reported by

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\(^{11}\) Renewable Energy World "More Than, 3 Million in US now Work in Clean Energy, Feb 22, 2017

FIG: 5

There are currently 8.1 million employees in the renewable industry. How many people will be employed in this sector by 2050?

- 7%
- 9%
- 11%
- 17%
- 4%
- 5%
- 6%
- 41%

Renewables Global Futures Report Great debate towards 100% renewable energy
Carbon Tracker. Meanwhile Business Week reports on floods of money going into climate adaption in many coastal cities. Michael Bloomberg and former Sierra Club executive Carl Pope outlined the bigger picture in Climate of Hope (2017).

This recent rebranding of 20 years of socially-responsible investing (SRI), ESG, "green" and "ethical" funds) has broadened the tent, allowing mainstream firms like BlackRock, Goldman Sachs, Bank of America and others to claim the new territory of post-industrial, post-fossil fuels and sustainable investment opportunities. However, some of these investments may not achieve the financial return they promise since intractable global problems of inequality, education, social equality and, health will always require traditional philanthropy, as Oxfam's Mara Bolis points out.

As the US Trump administration and its cabinet of special interest advocates tried to revive 19th and 20th century fossilized sectors, the "impact investing" trend rolls on. Michael Bloomberg opined "No matter what roadblocks the White House and Congress throw up, the United States can and I'm confident will-meet the commitments it made in Paris in 2015". Former US Treasury Secretary Henry Paulson opined on "How to Raise Trillions for Green Investments" in the New York Times, Sep. 20, 2016. Renewable investments also are gathering speed from the angry 3 million voter anti-Trump majority.

These majority voters were denied the presidency by the archaic "Electoral College" set up by the US founders to keep small states (many slave-holding) within the Union. Ironically, Alexander Hamilton wanted this Electoral College of wise elders, so as to protect against the rise of a populist demagogue! Seventeen US intelligence agencies confirmed that Russia had targeted the USA and its 2016 election with cyber attacks to deny Clinton the presidency and help Trump. Ongoing investigations as to possible collusion by the Trump election campaign team and similar Russian activities in European countries are exposing Putin's wider goals of weakening the post-World War 2 multilateral world order and liberal democracies.

Outraged US citizens galvanized in political demonstrations and resistance, also in many other countries. Similarly, green, ethical and impact investors have accelerated their demands on asset managers to shift their portfolios from fossil assets and fund all the rising startup in sustainability sectors

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12 Carbon Tracker, "Oil Industry Still In La La Land" Mar 16, 2017
13 Business Week, "Flooding of Money. The Upside of Climate Change", Mar 27-April 2, 2017
14 Next Billion "Impact Investing's Rush to the Mainstream, Who Are We Leaving Behind?" Mara Bolis, Oxfam, April 12, 2017
15 New York Times, "Climate Progress, With or Without Trump" M. Bloomberg, Mar 31, 2017
(see GTS categories). The new FERMI Investing Initiative group spun off from 2° Investing uses satire effectively to highlight the blindness of finance to climate risk-by adding a new category of risk of alien invasion as a proxy for climate risk in its hilarious "Stress-Testing Alien Invasion"!17 Cities and states in the USA joined in, with Chicago set to become 100% renewably powered.18 as seventeen states vowed to keep implementing the EPA's Clean Power Plan 19 Clean Edge's Clint Wilder foresees that Trump's executive order will not slow US industry's clean energy progress.20 The World Future Council foresees a shift in cities from petropolis to ecopolis (FIG: 6) i.e. from petroleum-dependent cities to those re-designed for renewably-resourced self-reliant sustainability.

There is a deeper trend beneath all these global events: the end of fossil fuel dominance globally along with oil producing interests and their financiers. In the USA, these fossil fuel interests include the Koch brothers, most Republicans and Trump’s cabinet, including former EXXON chief Rex Tillerson as well as mainstream asset managers; Vladimir Putin’s Russia, (an oil state); to OPEC members, including Venezuela (once the richest Latin American country, now an oil-addicted failed state), as well as coal-dependent countries. Last-ditch efforts to save coal with carbon capture and sequestration (CCS) and carbon capture and utilization (CCU) cuts efficiency by as much as 40% and add huge costs, but are still being set up.21 All these fossil-dependent countries have groups and sectors with common interests, think tanks and well funded lobbies and politicians slowing the inevitable transition to the renewably-resourced economies we track in GTS. This, of course, affects finance and has led to calls to slow down the global energy transition to renewables to avoid another financial meltdown. This deeper analysis helps explain the still ongoing forces I described in The Politics of the Solar Age (1981,1988) which I observed first-hand in Washington as a US government science policy advisor.

FIG: 6

18 Clean Tech, “Chicago set to become first Major US City to be powered 100% by Renewable Electricity”, Joshua S. Hill, April 11, 2017
19 EcoWatch, “17 States Raise Hell Over Clean Power Plan", April 6, 2017
20 Clint Wilder "Thanks to States and Cities Clean Energy Will Weather The Trump Assault", Clean Edge, April, 2017
21 21st Century Tech, "Can Carbon Capture and Utilization Mitigate the Impact of CO2 on Climate Change?, April 6, 2017
Forces Driving the Global Green Transition

Yet, even with Trump’s climate-denying cabinet still representing fossil interests, the shift continues to post-carbon strategies and investments in long-term sustainability, also evident in most corporate planning, as reported by Schneider Electric Corp. in its “Global Energy Market Trends” nearly 25% of the global Fortune 100 have defined renewable energy targets many seeking 100% long-term to improve their bottom lines.22 Business and political alliances are shifting across the old left-right spectrum. Current debates reveal at least two very different approaches to globalization, as I report to the American Sustainable Business Council;23 Firstly, the nativist, nationalism of right-wing, anti-immigration movements in the USA and European countries, and secondly, the grassroots globalists in the 195 countries who support the post-carbon, inclusive future envisioned in the UN’s SDGs; the green “glocalization” movements following a “small is beautiful” agenda.24 These new movements from across the spectrum, oppose the current dominant form of elite “Davos Man globalization still driven by corporations, based on GDP-measured growth, deregulation, tax havens, “free” trade, privatization, --- all dominated by finance and traditional economic models of profit-maximization.

These new movements, reacting to the 2008 financial crises and bailout of the big banks, now see global finance as the dominant player driving rising inequality and environmental disruption. Many NGOs, including London-based Positive Money and the New Economics Foundation, the Public Banking Institute in the USA and many others elsewhere, focus on the politics of money-creation, central banking, and credit-allocation, all seen as policy-driven rather than by an invisible hand of the market. (see also our TV Special "The Money Fix" www.ethicalmarkets.tv) These populist waves opposing corporate financial globalization also identify the single focus on money (in whatever fiat currencies) as harming all other values of family, community, equality, social justice and environmental quality of life. This also fuels demands for full recognition of all six forms of capital: finance, built, intellectual, social, human and natural, thus benefiting not only stockholders, but all stakeholders in corporate governance.25

22 Schneider Electric Energy and Sustainability Services, April, 2017
25 IIRC Newsletter "Integrated Reporting" April, 2017 (www.theirrc.org)
Green Finance Emerging

Investor and shareholder efforts have emerged over the past 30 years in global initiatives, including the UN Environment Program’s UNEP-FI: the UN Principles of Responsible Investing (unpri.org); the UN Global Compact’s 10 Principles of Corporate Citizenship (globalcompact.org), as well as those from the banking sector, the Equator Principles, as well as many institutional asset managers’ groups on climate change, including the Carbon Trust, the Carbon Disclosure Project (CDP), the Climate Disclosure Standards Board (CDSB), The Social Investment Forum, the Sustainable Investment Forum, Climate Action, Forum for the Future, World Investment Forum, Sustainable Stock Exchanges, The Future 500, the World Business Council on Sustainable Development, Ceres, HELIO International, with its HIFI Index for investors in collaboration with Ethical Markets and the Global Impact Investing Network (GIIN).

The most direct challenge to conventional global finance came from the UNEP Inquiry on Design of A Sustainable Financial System (www.unepinquiry.org), spearheaded in 2013 by co-directors Simon Zadek, founder of the successful European-based firm AccountAbility and former HSBC economist, Nick Robins, (author of The East India Company now a BBC TV documentary) who outlines the prospects for a greener future. By recruiting an influential advisory groups of top central bankers, finance ministers and stock exchange heads from China, India, Indonesia, South Africa, Brazil and other large key economies, the Inquiry was empowered to confront traditional financial centers and their prevailing “Washington Consensus” worldview and models. The Inquiry’s initial two-year mandate is now extended, due to its successful engaging of high-level global opinion-makers and its ground-breaking series of reports outlining all aspect of the new “greening” of finance based on the UN’s SDGs 17 goals. Its many reports first focused on the paradigm shifts required beyond the GDP-growth driven economics based on maximizing money returns to investors. Ethical Markets contributed reports on "Perspectives on Reform of Electronic Markets and Trading" (2014) and "Fintech: Good and Bad News for Sustainable Finance" (2016). In GTS (2016), presented by co-author Timothy Jack Nash at the OECD’s Green Growth Knowledge Platform, Korea in Sept. 2016, we examined key aspects of the needed reforms. These are based on the new metrics covering all six forms of capital and the need to expose the fraudulent accounting practices still widespread, of “externalizing” social and environmental costs from corporate and government balance sheets. Financial Management, the journal of the Chartered Institute of Management Accountants covered this in its May-June 2016 issue on "Values". (www.cimaglobal.com).

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The UNEP Inquiry, with its global reach, collated and documented all the progress toward greening financial markets, noting progress in Brazil, South Africa and other countries. China became a leader in this new green investing model, and its central bank cooperated in a major policy shift with the Peoples Bank of China outlining Chinese plans in their 2015 paper.\(^{27}\) When China acceded to the presidency of the G-20, its 2016 meeting in Hangzhou, China promoted this shift to green finance, now an official plank of the G20. The Inquiry also teamed up with the London-based Climate Bonds Initiative and this helped in the specular growth of green bonds in many countries, as reported by founder and CEO Sean Kidney in 2017.\(^{28}\) Bank of England head Mark Carney in the TFCD report 2016 endorsed expansion of green bonds calling for official standardization and recognition of criteria for use of their proceeds, so as to deepen and widen this green segment of the global bond market.\(^{29}\) These included 1) a term sheet standardizing these bonds, 2) definitional frameworks for validation of green projects, 3) integration into credit ratings, 4) green bond indexes and 5) harmonization of principles and standards for green bond listings. The herd behaviors of all markets can now be steered by such new standards to assure that the proceeds of all green bonds are applied to truly green, scientifically verified investments. My "Greening Trump's Infrastructure Plan" advocates applying such standards to any new US infrastructure spending.\(^{30}\) Meanwhile China is now a major issuer of green bonds with 27% of the total of $92 billion in 2016. In March 2017, the Green Bonds Pioneer Awards\(^{31}\) included eight pioneer issuers from China, Norway, Poland, Germany, Mexico, Netherlands, Costa Rica, Colombia, Finland, Luxembourg, Morocco and the Philippines.

The UN Inquiry's May 2016 report focused on "Green Finance for Developing Countries", and its latest report covers the role of FINTECH in reforming mainstream finance.\(^{32}\) As the green bond financing model went mainstream with many issues oversubscribed, the next stage became securitization. This financial tool became discredited in the USA after its over use in packaging mortgages helped precipitate the meltdown of the housing market in 2007. Wall Street's excesses in selling these packages of securitized mortgages to pension funds and unsuspecting municipalities should caution the use of securitization to further unlock capital into the green bond market.\(^{33}\) The European Union (EU) Roundtable on Green Securitization, April 24, 2017 may lead to deeper investment pools to finance the global green transition. The OECD estimates that annual issuance of green asset-backed securities


\(^{28}\) Climate Bonds, Green Bonds Highlights 2016

\(^{29}\) Phase 1 TCDF Report Mar 31, 2016, op. cit. and Climate Bonds Standards and Certification Scheme

\(^{30}\) Hazel Henderson "Greening Trump's Infrastructure Plan' Just Means, November 18, 2016

\(^{31}\) Green Bond Pioneer Awards, 2017

\(^{32}\) UN Inquiry: FINTECH Dec. 2016, Assessing the Implications

\(^{33}\) CDSB "Response to the TCFD Recommendations on Climate Related Financial Disclosure, Feb 12, 2017
could reach between US $280-380 billion by 2035. Therefore, monitoring and verifying uses of green bond proceeds is vital, and provided by Trucost, PNC, KPMG, EY, BDO, Carbon Trust, the Climate Disclosure Standards Board (CDSB) and many others. This will remain the key to further deepening of the green bond markets globally. Meanwhile Moody's report on environmental risks downplayed the US Trump administration effect on progress toward global decarbonization.

The OECD Global Forum on Development convened business and investment leaders in Paris, April 5, 2017 exploring the business case for the UN's SDGs. Outgoing UN Secretary General Ban Ki-Moon, called the global green transformation "unstopable" at his speech in Kigali, Rwanda. UNEP and Bloomberg Finance report "Global Trends in Renewable Energy Investment 2017" found that wind, solar and other renewables added 138.5 gigawatts to global power capacity in 2016 up 8% from 2015. FORTUNE and TIME co-sponsored a Global Forum at the Vatican with Pope Francis and 150 FORTUNE 500 leaders to discuss "The Business of Humanity". December 2-3 in Rome. In January, 2017 UNEP announced its new digital tool co-developed with China's Ant Financial by the Green Digital Finance Alliance to expand green finance. All this progress on green finance is led by China, now the largest issuer of green bonds, and the worlds generators and electric vehicles, as well as pioneering DC (direct current) grids more suited to carrying renewable electricity.

Clearly, while the US pioneered so many of the renewable energy technologies and still leads in many areas of research, as we have covered in our previous GTS reports, China has now assumed global leadership as the USA's Trump plans falter and regress back to serving fossilized interest donors. The new star at Davos is Chinese Premier Xi Jinping, sticking to the UN summit COP21 Paris accords in 2015 and COP22 om 2016 as "a responsibility we must assume for future generations".

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34 Climate Bonds Initiative "Green Securitization: Part of the Climate Finance Suite: Can the EU lead the way?" Sean Kidney, April, 2017 (www.climatetbonds.net)
36 OECD "Working together to Achieve the Sustainable Development Goals", DAC News (dac.news@newsletter.oecd.org)
38 FORTUNE, Jan 1, 2017 p9-16
39 UNEP (www.unep.org) Media Release " Ground-Breaking UN-Supported Digital Tool to Enhance Green Financials", Jan 20, 2017
40 The Economist "Rise of the Super Grid, "Jan 4, 2015, pg.7
41 The Economist "The New Davos Man", Jan 21, 2017, pg. 33
Today's increases in wind, solar and renewables continues disrupting the century-old model of providing electricity-seen as a death -spiral for many utilities and their financial backers. My proposal along with that of Joel Makower, co-author of The New Grand Alliance (2016) is to ease the short-term dilemma of asset-managers as they get up to speed on shifting to green sectors. They can simply recategorize their fossil reserves now at risk from "fuel" to "feedstocks". This way the can be valued for future use as materials, rather than being burned.

As Germany assumes the presidency of the G-20 from China, it's Green Finance Study Group sees opportunity for enhancing economic growth beyond the GDP model, toward green infrastructure and enhanced competitiveness through efficiency. These green global models were on the meeting agenda hosted by the Bank of America on "Greening the Financial System", April 20, 2017 convened by the UNEP and their Inquiry, Bloomberg Philanthropies, the European Banking Federation, the Paulson Institute (funded by former US Treasury Secretary Hank Paulson), the IIF, SIFMA, with our GTS and other invited participants. An indication of the new global resolve on addressing climate risks and accelerating the green transition, the US dropout has energized the 194 other countries still committed to the UN's COP21 and 21 accords and their SDGs. They may even punish US exports with a "carbon tariff".

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43 Hazel Henderson "Assessing Risk of fossil Reserves: Are They Fuel or Feedstocks? Just Means, and www.ethicalmarkets.com
44 New Scientist "The Price of Emission", April 8, 2017 pg 22-23
Leadership in Green Private Investing

As scientific and technological innovation continued unabated—particularly in storage and electrifying transport and vehicle recharging, green companies became more recognized. Imperial College, London and Carbon Tracker forecast by 2035 that electric vehicles (EVs) will make up 35% of road transport possibly halting fossil fuel growth by 2020. China is aiming to have 5 million EVs on the road by 2020 and Beijing’s 170,000 taxis will switch to all electric over the next 5 years. While Toyota is now selling hydrogen fueled cars, EVs with better capacity batteries and solar-powered EV charging stations are gaining as is demand for greener metals. Our GTS 2015 covered the new battery and storage technologies, along with prospects for lithium, cadmium nickel, compressed air, supercapacitors flywheels and using EVs for household storage --- as shown in our TV program "Green Building and Design" (2004) at www.ethicalmarkets.tv (FIG 7: Overview Storage Capacity)

Green Private equity groups including Generation Management funded by Al Gore and David Blood manages a $10 billion sized portfolio of pure play green companies, and Generate Capital has a pure play portfolio with similar companies as well as many using the popular power purchase agreements (PPAs) helping retail customers and businesses to install solar panels. Envision Solar, based in San Diego has delivered its solar-powered EV-charging stations to many cities and is still covering parking lots.

45 Eco-Watch, April 2017
46 The Guardian, April 2017
47 The Economist-“Volts Wagons”, Feb. 18, 2017 pg 53-54
48 The Economist-“The Richest Seam”, March 11, 2017 pg. 61-62
with its electricity-generating "solar trees"\textsuperscript{50} These Solar EV chargers require no digging, or permitting, and avoid grid-based fossil-generated electricity while offering security during power outages.\textsuperscript{**}


Pioneers include RS Finance in Portland, Oregon, based on the Austrian philosopher Rudolf Steier’s social philosophy, whose founder Mark Finser, serves on Ethical Markets Advisory Board as well as Green Alpha Advisors, Scarab Funds and London-based Menhaden Capital. We include these and many other boutique asset managers in our Ethical Money Directory—which is a public service with no charge for our selected listers or for those seeking patient, ethical capital—unlike Wall Street's conventional model of charging referral fees and brokering their contacts. London-based Aviva, one of the world’s largest insurance and asset management firms specializes in climate-risk and related green investing for its 33 million customers.\textsuperscript{52} A leader in targeting 100% of its portfolio to sustainable investments is Sonen Capital, based in San Francisco, chosen by leading green investors Charly and Lisa Kleissner and their Felicitas Foundation (see our TV program in 2010 with Charly Kleissner at www.ethicalmarkets.tv.

One of the most innovative startups is OpenInvest, which fills a key niche, especially for concerned ethical investors and millennials tired of listening to the nay-saying of their traditional financial advisors. These investors can now take charge of the makeup of their portfolios, getting rid of polluting, unethical company stocks by moving their money to OpenInvest and activating their own value choices. Taking personal action in ridding portfolios of unwanted stocks appeals to many activists choosing fossil-free, gender-neutral, LGBTQ or more energy-efficient and socially-responsible companies. Currently OpenInvest offers only choices within publicly-traded companies, but according to its co-founder Josh Levin, they hope to add more choices in private companies as they grow.\textsuperscript{53} An even deeper innovation is SolarCoin a blockchain based rewards currency for anyone who has successfully harvested free photons.

\textsuperscript{50} Envision Solar Press Release, Feb. 2017
\textsuperscript{**}Full disclosure: Hazel Henderson is an investor in Generate Capital and Envision Solar
\textsuperscript{51}US Trust-Merrill Lynch, with Foreword by Christopher Hyzy Chief Investment Officer Bank of America Global Wealth and Investment Management. 2016
\textsuperscript{52} Aviva, "Seeing Beyond the Tragedy of Horizons", 2017
\textsuperscript{53} Business Week “Positive Investing for the Social Activist”, Feb. 13, 2017 pg 40
from our Sun into usable electricity or power. This is the brainchild of Nick Gogerty, formerly with hedge fund Bridgewater and author of *The Nature of Value*, Columbia University Press (2012). Solar Coins are now worldwide and traded on a currency exchange in Zurich and are a partner of Ethical Markets.

There is still a huge need to connect the dots in global green markets, and many conferences have been filling this role by convening investors, entrepreneurs and green technology innovations including Investors Circle, Business for Social Responsibility, The B Team, We Mean Business, SolarPlaza, SOCAP, Social Venture Network, ShareAction, BrightTalk, The Global Impact Investing Network, Sustainatopia, Skytop Strategies, the FUTURE 500, and others, proliferating online every day. All these groups and networks including our own Ethical Markets and many business schools and universities complement the work of the UN's PRI and Global Compact, as well as the UNEP and its Inquiry.

Such conferences over the past 20 years were the most effective way to create the robust global green investments markets of today. Often they activated shareholders to bring proxy proposals to company annual meetings. This is still a viable strategy to engage many recalcitrant companies, as in the FUTURE 500’s 2017 report.\(^5^4\) Thus in this 2017 GTS, we have documented some of the evidence---growing every day, that green finance is indeed deepening. (Fig 8: Solar Photovoltaic Projections v. Real Market Developments) shows this progress. So many official projections of market penetration of solar energy have clearly often fallen behind actual performance---as confirmed by our new GTS total of private investments now at a cumulative $8.1 trillion since 2007.

\(^{54}\) FUTURE 500, March 2017
Sectors Covered


Governments and investors at all levels are turning their focus to growing greener economies as evidenced by the explosive increase in green bonds worldwide reported in August 2014’s GTS report, “Green Bonds Growing Green Infrastructure.” At the institutional level, we have long recommended investing at least 10% of institutional portfolios directly in companies driving the global Green Transition, thus updating strategic asset allocation models – both as opportunities and as risk mitigation. Examples seen in 2015 include Norway which holds the world’s largest sovereign wealth fund and CalPERS and CalSTRS, two of the world’s largest pension funds held in California. These government mandated shifts from fossilized sectors happened in part from concern for the environment and in part to mitigate holding stranded assets which will increase as low-carbon regulations are implemented. Now Saudi oil giant Aramco is making this shift, as described in the GTS 2016 Overview. Investments also serve as risk mitigation due to oil, coal and gas markets’ volatility sensitive to politics, wars and infrastructure damage.

This growing consensus validates models indicating that investing $1 trillion annually until 2020 can scale and reduce costs of wind, solar and other renewables, energy and material efficiency, green construction; can increase corporate green R&D, sustainable land-use, smart infrastructure, transport and urban re-design globally. Ceres Clean Trillion campaign56 aligns with a strategy recognized in the 2012 report by Mercer which suggests 40% of portfolios should be in Green Transition sectors.57 While the GTS tracks highly targeted sectors within the green economy, there is more than $21.4 trillion of assets under management incorporating environmental, social and governance factors in investment selection,

<table>
<thead>
<tr>
<th>Sector</th>
<th>Amount US $</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renewable Energy</td>
<td>$3,427,534,992,202</td>
</tr>
<tr>
<td>Energy Efficiency</td>
<td>$1,748,904,490,919</td>
</tr>
<tr>
<td>Life Systems</td>
<td>$1,660,880,346,366</td>
</tr>
<tr>
<td>Green Construction</td>
<td>$914,736,379,757</td>
</tr>
<tr>
<td>Corporate Green R&amp;D</td>
<td>$381,400,521,125</td>
</tr>
<tr>
<td><strong>Grand Total</strong></td>
<td><strong>$8,133,456,730,370</strong></td>
</tr>
</tbody>
</table>

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57 “Through the Looking Glass: how investors are applying the results of the climate change scenario study”. Mercer, LLC, New York, 2012.
representing 30.2% of the professionally managed assets in Asia, Australasia, Canada, Europe and the United States.  

What's Included

Renewable Energy, Energy Efficiency, Life Systems, Green Construction and Corporate Green R&D represent broad areas of green technologies, covering substantial capital investment in technologies which Hazel Henderson's years of research as a science advisor and which the Ethical Markets Advisory Board expertise indicate are continuing to contribute to a sustainable future.

The sectors evolve as the Green Transition takes hold. Last year the GTS added the Life Systems sector. The information and digitization can best be viewed through a Life Systems lens as detailed in the 2015 GTS Report “Breakdowns Driving Breakthroughs”, highlighting the interconnections between energy, water, food, education, health and quality of life.

Companies, organizations and the sources of financial data are screened by social, environment and ethical auditing standards. Accounting organizations IIRC, SASB, ICAEW, Tomorrow's Company, Long Finance, CIMA Global and others are applying sustainability auditing standards making it easier to value these more comprehensive and rigorous screens. Increasingly, we are finding companies which aspire to the even more demanding metrics of the Principles of Ethical Biomimicry Finance®. Data can be found in indexes such as Calvert, Domini and Pax World, the PowerShares Cleantech Portfolio, MSCI, Dow Jones Sustainability Indexes, London's FTSE4GOOD, NASDAQ OMX Green Economy Global Benchmark Index, ASPI Eurozone, as well as the many newsletters from around the world posted daily at www.ethicalmarkets.com. Data sources include Bloomberg, Yahoo Finance, Reuters, Clean Edge and many UN and other international studies, reports such as the Roen Financial Report, Sonen Capital Green Alpha Advisors, Zevin Asset Management, and other asset managers and companies listed free

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in our public service Ethical Money Directory, and findings from CSRHub and TBLI, as well as individual company reports.

**What’s Omitted**

International investments in the GTS tally are reported in US dollars, based on conversions from XE.com on April 4, 2017. Because the GTS focuses on private sector investments, government funded projects and initiatives are heavily discounted. Despite a common misperception, sustainable technologies can stand alone, without government subsidies. Fossil-fuel consumption subsidies worldwide are four times greater than subsidies to renewables.⁶⁰ Renewable energy and efficiency are competitive even in this hostile environment. The GTS purposefully discounts government investments so as to bypass the continuing political debate over the allocation of subsidies. Even limiting government funding, the GTS still exceeds $8.1 trillion, showing that green technologies are competitive in today’s market and that renewables specifically are already cheaper than nuclear power,⁶¹ as well as coal and oil when their external costs are included.

Our definition of ‘green’ is quite strict, omitting clearly unsustainable sectors as well as certain technologies having unsubstantiated claims, negative EROI or unexplored or untested consequences. For example, nuclear energy is not a sustainable option when EROI from mining, construction, uranium enrichment, processing, transportation, waste disposal and decommissioning costs are taken into account. Nuclear has enormous taxpayer subsidies. In the US, loans to nuclear power are secured by the Price-Anderson insurance provision of government underwriting because the insurance market cannot internalize the risk.⁶²

Several emerging technologies have been purposefully omitted either because of controversy or lack of consensus that they will make a long-term contribution to sustainability.

- Most proposals for “geoengineering” are speculative with unknown consequences perhaps more dire than the problem they aim to resolve.

- Recognizing its potential and obstacles, the European Commission is investing in nanotechnology with research, financing of responsible innovation and upgrading of the regulatory framework to render it capable of addressing new challenges.⁶³

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• 3-D printing has enormous potential, however its use to manufacture destructive products such as weapons and drones and the toxicity of its many chemical components require prudent observation and inclusion only on a case by case basis.

• The internet of things (IoT) is widely lauded for increasing efficiency but security, privacy and future repercussions are still to be seen. For example, already Aetna is using sleep monitoring to “reward” its employees.64

• Similarly, we exclude genetic engineering and artificial life-forms.

We omit so-called clean coal, still unproven, given coal carbon sequestration (CCS) reduces the efficiency of coal-fired plants by as much as 30%-40%.65 Despite major government subsidies, in the US there are few demonstration projects.66 As mentioned in the 2014 GTS report, efforts to set fire to underground coal deposits to capture their methane are even more preposterous.67 In addition, carbon is only one pollutant from coal, along with many other emissions including mercury and particulates damaging to health and the environment. We recommend pollution taxes (including on carbon emissions) as the most efficient way to curb such external costs to society.68

Biofuels are limited in the overall GTS tally even though their use worldwide is growing. While local use of biomass recycled sustainably on small farms and other traditional uses in developing countries will continue, too much is invested in industrial-scale facilities and exporting, as well as in genetically modified microbes to produce fuels – dubious propositions for long-term sustainability. Biofuel crops require water and land better suited for range or agriculture food production. The future of transport is more likely to be electrically powered as super capacitors which store electricity differently from batteries are used in electric and hybrid cars to store braking energy.69 As noted in Life Systems sector, exceptions are made for biofuels from algae or halophyte plants grown on seawater.

Renewable Energy

<table>
<thead>
<tr>
<th>Year</th>
<th>Amount US$</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>$170,200,000,000</td>
</tr>
<tr>
<td>2008</td>
<td>$224,200,000,000</td>
</tr>
<tr>
<td>2009</td>
<td>$209,500,000,000</td>
</tr>
<tr>
<td>2010</td>
<td>$267,300,000,000</td>
</tr>
<tr>
<td>2011</td>
<td>$334,700,000,000</td>
</tr>
<tr>
<td>2012</td>
<td>$282,100,000,000</td>
</tr>
<tr>
<td>2013</td>
<td>$281,000,000,000</td>
</tr>
<tr>
<td>2014</td>
<td>$322,200,000,000</td>
</tr>
<tr>
<td>2015</td>
<td>$397,000,000,000</td>
</tr>
<tr>
<td>2016</td>
<td>$375,000,000,000</td>
</tr>
<tr>
<td>Commitments</td>
<td>$564,334,992,202</td>
</tr>
<tr>
<td>TOTAL</td>
<td>$3,427,534,992,202</td>
</tr>
</tbody>
</table>

Investments in Renewable Energy include private technology development, equipment manufacturing, project finance and M&A activity. The sector is divided into current investments by year of funding and future commitments. Many of the current investment numbers are based on global trends reported by Bloomberg New Energy Finance as well as other international studies. This is the largest sector in this report which from 2007 to 2016 reached $3.427 trillion in investments and commitments.

Commitment numbers have been compiled project by project from daily monitoring by Hazel Henderson, online research and other sources, posted at [www.ethicalmarkets.com](http://www.ethicalmarkets.com) on our Green Prosperity, Energy Efficiency, GreenTech, SRI News, Trendspotting and Earth Systems Science pages. Future commitments include those from US banks such as Bank of America, Goldman Sachs, CitiGroup and Wells Fargo and include green bonds.
Renewables are challenging fossil fuels from unexpected places. Coal faces encroachment from natural gas, hydroelectric, solar PV, onshore wind, biofuels and geothermal which, together with efficiency and other renewables are exceeding forecasts by the International Energy Agency, as we report in the Overview, from REN21.\textsuperscript{70} Massive shifts from coal to locally produced natural gas by US utilities are risky given lower oil costs and price spikes due to lack of pipelines and water shortages from fracking.\textsuperscript{71} New geothermal technology designs address intermittency, normally managed with coal or gas, providing flexibility in delivering energy to the grid without imposing significant cost.\textsuperscript{72} New transmission lines for direct current (DC) are more efficient for renewable electricity than AC lines. Micro-grids and “islanding” of electricity generation are upending utility business models.\textsuperscript{73} While investments slowed in 2016, this reflects lower costs.

Walmart, Procter & Gamble, Google, Facebook, General Motors, Dow Chemical, have all signed fixed-priced contracts.\textsuperscript{74} Existing nuclear infrastructure is losing capacity because many nuclear reactors face “economic abandonment.”\textsuperscript{75} Reactors in two major US cities, Syracuse and Boston, will close within the decade because, even with their subsidies, it costs more to operate the plants than the revenue they generate.\textsuperscript{76}

Subsidies to fossil-fuel generated energy continue as an obstacle. The IMF estimates petroleum, coal and gas receives $1.9 trillion worldwide through direct subsidies, consumer rebates and avoided taxes on pollution.\textsuperscript{77} Yet the IMF agrees that reducing subsidies “can lead to a more efficient allocation of resources, which will help spur higher economic growth over the longer term,” as per David Lipton of the

\footnotesize
\textsuperscript{71} Deyette, J., et al. The Natural Gas Gamble, Union of Concerned Scientists, March 2015.
\textsuperscript{73} Rader, B. “The Finance Industry on DERs: Solar and Batteries are Coming,” RMI Outlet, Aril 14, 2015.
\textsuperscript{74} Brady, D. “Why companies like Google and Walmart are buying so much wind power”. Washington Post, April 12, 2016.
\textsuperscript{75} Cooper, M. “Renaissance in Reverse: Competition Pushes Aging US Nuclear Reactors to the Brink of Economic Abandonment”. Institute for Energy and the Environment, Vermont Law School, July 18, 2013.
\textsuperscript{76} Wernick, A. “Nuclear reactor closings in the US continue to roil the energy industry”. PRI, November 22, 2015.
IMF. The tremendous waste of capital to fossil-fuel subsidies will continue until energy efficiency and exergy are included in economic models (see GTS 2014 report). Pollution taxes, including on carbon, need to take hold. External costs need to be fully reflected in financial models, corporate balance sheets and national accounts. Egypt has reduced its deficit by making deep cuts to fuel subsidies. India has moved from subsidizing oil to taxing it, taking advantage of low oil prices. Reducing fuel subsidies is also part of China’s Greening Financial System plan.

Inclusion of biofuels is limited because production competes with food production and because studies, such as that from Cornell and Berkeley, show that biofuels have a negative EROI. As an exception, we include biofuels grown from algae on saltwater, as in the Boeing-Masdar project which yields better quality fuel for aircraft than petroleum distillates (see 2014 GTS report).

As a rule, Corporate R&D is omitted here and reported in Corporate Green R&D to avoid double-counting. Government R&D is discounted in our practice of limiting public investments as part of the tally.

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80 Cunningham, N. “Low Oil Prices Enable India To Abolish Subsidies And Start Taxing Fuels”. Oilprice.com, July 29, 2015.
84 Note: the Renewable Energy tallies for 2010, 2011 and Commitments (Appendix 1) are aggregates from industry and company press releases, limiting our ability to remove all Corporate R&D.
Energy Efficiency

Investments in **Energy Efficiency** include conservation efforts and initiatives and products focused on lowering energy needs or using less energy than a comparable product, reaching $1.7 trillion.

<table>
<thead>
<tr>
<th>Year</th>
<th>Amount US $</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>$85,994,451,247</td>
</tr>
<tr>
<td>2008</td>
<td>$94,107,749,303</td>
</tr>
<tr>
<td>2009</td>
<td>$103,011,531,368</td>
</tr>
<tr>
<td>2010</td>
<td>$112,784,229,050</td>
</tr>
<tr>
<td>2011</td>
<td>$148,667,945,000</td>
</tr>
<tr>
<td>2012</td>
<td>$228,240,600,000</td>
</tr>
<tr>
<td>2013</td>
<td>$233,883,200,000</td>
</tr>
<tr>
<td>2014</td>
<td>$262,299,000,000</td>
</tr>
<tr>
<td>2015</td>
<td>$270,514,250,000</td>
</tr>
<tr>
<td>2016</td>
<td>$176,614,168,750</td>
</tr>
<tr>
<td>Commitments</td>
<td>$50,798,345,542</td>
</tr>
<tr>
<td>SMARTGRID</td>
<td>$237,956,292,500</td>
</tr>
<tr>
<td><strong>Supply Chain Efficiencies</strong></td>
<td>$203,000,000,000</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>$1,748,904,490,919.33</strong></td>
</tr>
</tbody>
</table>

The definition of energy efficiency is in flux. Energy efficiency broadly counts: heat, power, waste to energy; improvements in construction materials such as windows, insulation and lighting; hybrid vehicles and charging stations; waste management, smart grid and supply chain efficiencies. The ripple effect of energy efficiency includes: energy savings, jobs creation, increased productivity, improved product quality, improved system reliability and optimizing manufacturing processes.\(^{85}\)

Energy efficiency metrics must include **exergy efficiency**, energy which could have been converted into work but was wasted instead. We use the overall exergy model of system-wide efficiency

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developed by our Advisory Board member Dr. John “Skip” Laitner.\textsuperscript{86} The ACEEE estimates $80 billion of the $156 billion dollars’ worth of energy used in production in 2013 was lost through inefficient conversion.\textsuperscript{87} For example, using combustion to heat releases far more energy than is used – exergy inefficient.

Smart grid technologies, anything used on the grid that enhances use of renewable energy, largely electrical components and equipment, are included in Energy Efficiency. Researchers have been careful when including Smart Grid investments. Too often, companies use those costs to increase rates rather than provide the promised lower costs to customers based on improved efficiency, touting instead power reliability, avoided outages and faster restoration times.\textsuperscript{88} An advantage of smart grid has been to help emerging markets leapfrog technology for energy infrastructure.\textsuperscript{89}

This sector also includes investments in batteries for electric vehicles and charging infrastructure, new storage technologies such as passive green off-grid buildings and super capacitors. The 2013 GTS report covered many of these innovations in energy storage.\textsuperscript{90} Morgan Stanley predicted in 2014 falling costs of batteries presents a tipping point encouraging households, vehicles and businesses to go off grid and off the pump.\textsuperscript{91} This interest has driven up tremendously the use and hence the cost of lithium, as we predicted this overshoot, and however imperfect and toxic this commodity is.\textsuperscript{92}

Widely considered the lowest hanging fruit for investors, efficiency provides remarkable ROI. The EU’s efforts toward 20% energy savings by 2020 has already resulted in EU buildings consuming half the energy used in the 1980s.\textsuperscript{93} Highlighting strides in production, the share of refrigerators meeting the highest energy efficiency classes increased from less than 5% in 1995 to more than 90% in 2010.\textsuperscript{94} The US Energy Star program has developed a Cash Flow Opportunity calculator to create a sense of urgency

\textsuperscript{88} Wong, G. “ComEd files for rate increase to help cover Smart Grid program”. Chicago Tribune, April 14, 2016.
\textsuperscript{92} Stafford, J. “Tesla And Other Tech Giants Scramble For Lithium As Prices Double”. OilPrice.com, April 12, 2016.
\textsuperscript{94} Ibid.
for manufacturers to change their processes and the products offered. This innovation is threatened by Trump's cuts to EPA.

Supply chain efficiency is recognized as a key component of energy efficiency has been noted by McKinsey & Co. since 2009. Companies are realizing the value of providing services specific to meeting this need such as Johnson Controls which is specifically targeting scaling up its program to help small and medium-sized enterprises. The numbers reported by the GTS are certainly understated as these smaller company efforts do not meet our $100 million investment accounting threshold.

95 US EPA. Calculate returns on energy efficiency investments. http://tinyurl.com/jcg3qwh
97 "Johnson Controls teams up to scale energy efficiency in corporate supply chains". Press release, ACEEE, June 11, 2015.
Life Systems

Technologies other than renewable energy and efficiency enhance quality of life, protect nature, provide for education, healthcare and food, protect and enhance ecosystem services. A system-wide transition toward efficiency, information and digitization can best be viewed through a **Life Systems** lens. Infrastructure from past eras no longer fit for purpose require redesign of urban infrastructure whether it be transit, healthcare, food and water delivery, education and information systems.

The Green Transition Scoreboard® collects investments in these areas under **Life Systems**. When we started tracking for 2014, Water, Community Investment, E-Learning, VC/PE/M&A, Land & Water Remediation and Waste & Recycling reached threshold minimums for inclusion in the GTS, totaling $876 billion in investments since 2007. In 2015, we added Fintech VC and Peer-to-Peer Lending, including crowdfunding of sustainability, as described further in the GTS 2016 Overview, reaching the new total of over $1.660 trillion invested since 2007.

![Life Systems Investments by Sub-Sector Since 2007 Totaling US $1.6 trillion](image)

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**Water, Land & Water Remediation, Waste & Recycling**

**Water** is the most important commodity for life originating on this planet. The GTS totals private investments in water since 2007 at $727.6 billion.
Most water infrastructure when working well goes unnoticed for decades. These investments include pipes, valves, filters, membranes, meters and biological systems. We omit the bottled water industry, privatization, large-scale hydroelectric dams. The GTS does count investments by utilities in water and wastewater systems. Given many utilities are owned and operated by various levels of government, a 60% discount has been applied.

Fresh water accounts for only 3% of water on the planet, and it is unequally distributed. Droughts cost billions in lost economic activity, with taxpayers often paying to remedy the resource depletion in a way which falls far short...
of what healthy ecosystem services can provide, with climatologists warning there is worse to come.\textsuperscript{98, 99}

As fresh water becomes increasingly scarce, questions arise as to the use of water in mining and fracking when fields and livestock are in distress or abandoned.\textsuperscript{100} A concern based on the enormous waste in mining, including water waste and contamination, led to the creation of Ethical Markets’ initiative the EthicMark\textregistered GEMS standard seeking to shift consumption from mined gems to lab-created gems from human ingenuity.\textsuperscript{101} For mining deemed “necessary”, methods to reduce water use reduce the cost of production as well.\textsuperscript{102}

In Europe, 44\% of fresh water consumption is used in energy production, mostly to cool thermal and nuclear power plants. In the US, a comparable 41\% of freshwater used goes to generate electricity, beating out agriculture at 37\%.\textsuperscript{103} Investments in water include infrastructure and clean drinking water and sanitation. While in 2013 it was estimated it would take over $384 billion over 20 years to ensure safe drinking water in the US, resolving the lead contamination disaster in Flint, Michigan, alone is estimated by Fitch Ratings at $275 billion.\textsuperscript{104, 105} The World Water Council and K-Water see “Water and Green Growth” as a new path to sustainability and opportunities for economic growth.\textsuperscript{106} Imagine where we would be if the 2004 World Health Organization recommended annual investment of only $22.6 billion had been implemented to improve water and sanitation services globally.\textsuperscript{107}

Largely overlooked, saline water constitutes 97\% of available supply. As reported in “Plenty of Water” (GTS 2014), enormous opportunities are under-appreciated in desert-greening and in growing food, fiber and biofuels from algae on seawater from the 10,000 varieties of halophyte (salt-loving) plants which are grown in many countries, on desert lands using solar energy. The UAE is pursuing aquaculture both for biofuel and food security.\textsuperscript{108} Our TV program “Investing in Desert Greening” reviews the possibilities.

\textsuperscript{98} “Australia’s Queensland hit by record drought”. BBC News Asia, March 7, 2014.
\textsuperscript{100} Carroll, R. “Exclusive: California used 70 million gallons of water in fracking in 2014”. Reuters, April 3, 2015.
\textsuperscript{101} “Scio Diamond receives another patent for lab-grown diamonds”. IP Frontline, February 9, 2016.
\textsuperscript{103} Power and Water at Risk. Union of Concerned Scientists, 2012.
\textsuperscript{104} Cart, J. “US water infrastructure needs $384-billion upgrade”. Los Angeles Times, June 4, 2013.
\textsuperscript{105} Dolan, M. “US could face a $300 billion lead pipe overhaul”. Detroit Free Press, March 5, 2016.
\textsuperscript{106} Water and Green Growth: A New Path to Sustainability, announced at the 7\textsuperscript{th} World Water Forum, Daegu, Korea, World Water Council and K-water, April 13, 2015.
\textsuperscript{108} Casey, T. “Aquaculture Meets Biofuel For Food Security In UAE”. CleanTechnica, March 17, 2016.
Land & Water Remediation and Waste & Recycling subsectors are reported individually based on specific project financing, totaling $66.4 billion combined. VC, PE, M&A refer to the same subsectors but reference market transactions. Much of the data comes directly from company reports. Site remediation in particular is on track to grow to a $40 billion market by the end of 2015, led in large part by remediation of contaminated land in China and the former Soviet Union.¹⁰⁹

Community Investing, E-Learning and Fintech

Community Investing refers to capital specifically directed to traditionally underserved individuals or communities, totaling $114.6 billion. In 2014, community investing across just the US, Europe, Asia, Canada and Australia/NZ totaled $109 billion. A more in-depth look needs to be taken at Latin America and Africa. Traditional markets still overlook the millions of cooperative enterprises which employ more people than all traditional for-profit, commercial companies combined.¹¹¹

E-Learning accounts for $66.4 billion in Life Systems. This subsector covers all forms of online and mobile education from MOOCs (massive open online courses) to education platforms to learning management systems (LMS) to for-profit institutions. The GTS research focuses on the first three, avoiding when possible investments in “for-profit” colleges and universities because of the many controversies over government subsidies, predatory lending, enormous student debt, poor graduation and employment results. Free MOOCs and other self-directed learning methods are popular despite low “graduation” or certificate earning rates, instead being self-paced and self-realized, where learners can absorb what is needed to solve local and personal challenges. Growth in the market is estimated at 7% per year.¹¹² Ethical Market Exploratorium is our free MOOC for global citizens and lifelong learners worldwide. (www.ethicalmarketsexploratorium.com)

Fintech as a subsector is described at length in the overview, Fintech: The Good and Bad News. Fintech, totaling $55.9 billion, facilitates the rise of the digital economy, including community investing and peer-to-peer lending. Global VC investments in fintech in 2015 reached 860 deals totaling $12.5 billion in investments.¹¹³

¹⁰⁹ $40 Billion World Site Remediation Annual Market by 2015, news release, The McIlvaine Company,
Peer-to-Peer (P2P) lending, a subset of fintech, is often overlooked while adding $13.4 billion to the overall Life Systems total. Much of its investments came first from VC looking to invest in peer-to-peer enterprises. Investments surfacing after 2007 included online tools for collaboration, for example, the rise of Airbnb. Etsy was an early entrant to the retail marketplace, now trading on Nasdaq and a Certified B Corporation. P2P investments share in the e-learning boom with software development which allows online and mobile collaboration among students and between them and instructors. 114

A current P2P hot topic is financial services which facilitate actual peer-to-peer investing. In 2015, BlackRock bought £12.7 million worth of shares in UK’s Funding Circle investment trust. 115 In spite of much optimism, a lack of accountability has led to problems discussed in our Overview. Adair Turner, former chair of London’s Financial Services Authority predicted that peer-to-peer lending losses “will make the worst bankers look like lending geniuses”. 116 A counter positive is that funds transferred via e-remittances are an important component in local investments. 117 The remittance market brings increased transparency and competitiveness, lowering the costs of sending money in part because of online money transfers which can easily be done from a cell phone.

Future Sub-Sectors

Investments in Life Systems are as wide-ranging as life on earth. Many subsectors other than those reported by the GTS receive green investment but do not have projects meeting the GTS $100 million reporting threshold.

- Agriculture: organics and non-GMO, vertical farming
- Forest and farmland remediation: natural methods of carbon sequestration, investing in protecting land for intrinsic value and to increase values of adjacent lands for development
- Aquaculture: fisheries, seaweed for food and feedstock, halophyte farming

• Healthcare: waste reduction,\textsuperscript{118} energy reduction and efficiency,\textsuperscript{119} quality of life for patients and healthcare workers \textsuperscript{120}

\textsuperscript{118} Howard, J. “10 reasons health care needs sustainability treatments”. GreenBiz.com, February 12, 2014.


Green Construction

From 2007 to 2016 Green Construction reached $914.7 billion in investments and commitments. The sector is divided into current investments by year of funding. Since public-sector information is not reported separately, the total has been discounted to account for government projects.

<table>
<thead>
<tr>
<th>Year</th>
<th>Amount US $</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>$50,464,262,053</td>
</tr>
<tr>
<td>2008</td>
<td>$56,701,418,037</td>
</tr>
<tr>
<td>2009</td>
<td>$63,709,458,468</td>
</tr>
<tr>
<td>2010</td>
<td>$71,583,661,200</td>
</tr>
<tr>
<td>2011</td>
<td>$80,431,080,000</td>
</tr>
<tr>
<td>2012</td>
<td>$90,372,000,000</td>
</tr>
<tr>
<td>2013</td>
<td>$101,668,500,000</td>
</tr>
<tr>
<td>2014</td>
<td>$108,375,000,000</td>
</tr>
<tr>
<td>2015</td>
<td>$121,921,875,000</td>
</tr>
<tr>
<td>2016</td>
<td>$157,131,000,000</td>
</tr>
<tr>
<td>TOTAL</td>
<td>$914,736,379,757</td>
</tr>
</tbody>
</table>

The GTS does not restrict green construction solely to LEED buildings and other certifications, wanting to give credit for effort and to recognize new innovations, given that established standards often experience a lag behind entrepreneurs. For example, the startup Carbon has raised $140 million for 3D printers which are faster and less-energy intensive than most 3D printers on the market.  

Amounts are calculated using the value of the green construction market, defined as construction built to LEED standards or that incorporate multiple green building elements, structural materials such as timber, steel and other metals, concrete, glass, insulation and green rooftops and broad application categories of framing, insulation, roofing, exterior siding and interior finishing. Figures include innovations in green roofs, eco-friendly carpets, recycled tiles, VOC-free glues and paints and cement-making that uses CO2. Projected CARG through 2019 is 12.5%.

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Green construction also applies to creating greener cities rather than just greener buildings, for example, Guangzhou in China and the long-term symbiosis in Kalundborg, Denmark, which started in the 1970s. The GTS only counts green construction materials, not including labor, making this the most conservatively under-reported sector of the GTS as explained in the 2014 GTS Report.

Aggregate data on green construction for countries other than the USA are a challenge to compile. To provide country-specific sources on green construction and efficiency not included here, please contact the GTS research team.

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Corporate Green R&D

The data collected for the GTS is the most comprehensive assessment of Corporate Green R&D available. The GTS research team reviews press releases, sustainability reports, and financial statements. The team has identified over 190 corporations and organizations responsible for the green R&D tallied in this report. Our 2016 total is $381 billion.

This $381 billion likely understates by half actual global Corporate Green R&D, considering how much goes unreported for competitive reasons. International companies’ R&D does not make it into the media. In most countries, companies are not required to report, and tens of thousands of middle-market and smaller companies have R&D budgets below the GTS reporting threshold.

<table>
<thead>
<tr>
<th>Year</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>$28,584,453,309</td>
</tr>
<tr>
<td>2008</td>
<td>$29,109,592,219</td>
</tr>
<tr>
<td>2009</td>
<td>$32,049,053,183</td>
</tr>
<tr>
<td>2010</td>
<td>$33,414,873,761</td>
</tr>
<tr>
<td>2011</td>
<td>$46,843,034,537</td>
</tr>
<tr>
<td>2012</td>
<td>$59,273,472,511</td>
</tr>
<tr>
<td>2013</td>
<td>$55,283,846,063</td>
</tr>
<tr>
<td>2014</td>
<td>$57,639,355,119</td>
</tr>
<tr>
<td>2015</td>
<td>$62,009,785,998</td>
</tr>
<tr>
<td>2016</td>
<td>$40,977,350,069</td>
</tr>
<tr>
<td>Commitments</td>
<td>$45,687,865,000</td>
</tr>
<tr>
<td>Total</td>
<td>$381,400,521,125.00</td>
</tr>
</tbody>
</table>

Investing in green R&D shows that a company integrates sustainability into its core strategy. This data helps identify innovative companies ahead of the curve in responding to heightening environmental risks and regulations. Green R&D serves as a strong indicator to investors, alert to the green transition to the Solar Age, that a company is both long-term and forward-looking. Green R&D provides a

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126 See for example, “Through the Looking Glass: how investors are applying the results of the climate change scenario study”. Mercer, LLC, New York, 2012; Deutsche Bank, “Sustainable Investing: Establishing Long-Term Value and Performance”. DB Climate Change Advisors, June 2012.
competitive advantage, preparing companies for market trends reflecting rising energy costs, water scarcity, demographic changes, and new regulations.\textsuperscript{127}

In the GTS 2016 our data showed the automotive industry as the largest investor in green R&D. Volkswagen, Robert Bosch, Toyota, BMW, Volvo and Audi are all RND Investors. The sector total of $381. billion does not capture the entire global investment. Many automobile companies, such as GM and Daimler, do not publicly disclose how much of their R&D is directed towards greening vehicles or production.

Energy generation, conservation and distribution account is also still a large investment input. The bad news is that there is still plenty invested in oil and gas exploration and production. The good news is that the 2016 spending outlook for oil and gas forecasts continued reductions.

In keeping with GTS attention to Life Systems, R&D for water is at $12.5 billion, up over $5 billion in just one year. See Life Systems: Water for trends in water investments.

Again for 2016, battery technology is a hot topic, foreseen by Hazel Henderson in her introduction to the 2013 GTS report. The automotive industry for EVs is pushing battery manufacturing, driving up the cost of key components such as lithium, mentioned previously.

\textsuperscript{127} Henderson, H. "Introduction and Overview" op. cit. 2013.
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 April 2017

Apple (AAPL)
Biomimicry 3.8
Brookfield (BEP.UN)
Boralex (BLX)
Centre for Social Innovation Community Bonds
Discovery Communications, Inc. (DISCA)
EnvisionSolar (EVSI)
Environmental Services (EVX)
Equal Exchange
First Trust Nasdaq Clean Edge Green Energy Index (QCLN)
Facebook (FB)
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*.

**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.

**Timothy Jack Nash**, MSc, Strategic Leadership Towards Sustainability, Blekinge Institute of Technology, Sweden, is a senior advisor for Ethical Markets Media, and, as director of sustainability research, lead researcher for this report. He teaches Economics at Sheridan College and is the principal of SSI – Strategic Sustainable Investments in Toronto, Canada.

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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

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“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, Centerpoint Investment Strategies

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Our turnkey manual, Principles of Ethical Biomimicry Finance® - co-developed with our partner, Biomimicry 3.8, is available for licensing to socially responsible asset managers.

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