PCA | PENSION CONSULTING ALLIANCE

PCA Response to Request for Information

Investment and Fiduciary Analysis of Prudent Strategies for Divestment of Securities Issued by Fossil Fuel Reserve Owners

June 15, 2018

Sarah Bernstein, Ph.D., FSA

Executive Summary

1) **Name and business address of responding party (if responding on behalf of a firm or organization, provide for that entity):**

PENSION CONSULTING ALLIANCE, LLC
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Portland, OR 97209

2) **Website address, if available**: www.pensionconsulting.com

3) **Name, address, email address and phone number for single point of contact for all communications.**

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4) **Please briefly describe your occupational and professional status and background, expertise related to the issues in this RFI and any other relevant background information.**

Ms. Bernstein joined PCA in 2002 as a Principal and now serves as PCA's head of ESG/Sustainability efforts. Special Expertise: ESG, Sustainability (including SASB's Fundamentals of Sustainable Accounting ("FSA"), general investment consulting, private equity consulting, expertise in environmental/clean tech investing. Please see recent report, "Sustainability Equity Indexes, May 2018", as a recent sample of her work. During her tenure with PCA, Ms. Bernstein has assumed senior responsibilities across varying clients and consulting projects. Prior to joining PCA, Ms. Bernstein worked as an equity analyst with several Wall Street firms including Kaufman Bros., First Union Capital Markets Corp., and US Bancorp Piper Jaffray. In the July 2000 issue of "Wall Street Journal 1999 Best on the Street," Ms. Bernstein was named No. 1 for Estimate Accuracy and No. 3 for Stock Picking within the Enterprise Software sector.

Prior to her Wall Street experience, Ms. Bernstein was an Economic Affairs Officer at the United Nations Secretariat where she analyzed investment, productivity, growth, inflation, technological change and employment in developed market economies for internal UN discussion and publication. In addition, Ms. Bernstein was a Vice President with Mantis Holdings, a Project Director with the Ontario Investment Fund Initiative, and a Senior Economist with the Cuomo Commission on Competitiveness. Ms. Bernstein earned a BA in Politics at the University of California and a Ph. D. in Economics at the New School for Social Research in New York.

5) **Please state whether the responder is able to provide the Investment Analysis Services, or a portion of such work, including legal fiduciary analysis services, and is likely to respond to an RFP that includes Investment Analysis Services. If yes, please respond to the questions in Attachment 1.**

Yes, PCA can provide the Investment Analysis Services excluding legal fiduciary analysis services. Yes, we are likely to respond to an RFP that includes Investment Analysis Services.

Responses to Questions

(Responders must address one or more of the following questions). Responders are encouraged to respond with other considerations and approaches not covered herein that would achieve the Comptroller's and Systems' purpose and objectives regarding potential prudent divestment strategies.

RFP Structure for Investment Analysis Services

1. **What specific areas, factors, risks and impacts should an RFP consider in order to enable selection of a provider or providers that can best conduct comprehensive and in-depth Investment Analysis Services?**
2. **What other important question should be included in an RFP that includes Investment Analysis Services?**
3. **What information and format do you believe would be useful for soliciting and evaluating Investment Analysis Services?**
4. **What criteria, experience and qualifications for service providers should be considered for Investment Analysis Services?**

Approaches to Investment Analysis Services

5. **What do you believe are the best approaches to:**
   a. **Determining the scope of companies, including further defining fossil fuel reserve owners, appropriate for divestment.**

   In PCA's opinion, the best approach to analyzing divestment of fossil fuel reserve owners, including defining the list of companies from which to divest, depends on the reason/perspective driving the divestment/exclusion discussion. We illustrate three approaches below, based on different goals for the divest/exclusion action:

   1) divest for morals/values,

   2) divest to avoid possible stranded asset downside risk without factoring in potential to mitigate those risks through corporate strategy shifts and/or shareowner proxy voting and engagement,

   3) divest to minimize climate change financial risk after factoring in potential to mitigate those risks through corporate strategy shifts and/or shareowner proxy voting and engagement.

1) **Divest for Moral/Values Reason**: If an institutional investor, for morals, or values reasons wants to disassociate its investment portfolio from all companies that own fossil fuel reserves, then the divestment and ongoing exclusion process from the portfolio can be straightforward:

   - Compile a list of every public and privately held company that owns fossil fuel reserves of any amount;
   - Revise the System's investment policy and policy guidelines for all investment managers and benchmark providers to indicate that the list of identified companies should be excluded going forward (set a date/time frame).
   - Identify all securities of these companies that are held in the System's investment portfolios.
   - Develop a divestment schedule based on the ease and cost of divestment (may have to make exceptions for expensive or difficult potential divestments, for example if any

portfolio companies of System's private equity investment funds are fossil fuel reserves owners).

- Keep the list updated; keep all investment service providers apprised of the updates; monitor investment service providers for compliance.

The System's divestment from coal focused only on coal used for energy production – thermal coal. A similar focus on fossil fuel reserves used for energy production seems logical within this framework.

2) **Divest to avoid possibility of downside investment risk of potentially stranded fossil fuel reserves assets, without factoring in potential to mitigate those risks through corporate shifts in business strategy, and/or shareowner proxy voting and engagement.** If divestment from fossil fuels reserves owners is due to potential fossil fuel reserves stranded asset risk, based on each fossil fuel reserves owner's current products, and assuming the corporate long-term business strategy and/or shareowner voting and engagement will be fruitless in mitigating this risk, then the definition of which fossil fuel reserve owners the System should divest should reflect the stranded asset risks. Divestment criteria should analyze:

    a. each fossil fuel reserves owner's current potential for stranded asset risk (including distinguishing types of fossil fuel reserves).

    b. identify the expected time frame which the assets are expected to potentially be stranded.

    c. distinguish fossil fuel reserves used to produce energy from non-energy products.

    Such an analysis might include, for example, the degree to which the Levelized Cost of Energy ("LCOE") of a specific fossil fuel energy production method exceeds the Levelized Avoided Cost of Electricity ("LACE") as an indication of whether that technology will be economically attractive to build (see for example the March 2018 U.S. Energy Information Administration report: *"Levelized Cost and Levelized Avoided Cost of New Generation Resources in the Annual Energy Outlook 2018"*).

    Because the concern is for stranded assets that are related to the global need to reduce carbon emissions, the analysis might further assess if the fossil fuel reserves are sold for purposes that generate high Co2 emissions. For example, Exxon Mobil's 2017 Annual Report indicates that the company generated revenues and net income from three core areas: upstream (exploration and production), downstream (refining and manufacturing), and chemicals. As shown below, 25% of Exxon Mobil Corp 2017 net income was generated chemicals – products generally not used to generate energy.

Exxon Mobil Corp. 2017 Income Statement Summary ($ Billions)	
Total Revenues	$244,363
Net Income by Segment	
Upstream: Exploration and Production	$7,521
Downstream: Refining and Manufacturing	$4,985
Chemicals	$4,183
Other	$0

Chemicals includes a wide range of fossil fuel related products from tires to skin care ointments and lotions that are not used for energy production and do not produce high greenhouse gas emissions. For example, Exxon Mobil is the global market share leader in the synthetic rubber used to make tires for vehicles. Today, 60-70% of the rubber used in tire production is synthetic rubber instead of natural rubber. Synthetic rubber is used in the tires of all types of cars, including zero emission electric cars.

3) **Underweight or divest climate change financial risk laggards/invest or overweight climate change financial risk leaders.**

Climate change financial risks and opportunities manifest throughout the economy. In PCA's opinion, the global transition to primarily renewable energy is underway. We believe the transition may likely be largely complete by the end of the 21st century. We believe climate change, and energy transition related risks and opportunities will likely accelerate in the near-term decades. If the goal of fossil fuel reserve owner divestment is to avoid potential long-term risks from climate change and increase exposure to potential long-term opportunities from climate change, then, in PCA's opinion, divestment as a tool is best considered within a wider context than the one metric – ownership of fossil fuel reserves.

In our opinion, a company's climate risk/opportunity should be compared to its peers on approaches and metrics appropriate to their industry. For companies that lag their peers materially in adapting their products and practices to climate change, divestment should be weighed against the impact of retaining the System's shareholder voting power to further change, up to and including voting against the election/re-election of boards of directors and company chairs.

In each industry, companies exhibit a wide spectrum of adapting to climate change. Even within the oil and gas sector, companies such as Total are aggressively investing to participate in a renewable energy future. As another industry example, in our opinion, companies in the highly carbon emission intensive utilities sector should be compared to the grid of which they are a part, not to global emissions rates. (See for example, attached whitepaper by Ecofin, in association with Carbonanalytics: "*The role of utilities in decarbonizing portfolios, January 2017")*. The Real Estate industry faces physical climate risks, in addition to energy use/efficiency and policy change risks that should be addressed.

In this third framework, divestment would not be based solely on whether a company owns fossil fuel reserves. Instead, divestment may be a consequence for select companies across the economy, based on a view that the given company demonstrates persistent inaction compared to peers on the climate change risks and opportunities its industry faces, and that shareholder engagement and voting cannot effect change in a timely way to avoid climate change risks.

The approaches to question 5b, 5c, 5d, 5e and 5f below would adjust accordingly, depending on the primary goal of the divestment.

b. Determining the timetable and specific milestones within a five-year period appropriate for divestment.

I. A timetable within a five-year period for divestment of fossil fuel reserves owners might seek to balance three considerations:

1) Long-term value of sub-industry. For example, differences in leveraged cost of energy between different types of fossil fuels compared to renewables.
2) Expected long-term value from shareholder proxy voting and engagement
3) Ease and costs of divestment by asset class and within each asset class by investment vehicle, such as passive or actively managed funds.

II. A timetable over a longer-term period for divestment of fossil fuel reserves owners might consider investing in renewables generated energy/divesting from fossil fuel energy in concert with the New York City timetable to use 50 percent renewable energy by 2030 and achieve an 80 percent reduction in greenhouse gas emissions by 2050.

c. Assessing appropriate divestment approaches based on asset classes, strategies and styles.

In PCA's opinion, divestment should be considered as a potential tool to avoid financial risks of climate change when companies lag materially behind their industry peers in addressing such risks, and it is determined that shareholder engagement and voting will be ineffectual in addressing such risks. Within each asset class, the assessment of an appropriate divestment approach should include industry-level assessment of the material risks, company level assessment of how the risks (and opportunities) are being addressed, as well as security level assessment of these risks. For example, green bonds are being issued by some oil and gas majors to fund investments in renewables. An appropriate divestment approach should incorporate generally the distinctions between bond and stock holders, and analysis of the specific securities being held.

d. Analyzing the investment risks posed by climate change and fossil fuel reserve owners to the Systems' portfolios (including scenario analysis)

e. Analyzing potential investment impacts on the Systems' portfolios of divesting from the securities of fossil fuel reserve owners, including impacts on return, risk, diversification and cost (including tracking error).

f. Assessing potential alternative investments available to the Systems that have risk and return characteristics equivalent to the securities that may be divested.

6. Are there any precedents that can help guide the approach to analyzing the impacts of and determining a prudent strategy for divesting from fossil fuel reserve owners.

PCA was privileged to assess climate change related divestment for the Vermont Public Investment Corporation ("VPIC") when their Board discussed issues of potential divestment. Please see attached February 2017 PCA report, "Climate Risk Divestment Discussion".

7. What are ways to address the costs of externalities in investment portfolios that can help mitigate risk?

In our opinion, ways to address the cost of externalities in investment portfolios depends on the nature of the externalities.

8. How do you view the extent to which the market currently prices in climate change risk and, specifically, the economic and investment risks related to carbon intensive businesses such as fossil fuel reserve owners.

In PCA's opinion, the market has not fully priced in climate change risk for carbon reserve owners, for carbon emissions intensive businesses, or for all companies facing physical risks of climate change. Climate change impacts and time frames are not yet fully disclosed, or even clear. Carbon markets, which might add further pricing information are nascent, and not available globally. That said, in PCA's opinion, climate risks across industry are much more prominent part of investment market discussions, and priced in more than they were even five years ago.

9. How could divestment be effective in influencing fossil fuel reserve owners to take steps toward addressing carbon risk?

In general, in our opinion, the most direct impact investors can have to encourage fossil fuel reserve owners to address carbon risks is to reduce their demand for fossil fuel reserves energy – for both stationary and transportation uses. Divesting from publicly listed fossil fuel reserve owners, while continuing to buy products that rely on fossil fuel reserves, contributes to the profits of the reserves owners, while giving up the shareholder vote, possibly to an investor that is unconcerned about climate risks.

PCA believes that the effectiveness of divestment in influencing fossil fuel reserve owners to take steps toward addressing carbon risk depends in part on the asset class. For example,

> For publicly listed equities, divestment transfers shares to other investors, and does not increase financing for fossil fuel reserve owners. Divestment by investors that care about carbon risk can reduce the shareholder votes in favor of fossil fuel reserve owners addressing carbon risk, thus reducing the pressure by shareowners to address carbon risks.
>
> For equity in privately held companies that own fossil fuel reserves, divestment, or excluding from future investment without stipulations that they address and disclose carbon risk would conceivably make it more difficult for such companies to raise capital they are using to run/grow their business.

Attachment 1

Please answer these questions only if you are able to provide the Investment Analysis Services, or a portion of such work that would be sought in the above-referenced RFP and would likely respond to that RFP.

a) **What services can you provide that could satisfy the Investment Analysis Services sought in the above-referenced RFP? Describe briefly what other services relating to mitigating climate change or carbon risk you can provide.**

PCA can and would be honored to provide the investment analysis services expressed in the above questions.

PCA can also provide:

- active and passive ESG investment manager search, and benchmark search expertise due to our knowledge of and experience with the ESG manager market;
- consulting services to enhance for the 21st century the System's ESG and climate change related Investment Beliefs and Investment Policy;
- consulting services to assess and enhance responsible contractor and energy efficient, and climate risk mitigation Real Estate policies and programs.
- PCA is currently structuring a cost-effective service to provide ESG engagement services to assist institutional investor clients in further pooling their impact in shareholder engagement.

b) Describe your business including your primary business activity and all the professional services that you or your company or organization provide.

Since the firm's founding in 1988, PCA has acted as a fiduciary on behalf of clients' Boards and Committees by providing ongoing strategic guidance involving all aspects and asset classes of its clients' aggregate portfolios. Representing over $1 trillion in total assets under management, PCA clients are all U.S. institutional investors, primarily U.S. public pension funds. Consulting services offered by PCA include, but are not limited to, asset allocation, strategic planning, custom capital market assumptions, portfolio analytics, economic environment analysis, ESG and climate change analysis, manager searches, policy and investment beliefs review, research, risk modeling and analytics, fund operations and management assistance.

c) What skills, experience, expertise or tools do you have that enable you to provide Investment Analysis Services? Please include a list of similar prior projects and/or services; a description of experience with providing similar services to public pension funds or other institutional investors; and the length of time that you and your company or organization have provided such services.

PCA has analyzed issues of divestment and engagement for our pension fund clients for decades. We have provided investment consulting services on environmental, social and governance ("ESG") issues since our founding in 1988. The issues have changed over time. During the last decade, PCA has developed its expertise in ESG and climate risk. We have worked with public fund clients to help them develop ESG related investment beliefs, update their Investment Policy for ESG concerns, analyze their investment benchmarks and portfolios for material ESG risks, and assess the potential impact of divestment from fossil fuel reserve owners on their portfolio.

PCA was privileged to be selected to assess climate change related divestment for the Vermont Public Investment Corporation ("VPIC") when their Board discussed issues of potential divestment. Please see attached February 2017 PCA report: "*Climate Risk Divestment Discussion*".

d) Would you be willing to serve as a fiduciary to the Systems if you performed the Investment Analysis Services?

YES. Since the firm's founding in 1988, PCA has acted as a fiduciary on behalf of clients' Boards and Committees by providing ongoing strategic guidance involving all aspects and asset classes of its clients' aggregate portfolios.

e) What are your sources of income other than from clients? If you are a not-for-profit organization, please identify your donors.

PCA derives 100% of its revenue and income from providing non-discretionary investment consulting services to its institutional investor clients. PCA, as a matter of business philosophy, does not offer its consulting services to the investment management or brokerage communities. The firm does not receive any income from selling services to the investment management community and does not provide portfolio management services, OCIO, or dealer/brokerage services. We believe these other structures can impact the alignment of interests between a consultant and its client.

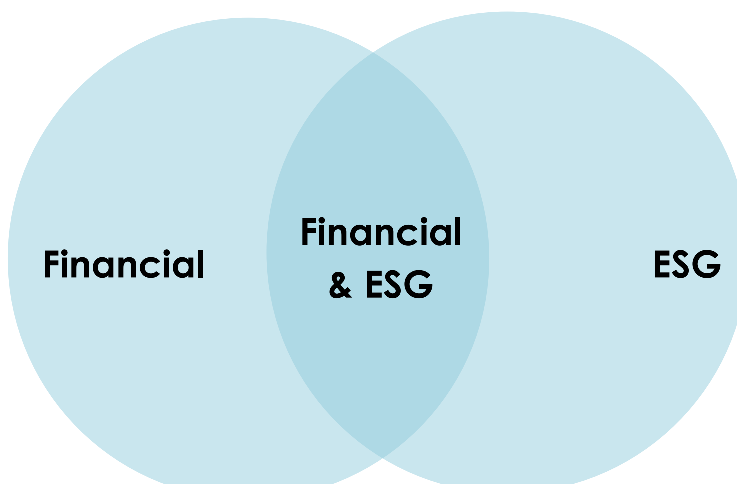
f) What is the estimated pricing structure and cost for provision of Investment Analysis Services?

PCA estimated pricing structure and cost for provision of Investment Analysis Services to the Systems.	
Investment Analysis Service	**Cost***
Analysis of divestment of fossil fuel reserves owners using one definition of owners.	$100,000
Analysis of divestment of fossil fuel reserves owners with three different definitions of fossil fuel reserve owners (such as all, subset limited by market cap, subset limited by type of fossil fuel)	$150,000
Climate friendly and/or ESG and/or SDG passive and/or active manager, or benchmark search	TBD based on specific request
Consulting services to assist refining the System's Investment Beliefs and Investment Policy to reflect ESG issues including climate change.	TBD based on specific request

*Plus out of pocket costs for travel and shipping.

Sustainability Equity Indexes

May 2018



Sarah Bernstein, Ph.D., FSA

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Executive Summary

Sustainability (Environmental, Social, and Governance ("ESG")) equity indexes have evolved to become a viable option within an institutional investor's investment policy. Sustainability indexes are no longer new – some have been offered for nearly 30 years. In just the last five years, these indexes have matured sufficiently to offer a new range of options that PCA believes can be seriously considered by institutional investors.

- **Continued development and new variants of sustainability indexes are expected.** As of 1Q2018, we identified 42 distinct indexes that reflect E, S, G, and/or ESG themes from FTSE/Russell, MSCI, and S&P Dow Jones Indices ("S&PDJI") combined. Each provider reviewed offers more than one ESG index, at least one low carbon or climate index, and an ex-fossil fuel and ex-coal index among their suite of sustainability indexes**.** The range of indexes include some appropriate for core equity portfolios and some that are narrower theme-based. We anticipate the creation of new sustainability indexes, including more indexes that reduce climate risk while increasing climate opportunity exposure, and new indexes focused on investments in-line with the United Nations ("UN") Sustainable Development Goals ("SDGs", Appendix I) as, for example, S&PDJI's recently announced forthcoming SDG-lens indexes.

- **Investment returns and risk are considered in the design of 25 of 42 sustainability indexes**. We found 14 indexes designed to outperform the financial risk/return of the parent index (integrate) and 11 designed to reflect values and achieve or outperform the risk/return of the parent index (impact).

- **Index construction: reweighting is on the rise, but indexes built by excluding stocks still lead**. A growing number of sustainability indexes preserve the broad market exposure of the parent index (and consequently the parent shareholder proxy voting and engagement potential) by reweighting the constituent stocks by ESG factor/s, rather than excluding or selecting securities by ESG factors. Some ESG indexes also maintain the parent index country, industry, and/or size characteristics to better match the return/risk of the parent index. A few ESG indexes are optimized to track the parent index risk and return within a relatively narrow range.

- **Comparability over time may be a challenge.** Index rule adjustments (e.g., defining materiality; changing weights of underlying E, S, and G factors in the total ESG score; introducing adjustments such as ESG momentum), and data quality improvements (as more companies report on ESG and reporting becomes more standardized) will likely enhance the fit of ESG indexes with institutional investor goals but perhaps at the expense of detailed historical comparability of any given index.

- **Today's E indexes are highly relevant to the 21st century but are not timeless like standard market cap weighted indexes.** Most E indexes capture some aspect of today's global energy transition. Renewable energy is projected to be the world's fastest growing energy source through 2050. Renewable energy jobs exceeded 10 million for the first time in 2017. We believe this energy transition is very long-term, but finite, and may be most relevant during the 21st century. As renewable energy becomes mainstream and fossil fuels decline in market share, indexes that exclude or underweight fossil fuels should trend toward the parent indexes.

- **Fees.** Sustainability index license fees tend to be a few basis points higher than parent indexes, reflecting the research required to develop and maintain sustainability indexes.

Investment Returns and Risk, and ESG Results for 12 Sample Sustainability Indexes

For this report, we investigated the financial and ESG performance of four sustainability indexes from each index provider (FTSE/Russell, MSCI, and S&PDJI). From each provider, we analyzed an ESG index, an ex-fossil fuel index, an index with low carbon, and one additional index as indicated below. We note that the 5-year annualized trailing performance history reviewed here is limited. The five-year performance ending March 30, 2018 includes no significant recession or down market in the U.S. or global developed markets.

FTSE Developed	MSCI World	S&P 500
4Good	ESG Leaders	ESG Factor Weighted
ex-Fossil Fuel	ex-Fossil Fuel	Fossil Fuel Free
Divest Invest 200	Low Carbon Target	Carbon Efficient
Green Revenues	Women Leadership	Fossil Fuel Free Carbon Efficient

Risk and Return Performance – Annualized Trailing Five-Years Ending March 30, 2018

- **Eight of the 12 sustainability indexes outperformed the parent index gross return; six outperformed the risk-adjusted return**. Eight of these 12 sustainability indexes generated higher returns, gross of license fees, than their parent index; four reported lower risk (standard deviation); and six outperformed the parent index on risk-adjusted return (return/risk).

- **Sustainability indexes designed to generate performance near the parent index succeeded.** Two indexes designed for low tracking error show the lowest tracking error among the 12 indexes reviewed: FTSE Green Revenues index (0.10%), and MSCI Low Carbon Target index (0.40%).

- **Market dynamics can overshadow distinctions between primary goals of sustainability indexes.** For this five-year period, the energy market weighed materially on the results for these 12 sustainability indexes. Five of the six sustainability indexes that generated a risk-adjusted return above the parent index exclude fossil fuel reserves companies, including four values-oriented indexes and one impact-oriented index. The outperformance occurred in U.S. large cap and global developed markets.

- **Mixed results of ESG indexes compared to parent indexes reflected index design**. For this five-year period, the S&PDJI ESG Factor Weighted index, which includes nearly all the securities of the parent index, outperformed its parent on gross and risk-adjusted return for both the S&P 500 index (U.S. large cap) and the S&P 1200 index (developed markets). The FTSE4Good Developed Market and the MSCI World ESG Leaders, which each include less than half of their respective parent index securities, slightly underperformed their respective parent indexes.

ESG Scores and Metrics Performance

- **RobecoSAM and MSCI ESG scores for the indexes reviewed clustered in a middle range** near the parent indexes. The MSCI ESG scores for individual companies can range from 0 to10. The MSCI ESG scores for these 15 indexes ranged from 5.0 to 6.6. Similarly, the RobecoSAM ESG scores for these indexes ranged from 57.9 and 64.4, compared to the possible 0 to 100 range.

- **The six sustainability indexes that generated a higher risk-adjusted return than their parent either matched or exceeded their parent ESG score from MSCI and/or RobecoSAM.**

- **Each sustainability index is not necessarily designed to improve all MSCI E, S, and G scores.** Most of the indexes we reviewed received MSCI E, S, and G scores equal to or above the parent index. However, for example, the FTSE Divest Invest 200 had a higher E score but lower S and G scores than the parent FTSE Developed. The S&P 500 ESG Factor Weighted index registered higher S and G scores than the parent but a lower E score.

- **E scores generally reflected carbon emissions and carbon reserves but not necessarily green revenues**. The nine sustainability indexes with higher E scores than the parent index all had lower carbon emissions intensity than the parent. Eight of these had lower carbon reserves intensity than the parent. However, only five had green revenues exposure above the parent.

The civilian firearm producers and retailers weight in ESG indexes is often zero or near zero. For some ex-fossil fuel and low carbon indexes, civilian firearm retailer weights are higher than the parent index.

Introduction

Rapid evolution in index construction and sustainability data have exponentially broadened the type of indexes available to benchmark sustainability equity portfolios and made passive equity sustainability investing viable for a wide range of investor goals. Historically, sustainability equity investing primarily meant investing according to social values, typically labeled socially responsible investing. Investment strategies that went beyond straightforward exclusion of specific securities for a social or environmental value (such as ex-tobacco, ex-controversial weapons, or ex-fossil fuels) were predominantly the purview of active investment managers. Today, in addition to indexes that capture social or environmental values without explicit concern for financial risk and return, indexes are now offered that integrate ESG material risks to seek improved risk-adjusted returns. Other sustainability indexes are designed to generate both a financial and social value/s outcome.

This report examines the equity sustainability index market, as evidenced by the products from three major global index providers – FTSE/Russell, MSCI, and S&PDJI. Our discussion focuses on the potential role of sustainability indexes in passive equity investing for institutional investors. Institutional investors, including pension plans, foundations and endowments, and institutions that manage individual participant-driven investment programs (such as 401k or 529 plans), will vary when considering whether their investment framework might benefit from incorporating any passive equity sustainability strategy. Outside the scope of this review are Smart Beta or factor indexes that incorporate ESG factors.

We refer to all indexes that use an Environmental "E", Social "S", and/or Governance "G" element in index design as sustainability indexes, including "ESG" indexes, which use all three elements. We concentrate on two key questions:

1) How is ESG defined? We categorize sustainability indexes by the primary goal of each index:

   - Integrate – integrate ESG factors to improve risk-return results of a portfolio,
   - Values – express social or environmental value/s, without a constraint to achieve market returns, and
   - Impact – achieve social or environmental goal/s while generating competitive market returns (meet underlying parent index returns).

   For each index, we identify the construction approach and the implications for proxy voting and shareholder engagement.

2) What are the financial and ESG outcomes compared to the parent indexes? For 12 indexes (four sustainability indexes from each index provider) we:

   - Investigate the index return and risk compared to the parent index, and
   - Analyze the ESG, green revenue, and carbon metrics compared to the parent index.

We thank FTSE/Russell, MSCI, and S&PDJI for providing information on their respective sustainability indexes, including performance data on four sustainability indexes and a parent index from each provider. We thank the following firms for providing sustainability metrics for all the indexes we reviewed: green revenues exposure (FTSE/Russell); overall ESG scores (MSCI and RobecoSAM); E, S, and G scores (MSCI); carbon metrics (MSCI and S&PDJI-Trucost); and exposure to MSCI definition of civilian firearms producers and retailers (FTSE/Russell and S&PDJI).

Sustainability Indexes Overview

The earliest three published (not custom) sustainability indexes that are offered today by FTSE/Russell, MSCI, or S&PDJI were ESG indexes. Each index incorporated Environmental, Social, and Governance issues. The MSCI KLD 400 Social index was launched 28 years ago in 1990, the S&PDJI Dow Jones Sustainability Index ("DJSI") in 1999, and the FTSE/Russell FTSE4Good index in 2001. The first E index – S&P Global Water – came to market in 2007, the first S index – MSCI ex-Controversial Weapons – launched in 2011, and G and Environmental & Social ("ES") indexes appeared by 2015.

First Sustainability Equity Indexes by Category from Major Index Providers FTSE/Russell, MSCI, S&PDJI			
Type	**Launch Year**	**Index Name**	**Description**
ESG	1990	MSCI KLD 400 Social	Include companies with outstanding ESG ratings and exclude companies whose products have negative S or E impacts
E	2007	S&P Global Water	Provide liquid exposure to 50 companies from around the world that are involved in water related businesses
S	2011	MSCI ex Controversial Weapons	Exclude companies in chemical, biological and depleted uranium weapons, cluster bombs, and landmines
G	2015	MSCI World Governance-Quality	Capture both the financial and G aspects of quality investing. G is measured through factors such as independence and diversity of board of directors, ownership and control structure of the company, accounting practices, and auditor opinions
ES	2015	S&P 500 Environmental & Socially Responsible	Exclude tobacco, military, and fossil fuels and then select top 75% of market cap by ES score

Sources: FTSE/Russell, MSCI, and S&PDJI.

The number of sustainability indexes has grown exponentially over the past 20 years, increasing from three in 2001, to seven by 2010, and to 42 distinct sustainability index series available by 1Q2018 from FTSE/Russell, MSCI and S&PDJI. Most sustainability indexes are series because they can be applied to different parent indexes. For this report we use index and index series interchangeably.

Total Number of Sustainability Index Series from FTSE/Russell, MSCI, and S&PDJI		
Type of Index	**Year First Index Launched**	**2017 Year-End**
Total		**42**
ESG	1990	**13**
E	2007	**19**
S	2011	**5**
G	2015	**3**
ES	2015	**2**

Sources: FTSE/Russell, MSCI, and S&PDJI.

Each firm offers at least two ESG indexes and at least five E indexes. MSCI and S&PDJI also offer specialized S indexes, G indexes, and indexes that combine ES factors.

Nearly half (19) of today's 42 distinct sustainability index approaches fall in the Environmental category. Many of the environmental indexes focus on reducing exposure to carbon emissions or to carbon reserves. Some incorporate reducing carbon exposure and increasing green exposure. The FTSE Green Revenues index concentrates solely on increasing green revenues. The underlying concept is that green revenues are being generated by very large companies, including publicly listed companies, that often have wide-ranging product lines in addition to green revenues, even oil and gas companies. For example, Valero, an energy oil and gas refining company, generated 3.7% of its operating revenue ($3.5 billion) from ethanol biofuel in 2017. Environmental indexes also capture specific submarkets, such as S&PDJI's Global Water and Global Clean Energy.

The 13 sustainability indexes that include ESG factors make them second most common among those currently available through FTSE/Russell, MSCI and S&PDJI. Sustainability indexes that concentrate on individual S, G, or ES concerns comprise the remaining 10 sustainability indexes from these three index providers.

The chart below summarizes the primary objectives and associated financial expectations of sustainability indexes, outlines the construction approaches being used today, and details the general shareholder voting rights and engagement implications of different construction techniques.

Primary Objectives and Construction Implications of ESG Indexes			
	Primary Objective		
	Integrate	**Values**	**Impact**
Construction Approach	Incorporate ESG criteria to enhance long-term return and/or manage ESG financial risk compared to parent index	Align with investor ethical/social/political values	Seek to generate measurable social or environmental benefits and meet or exceed financial returns of parent index
Typical Sustainability Index License Fees			
	Pay a few basis points more than for parent index (more for more complex construction)		
ESG Characteristics			
Exclude	Give up shareholder voting rights and engagement at companies with ESG concerns Portfolio diversification reduced		
Select	Retain shareholder rights and engagement on leaders within theme Portfolio diversification reduced to specific theme		
Reweight	Retain shareholder voting rights and engagement Portfolio diversification reweighted by ESG factor/s		
Matching Parent Index Characteristics			
Optimize	Keep tracking error low		
Maintain	Match parent index industry, country, and/or size weights		
Resulting Financial Expectations	Gross of index license fees, seek higher return, and/or lower risk than parent index; if optimized, meet parent index return and risk, gross of license fees	Potential for lower return and/or higher risk than parent index	Gross of index license fees, meet parent index return and risk

Using this framework, we identify the primary objective and construction approach of sustainability indexes as shown in the table on the following page (see Appendix II for summary of each index).

Primary Objectives of ESG Indexes					
		Primary Objective			Keep Vote to Improve ESG
Index ESG Category and Name	**Construction Approach**	**Integrate**	**Values**	**Impact**	
Total Number of ESG Index Series		**14**	**17**	**11**	
FTSE/Russell					
ESG-ESG	Reweight, Maintain	✓			Yes
ESG-4Good	Exclude, Select		✓		-
E-ex-Fossil Fuel	Exclude		✓		-
E-ex-Coal	Exclude		✓		-
E-Environmental Opportunities	Select			✓	-
E-Divest Invest	Exclude, Select, Reweight			✓	-
E-Green Revenues	Reweight, Maintain			✓	Yes
E-Climate	Reweight, Maintain			✓	Many
MSCI					
ESG-ESG Universal	Exclude, Reweight, Maintain	✓			Many
ESG-ESG Leaders	Select, Maintain	✓			
ESG-ESG Focus	Exclude, Reweight, Optimize	✓			-
ESG-ESG Select	Exclude, Select, Optimize	✓			-
E-Low Carbon Leaders	Exclude, Optimize	✓			-
E-Low Carbon Target	Reweight, Optimize	✓			Many
G-Governance Quality	Reweight	✓			Yes
ESG-SRI	Exclude		✓		-
ESG-KLD 400 Social	Exclude		✓		-
E-ex-Fossil Fuel	Exclude		✓		-
E-ex-Coal	Exclude		✓		-
S-ex-Controversial Weapons	Exclude		✓		-
S-Catholic Values	Exclude		✓		-
S-Islamic	Exclude		✓		-
ES-Sustainable Impact	Select			✓	-
E-Global Environment	Select			✓	-
G-Women's Leadership	Select			✓	-
S&PDJI					
ESG-ESG Factor weighted	Reweight, Maintain	✓			Yes
ESG-DJSI Diversified	Select, Maintain	✓			-
ESG-DJSI Diversified Select	Exclude, Select, Maintain	✓			-
G-LTVC Global	Select	✓			-
S-CAPEX & Human Capital	Select	✓			-
E-Carbon Efficient	Reweight, Maintain	✓			Yes
ESG-DJSI	Select		✓		-
ESG-DJSI ex-'sin' stocks	Exclude		✓		-
E-Fossil Fuel Free	Exclude		✓		-
E-Fossil Fuel Free Carbon Efficient	Exclude, Reweight, Maintain		✓		-
E-Fossil Fuel Free Carbon Effect Select	Exclude, Optimize		✓		-
E-Climate Change Low Vol. High Div.	Select		✓		-
S-Catholic Values	Exclude, Maintain		✓		-
E-Carbon Efficient Select	Exclude, Optimize			✓	-
E-Global Water	Select			✓	-
E-Global Clean Energy	Select			✓	-
ES-Environment & Socially Responsible	Exclude, Select			✓	-

Sources: FTSE/Russell, MSCI, and S&PDJI.

Financial results are considered in the design of 25 of the 42 sustainability index series. We found that, together, FTSE/Russell, MSCI, and S&PDJI offer 14 index series designed to outperform financial risk/return of the parent index (integrate), 11 index series designed to reflect values and achieve risk/return of the parent index (impact), and 17 index series designed to reflect values without explicit consideration of financial results (values).

Index construction techniques also impact shareholder voting and engagement. In contrast to reweighting, when indexes exclude companies to remove exposure to an ESG concern, investors lose the ability to influence the company as a shareholder. For indexes that exclude companies where shareholder engagement and voting is deemed unable or highly unlikely to change the ESG issue, losing voting rights would be of less concern. Selection is often employed in sustainability theme-based portfolios to deliberately select high performers. These indexes typically restrict the portfolio to a minor portion of the parent universe, such as the MSCI Women's Leadership index. Such indexes are typically most appropriate outside an investor's core equity portfolio, thus, leaving the institutional investor with exposure and shareholder rights to underperforming companies in their core portfolio.

Most Integrate indexes are constructed to maintain or optimize results compared to the parent index. Eleven of the 14 integrate-oriented indexes employ either maintain (seven indexes) or optimize (four indexes) construction techniques in relation to the parent index. The three integrate sustainability indexes that do not use a maintain or optimize technique in their construction, combine S or G factors with other financial-oriented metrics to reweight or select stocks. For example, MSCI's Governance Quality index reweights using G factors and traditional financial quality metrics. S&PDJI's Long Term Value Creation ("LTVC") index selects stocks that rank high on RobecoSAM's economic dimension scores and on S&PDJI's financial quality scores. S&PDJI's Capex and Human Capital index selects stocks that are proactively making investments in physical and human capital, using RobecoSAM's human capital score, capital expenditures (capex) revenue effect, and capex R&D growth.

Values-oriented indexes are typically constructed by excluding securities that conflict with the social or ethical values being sought. Fifteen of the 17 values-oriented sustainability indexes are constructed using exclusion, and two employ selection as the sole construction approach. Eleven of these 15 values sustainability indexes use exclusion as the sole construction approach. Three S&PDJI values indexes exclude securities and employ either a maintain or optimize technique. The S&PDJI Catholic Values index, maintains the sector weights of the parent index. Two S&PDJI E indexes are categorized as values indexes because the construction approach begins by excluding fossil fuels, irrespective of financial analysis. The Fossil Fuel Free Carbon Efficient index maintains industry characteristics of the parent, and the Fossil Fuel Free Carbon Efficient Select index is optimized to keep a low tracking error to the parent index.

Impact indexes often rely on selection in the construction approach. Seven of the 11 impact-oriented indexes are constructed by selecting securities based on sustainability criteria, of which six rely on selection as the sole construction method. Most of these indexes define a strong ESG theme-based, relatively narrowed portfolio, such as S&PDJI's Global Water and Global Clean Energy, MSCI's Global Sustainability and Women's Leadership, and FTSE's Environmental Opportunities and Divest Invest 200. Two FTSE impact-oriented indexes reweight securities and maintain parent index characteristics – the FTSE Green Revenues and Climate Change indexes.

Comparability over time may be a challenge. In our opinion, sustainability index rule adjustments (e.g., defining materiality; refining E, S, and G metrics; adjusting weights of E, S, G factors; introducing new measures, such as ESG momentum), data quality improvements, growing standardized reporting, a growing focus on materiality in reporting (e.g., as codified, for example, by the Sustainable Accounting Standards Board ("SASB")), regulatory changes, and use of today's infant technologies (such as blockchain to gain accuracy, speed, and reduce expense of data gathering) are increasing the fit of sustainability indexes with institutional investor goals. We believe ESG metrics have become mainstream in the global institutional investor market. However, in our opinion, this field is still developing. We anticipate constraints to detailed comparability of sustainability indexes over time.

There are more sustainability index variants to come. We expect new sustainability indexes to be developed. This may include additional indexes that reduce climate risk exposure (such as reducing carbon exposure) and simultaneously increase climate opportunity (such as increasing green revenues exposure). It may also include new indexes that concentrate on investments in-line with the UN SDGs (Appendix I) as exemplified by S&PDJI's recent announcement of forthcoming SDG-lens indexes.

Return and Risk (Annualized 5-Year Trailing Ending March 30, 2018)

For this review, we investigated the financial and ESG performance of 12 sustainability indexes (four from each provider) compared to a parent index. From each firm, we reviewed an ESG index, an ex-fossil fuel index, a low carbon index, and one additional index from each, as shown below. These 12 indexes include a mixture of integrate, values, and impact primary goals, and a variety of construction methods. The parent indexes are the FTSE Developed, MSCI World, and the S&P 500. We note that the performance history reviewed here is limited. The five-year trailing performance ending March 20, 2018 includes no significant recession or down market in the U.S. or global developed markets.

Primary Objectives of Sustainability Indexes		
Index ESG Category and Name	**Construction Approach**	**Primary Objective**
FTSE Developed		
ESG-4Good	Exclude, Select	Values
E-ex-Fossil Fuel	Exclude	Values
E-Divest Invest 200	Exclude, Select, Reweight	Impact
E-Green Revenues	Reweight, Maintain	Impact
MSCI World		
ESG-ESG Leaders	Select, Maintain	Integrate
E-Low Carbon Target	Reweight, Optimize	Integrate
E-ex-Fossil Fuel	Exclude	Values
G-Women's Leadership	Select	Impact
S&P 500		
ESG-ESG Factor weighted	Reweight, Maintain	Integrate
E-Fossil Fuel Free	Exclude	Values
E-Carbon Efficient	Reweight, Maintain	Integrate
E-Fossil Fuel Free Carbon Efficient	Exclude, Reweight, Maintain	Values

Sources: FTSE/Russell, MSCI, and S&PDJI.

Eight of the 12 sustainability indexes outperformed parent gross return; six outperformed risk-adjusted return. As shown in the table on the following page, for the trailing five-year period ending March 30, 2018, eight of these 12 sustainability indexes generated higher returns, gross of license fees, than their parent index and four reported lower risk (standard deviation). Six of these sustainability indexes outperformed the parent index on risk-adjusted return (return/risk). See Appendix III for one-, three-, and five-year results.

Energy market dynamics outweighed index primary goals and index construction methods for this five-year period. The S&PDJI ESG Factor Weighted index was the one sustainability index looked at that outperformed its parent index and did not exclude fossil fuels. The other five of the six sustainability indexes that outperformed on risk-adjusted return exclude fossil fuels. The outperformance was regardless of whether the parent index was confined to a U.S. large cap universe – the S&P 500 – or spanned the global developed markets – the FTSE Developed or the MSCI World universe. Four of the six indexes that outperformed are values ("V") oriented and are constructed including exclusions independent of financial performance. This includes the three ex-fossil fuel indexes, and S&PDJI's Fossil Fuel Free Carbon Efficient index. In addition, FTSE's Divest Invest outperformed. This index has impact ("I") as its primary goal. The FTSE Divest Invest excludes the oil and gas sector, among other exclusions, and invests in green securities. For this period, indexes we reviewed that are constructed based on carbon emissions – MSCI's Low Carbon Target and S&PDJI's Carbon Efficient – slightly underperformed their parent indexes.

Sustainability Indexes Annualized Risk Return Statistics (Five-Years Ending March 30, 2018)									
Name of Index (Primary Goal)	**Tracking Error**	**No. of Firms**	**Average Mkt Cap ($Billions)**	**Return***	**Risk**	**Return/ Risk**	**Sharpe Ratio**	**Max Drdwn**	**Retain Voting Rights to Improve Market**
FTSE DEVELOPED	**0.00%**	**2141**	**$19.0**	**10.37%**	**10.10%**	**102.7%**	**0.99**	**-12.05%**	
4Good (V)	1.40%	878	26.8	10.33%	10.46%	98.8%	0.96	-12.67%	-
ex-Fossil Fuels (V)	0.90%	2051	10.6	11.07%	10.02%	110.5%	1.06	-10.92%	-
Green Revenues (I)	0.10%	2141	19.0	10.34%	10.09%	102.5%	0.99	-11.74%	Yes
Divest Invest 200 (I)	1.90%	205	70.1	11.95%	10.19%	117.3%	1.12	-9.57%	Many
MSCI WORLD	**0.00%**	**1,649**	**$24.1**	**9.70%**	**10.19%**	**95.2%**	**0.91**	**-17.95%**	
ESG Leaders (In)**	0.75%	805	24.3	9.20%	10.00%	92.0%	0.88	-17.26%	-
ex-Fossil Fuels (V)	0.94%	1,577	23.7	10.58%	10.12%	104.5%	1.00	-16.74%	-
Low Carbon Target (In)	0.40%	1,277	27.3	9.72%	10.22%	95.1%	0.91	-17.93%	Many
Women' s Leadership (I)	1.98%*	570	36.0	13.7*	7.97*	171.9%*	1.50*	-8.53	-
S&P 500	**0.00%**	**505**	**$46.7**	**13.31%**	**9.87%**	**134.9%**	**NA**	**-8.66%**	
ESG Factor Weighted (In)	2.22%	501	47.0	13.71%	10.10%	135.7%	NA	-10.97%	Yes
Fossil Fuel Free (V)	0.85%	478	47.0	14.30%	9.91%	144.3%	NA	-8.37%	-
Carbon Efficient (In)	0.82%	500	47.1	13.40%	10.10%	132.7%	NA	-8.66%	Yes
Fossil Fuel Free Crbn Effnt (V)	0.90%	477	47.1	14.42%	10.05%	143.5%	NA	-8.59%	-

Sources: FTSE/Russell, MSCI, and S&PDJI. Green highlight indicates outperformance of parent index; yellow highlight marks underperformance of parent index; no highlight indicates results equal parent index.
**Since May 31, 2016 to March 30, 2018. For this period, the MSCI World return was 14.25%, the Sharpe Ratio was 1.72, and the Max Drawdown was -9.15%.*
***In = Integrate.*

ESG indexes generated gross return and risk-adjusted return mixed results compared to parent indexes. The S&P 500 ESG Factor Weighted index includes all but four of the total 505 securities in the S&P 500 index. For this five-year period, this ESG index outperformed on gross return and, despite slightly higher risk, generated a risk-adjusted return above the S&P 500. For this period, both ESG indexes with a global developed market parent – the FTSE4Good (values primary goal) and the MSCI World ESG (integrate primary goal) – slightly underperformed their respective parent index. In contrast to the S&PDJI ESG Factor Weighted index, these FTSE and MSCI indexes are constructed by selecting strong ESG stocks, such that the number of securities in the ESG index is narrowed to less than half of the parent index.

Although the MSCI World ESG Leaders index risk was lower than the parent index, risk was not sufficiently reduced to outweigh the modest underperformance to produce a higher risk-adjusted return than the parent index for this period. Time frame and parent universe matter. For example, MSCI's recent review, "*Foundations of ESG Investing Part 3: Integrating ESG into Passive Institutional Portfolios,*" found that between August 31, 2010 and December 31, 2017 the MSCI All Country World Index ("ACWI") ESG Leaders and MSCI ACWI ex-US ESG Leaders indexes narrowly outperformed their MSCI ACWI parent indexes on return, risk, and return/risk, while the MSCI US ESG Leaders index slightly underperformed on return and return/risk, despite a modestly lower risk. MSCI found that the US ESG Leaders underperformance was largely due to a handful of strong tech stocks being excluded due to below-average ESG ratings (including Apple Inc., Facebook Inc., and Amazon.com Inc.) during a strong technology market.

For additional perspective on whether the difference in ESG performance primarily reflected the difference in underlying universes – the S&P 500 large cap U.S. universe compared to the FTSE and MSCI World developed market universes – we looked at the S&P 1200 ESG Factor Weighted index. For this period, the ESG index design also outperformed the parent index. As shown in the table on the following page, for this trailing five-year period, the S&P 1200 ESG Factor Weighted index outperformed on gross of license fee returns and incurred slightly higher risk than its parent index to generate an overall higher risk-adjusted return than the parent S&P 1200 index.

Sustainability Indexes
Annualized Risk Return Statistics
(Five-Year Period Ending March 30, 2018)

Name of Index (Primary Goal)	Tracking Error	No. of Firms	Return	Risk	Return/ Risk
MSCI WORLD	**0.00%**	**1,649**	**9.70%**	**10.19%**	**95.2%**
ESG Leaders (In)	0.75%	805	9.20%	10.00%	92.0%
ESG Universal (In)	0.73%	1617	9.76%	10.27%	95.0%
S&P 500	**0.00%**	**505**	**13.31%**	**9.87%**	**134.9%**
S&P 500 ESG Factor Weighted (In)	2.22%	501	13.71%	10.10%	135.7%
S&P 1200	0.00%	1221	9.96%	10.10%	0.99
S&P 1200 ESG Factor Weighted (In)	2.20%	1204	10.73%	10.36	1.03%

Sources: FTSE/Russell, MSCI, and S&PDJI.

The financial performance results for MSCI World ESG Leaders compared to the MSCI World ESG Universal illustrates how construction can affect financial results. A key construction approach difference between these two indexes is that the MSCI ESG Universal retained all but 32 of the MSCI World's 1,649 constituents, whereas the ESG Leaders narrows the MSCI World by roughly half. The MSCI ESG Universal excludes the worst ESG rated companies, then reweights by ESG, and maintains parent industry and country weightings. MSCI ESG Leaders selects high performing ESG companies and maintains parent index characteristics. For this period, the MSCI ESG Universal slightly outperformed the MSCI World return based on modest additional risk to bring the risk adjusted return to 95.0%, nearly equal to the MSCI World's 95.2% and above the MSCI ESG Leaders 92.0% risk adjusted return.

Sustainability indexes that were designed to generate performance near parent index performance succeeded. The FTSE Green Revenues (impact) and the MSCI Low Carbon Target (integrate) both matched their parent index Sharpe Ratios and underperformed their parent return/risk measures by a de minimis amount. The FTSE Green Revenues index retains all the securities of the parent index and adjusts to overweight companies with green revenues. MSCI's Low Carbon Target index is optimized to keep its tracking error low. For this period, these two indexes show the lowest tracking error among the 12 sustainability indexes presented above: 0.10% for the FTSE Green Revenues index, and 0.40% for the MSCI Low Carbon Target index.

The MSCI Women's Leadership Index is categorized as having impact as its primary goal. This index selects securities based on the degree of women's leadership in the company. As of March 30, 2018, the index represented 570 securities (less than one-third of the securities in the parent MSCI World index) with an average market capitalization of $36 billion (1.5 times that of the parent index). The Women's Leadership index data extends back to May 31, 2016. Since inception through March 30, 2018, the Women's Leadership index generated slightly lower gross of index fee returns and risk-adjusted returns than the MSCI World parent index, but registered a lower maximum drawdown than the parent index.

ESG Scores

This section explores the overall ESG scores from MSCI and from RobecoSAM for each of the 12 sustainability indexes, compared to their respective parents. MSCI and RobecoSAM ESG scores incorporate individual E, S, and G scores. Please note that each index provider uses its own ESG scores to develop its sustainability indexes. MSCI scores are only used by MSCI. S&PDJI incorporates RobecoSAM ESG scores, which are not used by FTSE/Russell or MSCI. FTSE/Russell generates its own internal ESG rankings and incorporates Sustainalytics ESG research. Comparing two sets of ESG scores for each index provider allows some perspective on how the data construction may or may not be reflected across two distinct ESG scoring systems. For this report, we only had MSCI's data available for individual E, S, and G scores.

For perspective, the MSCI ESG constituent scores can range from 0 to 10. For the 1,649 constituents of the MSCI World index, they ranged from 0.8 to 8.8. Similarly, the RobecoSAM constituent scores can range from 0 to 100. The 505 constituents of the S&P 500 index ranged from 25.0 to 89.5.

MSCI and RobecoSAM ESG scores produce similar but not identical index rankings. We found for the indexes reviewed here, that the ESG scores from MSCI and RobecoSAM, both kept within a narrow middle range of the possible ESG scores from each vendor. As shown below, RobecoSAM scores for these 15 indexes ranged from 57.9 to 64.4. MSCI's scores ranged from 5.0 to 6.6.

Sustainability Indexes ESG Statistics (May 31, 2017)				
Name of Index	No. of Firms	5-Year Annualized Return/ Risk (%)	MSCI ESG Score	RobecoSAM ESG Score
FTSE Developed	**2141**	**102.7**	**5.5**	**62.6**
4Good	878	98.8	6.1	62.5
ex-Fossil Fuels	2051	110.5	5.5	62.5
Green Revenues	2141	102.5	5.5	62.6
Divest Invest 200	205	117.3	5.6	64.2
MSCI WORLD	**1,649**	**95.2**	**5.5**	**62.6**
ESG Leaders	805	92.0	6.6	64.4
ex-Fossil Fuels	1,577	104.5	5.6	62.5
Low Carbon Target	1,277	95.1	5.6	62.6
Women's Leadership	570	-	6.0	62.5
S&P 500	**505**	**134.9**	**5.0**	**58.6**
ESG Factor Weighted	501	135.7	5.0	59.6
Fossil Fuel Free	478	144.3	5.0	58.6
Carbon Efficient	500	132.7	5.0	57.9
Fossil Fuel Free Carbon Efficient	477	143.5	5.1	57.9

Sources: FTSE/Russell, MSCI, and S&PDJI.
**Periods ending March 30, 2018.*

We observed some differences in ranking among these indexes by MSCI and RobecoSAM ESG scores. For example, as shown in the table on the following page, the FTSE Developed 4Good Index is ranked by MSCI with the highest ESG score among the FTSE indexes reviewed (6.1 compared to the parent index low of 5.5). In contrast, among the FTSE indexes reviewed, the RobecoSAM ESG score for the FTSE

Developed 4Good index shares the lowest rank with the FTSE ex-Fossil Fuels index (62.5). For this period, the FTSE Developed Divest Invest 200 achieved the highest RobecoSAM ESG rating among these FTSE Developed indexes (64.2). In our opinion, ESG ratings are still relatively new to the market, still undergoing development, and still require industry-wide discussion and analysis regarding how best to capture material ESG risks and opportunities. We expect to continue to see such relatively minor differences on ratings of broad market indexes between ESG rating vendors.

The six sustainability indexes that generated a higher risk adjusted return than their parent either matched or exceeded their parent ESG score from one or both MSCI and RobecoSAM. The FTSE Divest Invest 200 exceeded both MSCI and RobecoSAM ESG scores. The MSCI ex-Fossil Fuels and S&PDJI Fossil Fuel Free Carbon Efficient narrowly surpassed the MSCI ESG score of their respective parent index. The S&PDJI ESG Factor Weighted exceeded the RobecoSAM ESG score and matched MSCI's ESG score for the parent index. The S&PDJI Fossil Fuel Free index matched its parent ESG scores from both vendors. The FTSE ex-Fossil Fuels index matched the MSCI ESG Score and slightly underperformed RobecoSAM's ESG score for its parent index.

ESG index ESG scores generally outperformed parent and other sustainability index ESG scores. The FTSE and MSCI ESG indexes registered the highest MSCI ESG scores compared to their respective benchmarks. Using the RobecoSAM ESG scoring, the MSCI ESG Leaders index also registered the highest score among the 15 indexes reviewed here. The FTSE4Good index's RobecoSAM ESG score was just shy that of the FTSE Developed — 62.5 versus 62.6. Based on RobecoSAM ESG scores, the ESG Factor Weighted index generated an ESG score above the S&P 500 and above the three S&P 500 climate related indexes reviewed here. The S&P 500 ESG Factor Weighted MSCI ESG score matched that of the S&P 500's 5.0 score. The difference in S&PDJI ESG Factor Weighted index relative scores by MSCI and RobecoSAM may reflect S&PDJI's use of RobecoSAM's ESG data in index construction.

E, S, and G Individual Ratings

Below, we report the individual MSCI E, S, and G scores, along with the total ESG score for each of the 15 indexes. Like the overall ESG scores, the MSCI individual E, S, and G scores for these 15 indexes cluster in the mid-range of the possible scores.

Sustainability Indexes MSCI E, S, and G Scores (May 31, 2017)						
Name of Index	No. of Firms	5-Year Annualized Return/ Risk (%)	ESG Score	E Score	S Score	G Score
FTSE Developed	**2141**	**102.7**	**5.5**	**5.5**	**4.4**	**4.9**
4Good	878	98.8	6.1	6.1	4.7	4.9
ex-Fossil Fuels	2051	110.5	5.5	5.8	4.4	4.9
Green Revenues	2141	102.5	5.5	5.5	4.4	4.9
Divest Invest 200	205	117.3	5.6	6.1	4.3	4.7
MSCI World	**1,649**	**95.2**	**5.5**	**5.5**	**4.4**	**4.9**
MSCI World Highest Constituent Score	1,649		8.8	10.0	10.0	9.5
MSCI World Lowest Constituent Score	1,649		0.8	0.0	0.0	0.0
ESG	805	92.0	6.6	6.1	4.9	5.3
ex-Fossil Fuels	1,577	104.5	5.6	5.8	4.4	4.9
Low Carbon Target	1,277	95.1	5.6	5.7	4.5	4.9
Women's Leadership	570	-	6.0	5.5	4.6	5.4
S&P 500	**505**	**134.9**	**5.0**	**5.4**	**4.2**	**4.6**
ESG Factor Weighted	501	135.7	5.0	5.1	4.3	4.9
Fossil Fuel Free	478	144.3	5.0	5.7	4.1	4.6
Carbon Efficient	500	132.7	5.0	5.5	4.2	4.7
Fossil Fuel Free Carbon Efficient	477	143.5	5.1	5.7	4.2	4.7

Sources: FTSE/Russell, MSCI, and S&PDJI.

Each ESG index scored above its parent index on at least two of three MSCI E, S, and G scores. The FTSE Developed 4Good registered higher E and S scores as well as a G score equal to the FTSE Developed parent index. The MSCI ESG index outperformed the parent MSCI World on all three of MSCI's E, S, and G ratings. The S&P 500 ESG Factor Weighted Index generated higher MSCI S and G score and a lower MSCI E score than the parent S&P 500 index. As mentioned above, FTSE/Russell and S&PDJI rely on their own internal ESG data and that of vendors such as Sustainalytics and RobecoSAM to create their sustainability indexes. Thus, the E, S, and G scores and data FTSE/Russell and S&PDJI use to develop these indexes may differ from MSCI's individual E, S, and G ratings.

Outperformance on ESG scores does not always reflect outperformance on individual E, S, and G scores. These results reflect the concentration on one or more E, S, or G areas in the construction of indexes not specifically designed to improve combined ESG results. For example, the FTSE Developed Divest Invest 200 index focuses on climate change issues and narrowly outperformed the ESG score of the FTSE Developed (ESG score of 5.6 versus 5.5). This overall score reflected a high MSCI E score (6.1 versus the parent score of 5.5), while the MSCI S and G scores were slightly below the parent index.

Each E index scored above its parent index on MSCI's E scores, except the FTSE Green Revenues, which matched the parent index on all E, S, and G scores. The Green Revenues index tilts modestly toward companies large and small with green revenues but does not exclude any high carbon reserves or emissions companies. Today's E ratings tend to focus on company exposure to high carbon reserves and emissions that may be identified as material risks in some industries and not necessarily green revenue material opportunities.

The MSCI Women's Leadership overall MSCI ESG score was higher than the parent MSCI World. This score reflected a higher MSCI S and G score than the MSCI World, with an E score that matched the MSCI World.

Environmental Metrics

In this section, we examine environmental statistics for each index. The table below includes the MSCI E score, the FTSE green revenues exposure metric, MSCI and S&PDJI-Trucost's measures of carbon emissions per million USD invested, and S&PDJI-Trucost's carbon reserves measure of embedded emissions per million USD revenues.

Two indexes generated better 5-year annualized risk adjusted returns and improved every E metric compared to their parent indexes. Compared to their parent indexes, the FTSE Developed Divest Invest 200 and MSCI World ex-Fossil Fuels each show higher E scores, better results on each carbon and green metric, and higher risk adjusted returns.

Eleven of the 12 sustainability indexes' recorded E scores were equal to or higher than their parent indexes. Every sustainability index reviewed here, except the S&P 500 ESG Factor Weighted index, had an MSCI E score equal to or higher than its respective parent index. The S&P 500 ESG Factor Weighted index reported a worse MSCI E score as well as worse carbon and green revenue measures across the board compared to the S&P 500 parent index, while matching MSCI's overall ESG score for the parent index. ESG indexes are not generally geared toward improving one individual E, S, or G element over the combined ESG score.

Sustainability Indexes
Environmental Metrics
(May 31, 2017)

Name of Index	No. of Firms	5-Year Annualized Return/ Risk (%)	MSCI E Score	FTSE Green Revenues Exposure	MSCI Carbon Intensity: Tons CO2 Emissions /mm USD Invested	S&PDJI Carbon Intensity: Tons CO2 Emissions/ mm USD Invested	S&PDJI Carbon Reserves Intensity: Tons CO2 Embedded Emissions/mm USD Revenue*
FTSE Developed	**2141**	**102.7**	**5.5**	**1.52**	**141.8**	**191.2**	**5634.14**
4Good	878	98.8	6.1	1.36	80.5	121.8	6592.44
ex-Fossil Fuels	2051	110..5	5.8	1.61	145.8	160.8	0.08
Green Revenues	2141	102.5	5.5	2.28	120.2	194.4	5567.82
Divest Invest 200	205	117.3	6.1	9.48	56.2	73.7	67.08
MSCI WORLD	**1,649**	**95.2**	**5.5**	**1.48**	**129.9**	**177.9**	**6002.29**
ESG	805	92.0	6.1	1.63	102.2	140.1	5967.23
ex-Fossil Fuels	1,577	104.5	5.8	1.51	103.2	146.0	152.50
Low Carbon Target	1,277	95.1	5.7	1.78	32.8	62.5	611.65
Women's Leadership	570	-	5.5	1.92	132.6	174.5	4237.51
S&P 500	**505**	**134.9**	**5.4**	**1.11**	**103.5**	**132.1**	**2701.98**
ESG Factor Weighted	501	135.7	5.1	1.05	158.0	188.0	3049.68
Fossil Fuel Free	478	144.3	5.7	1.10	84.0	110.8	0.00
Carbon Efficient	500	132.7	5.5	1.05	68.9	91.6	2238.82
FF Free Crbn Efficient	477	143.5	5.7	1.00	50.9	71.4	0.00

Sources: FTSE/Russell, MSCI, and S&PDJI.
**The carbon reserves metrics are as of May 2018.*

Indexes with an E score equal or higher than their parent index generally had better carbon and green metrics than their parent. For the most part, the 11 sustainability indexes with an equal or higher MSCI E score than their respective parent index also generated better carbon and green revenue metrics than the parent index. Three exceptions were:

- The S&P 500 carbon related indexes all scored lower than the S&P 500 on the FTSE green revenues exposure measure.

- The FTSE Developed 4Good Index scored higher than the FTSE Developed on MSCI's E score and on carbon emissions but worse than the parent index on the FTSE green revenues exposure and on S&PDJI carbon reserves measures.

- The FTSE ex-Fossil Fuels, FTSE Green Revenues, and the MSCI Women's Leadership indexes each scored above their respective parent index on MSCI's or S&PDJI's carbon emissions intensity metric but scored marginally below their parent index on the other carbon intensity measure. For example, The FTSE ex-Fossil Fuels index registered an MSCI carbon intensity of 145.8; just higher than the parent's 141.8, and an S&PDJI carbon intensity measure of 160.8 improved over the parent's result of 191.2.

The MSCI ex-Fossil Fuels carbon reserves metric seems inconsistent without additional explanation. Why does MSCI's ex-Fossil Fuel index show fossil fuel reserves intensity of 153.50 rather than zero or near zero fossil fuel reserves as might be expected from the index name? The reason is that S&PDJI's definition of fossil fuels reflects all carbon reserves, including reserves that are not used for energy application. For instance, companies holding metallurgical coal reserves (used for iron and steel production rather than energy) are included in S&PDJI's carbon intensity measure. Both FTSE and S&PDJI construct their ex-fossil fuel indexes based on this comprehensive definition of carbon reserves. In contrast, MSCI excludes only companies that have proved and probable coal reserves and/or oil and natural gas reserves used for energy purposes. Thus, the MSCI ex-Fossil Fuel index includes exposure to the few companies that have metallurgical fossil fuel reserves but no thermal fossil fuel reserves.

Exposure to Civilian Firearms Producers and Retailers

The rising public concern in the United States over mass shootings is raising questions by institutional investors of how effectively engagement and proxy voting can reduce the sales of weapons to civilians and especially young people, particularly automatic and semi-automatic weapons. We find institutional investors increasingly questioning the extent of their exposure to both producers and retailers of civilian firearms. As examples, we investigated the civilian weapons exposure of the FTSE Developed (the widest number of companies among the three parent indexes reviewed, representing large and mid-cap stocks) and the S&P 500 (the smallest number of companies among the parent indexes reviewed here, representing large cap stocks) compared to the respective sustainability indexes for which this report is investigating financial and ESG performance.

As shown in the table below, we found that, overall, the exposure to civilian firearms producers and retailers was small for the FTSE Developed and the S&P 500, using MSCI's definition of civilian firearms producers and retailers. We further found that indexes designed to look at overall ESG metrics reduced exposure to civilian firearms producers and retailers compared to the parent index even though these ESG index designs do not negatively weight companies with civilian weapons in the definitions of strong ESG companies. In contrast, low carbon and ex-fossil fuel index company exposures to civilian weapon retailers were mixed. Since the constituent securities in these indexes are reweighted away from fossil fuel companies, the weight of civilian weapons retailers may increase, as was the case for the three S&PDJI carbon related indexes as well as the FTSE Green Revenues and Divest Invest 200 indexes.

Sustainability Indexes
Civilian Firearms Producers and Retailers Exposure Examples (March 31, 2018)

				Number of Companies (#) and Market cap weight (Wgt%) of Civilian Firearms					
				Producers		Retailers		Producers and Retailers	
Name of Index	**No. of Firms**	**5-Year Annualized Return/ Risk (%)**	**ESG Score**	**#**	**Wgt**	**#**	**Wgt**	**#**	**Wgt**
FTSE Developed	**2141**	**102.7**	**5.5**	**2**	**0.0129**	**2**	**0.365**	**4**	**0.378**
4Good	878	98.8	6.1	0	0	0	0	0	0
ex-Fossil Fuels	2051	110.5	5.5	2	0.0129	2	0.350	4	0.363
Green Revenues	2141	102.5	5.5	2	0.0124	2	0.357	4	0.369
Divest Invest 200	205	117.3	5.6	0	0	1	0.531	1	0.531
S&P 500	**505**	**134.9**	**5.0**	**0**	**0**	**2**	**0.67**		**0.67**
ESG Factor Weighted	501	135.7	5.0	0	0	2	0.18		0.18
Fossil Fuel Free	478	144.3	5.0	0	0	2	0.70		0.70
Carbon Efficient	500	132.7	5.0	0	0	2	0.76		0.76
Fossil Fuel Free Carbon Efficient	477	143.5	5.1	0	0	2	0.80		0.80

Sources: FTSE & S&PDJI civilian firearms exposures. MSCI definitions: the definition of firearms that is used may vary among providers. For this analysis, we used the MSCI ESG Research definitions of civilian firearms producers and retailers, which are typically defined separately from controversial weapons. These definitions are: ***Civilian Firearms Producer –*** *companies that manufacture firearms and small arms ammunitions for civilian markets. The research does not cover companies that cater to the military, government, and law enforcement markets.* ***Civilian Firearms Retailer –*** *companies that derive any amount of annual revenues from the distribution (wholesale or retail) of firearms or small arms ammunition intended for civilian use.* ***Civilian Firearms – Any Tie –*** *companies that have an industry tie to the manufacture or retail of civilian firearms.* ***Controversial Weapons*** *– companies involved with the production of cluster bombs, landmines, depleted uranium weapons, or chemical and biological weapons.*

For example, the FTSE Developed index includes two manufacturers and two retailers of civilian firearms. Combined, these four companies accounted for 0.4% of the market cap of the FTSE Developed. In comparison, the FTSE4Good and the Divest Invest 200 indexes have zero exposure to manufacturers and, respectively, have exposure to zero and one retailer/s of civilian weapons. Thus, while the FTSE4Good index is not designed to exclude civilian firearms, the criteria used to select strong ESG companies ended up eliminating civilian arms producers and retailers. In contrast, the Divest Invest 200 index weight of civilian firearms retailers increases compared to the parent index as the universe is narrowed to 205 of the 2141 FTSE Developed companies. The remaining companies are then reweighted (see Appendix II for details).

The S&P 500 contained no producers of civilian firearms, and thus, all the sustainability index variants have zero exposure to producers of civilian firearms. The S&P 500 included two retailers of civilian firearms, Walmart and The Kroger Co. Together, both multi-line large cap retailers accounted for 0.7% of the total S&P 500 market capitalization. Because S&PDJI takes an approach to the sustainability indexes reviewed here that primarily reweights (rather than excludes) securities, all the sustainability indexes examined here include both Walmart and The Kroger Co. However, in the ESG Factor Weighted Index, the civilian firearms market cap weight is reduced significantly to less than one-third of its S&P 500 weight, despite the index design that includes no criteria to underweight civilian firearms producers or retailers. In contrast, the weight of civilian firearms retailers in each of the three S&P 500 carbon-related indexes reviewed here increases slightly compared to the parent index, as constituent securities are reweighted away from fossil fuel reserves and carbon emissions.

Conclusion

The widening range of sustainability indexes presents new possibilities for passive equity investing to integrate financial impact and ESG issues. Passive sustainability equity investing may be accomplished with much lower fees than active management; however, sustainability index license fees are typically a few basis points above the parent index. Consideration of any specific sustainability index, either as part of a core equity portfolio or as a satellite holding, should carefully review the primary investment goals and how the index construction effects risk, return, diversification, shareholder voting and engagement, ESG exposure on the issues of concern, and index license fees.

The ESG indexes designed to integrate ESG metrics to enhance returns of the parent index that we reviewed did not always achieve that goal during the 5-year period reviewed, which included no significant recession or down market. We believe these results may reflect the continued modification of ESG index construction and, more generally, that overall ESG indexes, depending on construction method, may be similar to value or growth indexes – the factors being used may go in and out of favor in the market.

The outperformance of ex-fossil fuel indexes during the five-year period reviewed, in our opinion, highlights how broad macro factors may overwhelm any sustainability index design. The outperformance reflects recent pricing in oil and gas markets and may also have captured an element of the long-term energy transition away from dependence on fossil fuels that is currently underway.

Going forward, we anticipate both refinement of existing sustainability index approaches and the introduction of new indexes.

Appendix I: UN Sustainable Development Goals

The Sustainable Development Goals (SDGs) are a new, universal set of goals, targets, and indicators that UN member states will be expected to use to frame their agendas and political policies over the next 15 years. The 17 SDGs are listed below. Within the goals are 169 targets that put some specifics to these broad goals. The U.N. states that "responsible business and investment will be essential to achieving transformational change through the SDGs. For companies, successful implementation will strengthen the enabling environment for doing business and building markets around the world."

1. **No Poverty**. End poverty in all its forms everywhere.
2. **Zero Hunger.** End hunger, achieve food security and improved nutrition, and promote sustainable agriculture.
3. **Good Health and Well Being.** Ensure Healthy lives and promote well-being for all ages.
4. **Quality Education**. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.
5. **Gender Equality**. Achieve gender equality and empower all women and girls.
6. **Clean Water and Sanitation**. Ensure availability and sustainable management of water and sanitation for all.
7. **Affordable and Clean Energy**. Ensure access to affordable, reliable, sustainable, and modern energy for all.
8. **Decent Work and Economic Growth**. Promote sustained, inclusive, and sustainable economic growth; full and productive employment; and decent work for all.
9. **Industry, Innovation, and Infrastructure.** Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation.
10. **Reduced Inequality**. Reduce inequality within and among countries.
11. **Sustainable Cities and Communities**. Make cities and human settlements inclusive, safe, resilient, and sustainable.
12. **Responsible Production and Consumption**. Ensure sustainable consumption and production patterns.
13. **Climate Action**. Take urgent action to combat climate change and its impacts.
14. **Life Below Water**. Conserve and sustainably use the oceans, seas, and marine resources for sustainable development.
15. **Life on Land**. Protect, restore, and promote sustainable use of terrestrial ecosystems; sustainably manage forests; combat desertification; halt and reverse land degradation; and halt biodiversity loss.
16. **Peace and Justice Strong Institutions**. Promote peaceful and inclusive societies for sustainable development; provide access to justice for all; and build effective, accountable, and inclusive institutions at all levels.
17. **Partnerships for the Goals**. Strengthen the means of implementation and revitalize the global partnership for sustainable development.

Appendix II: ESG Indexes

This appendix provides summary descriptions of the indexes provided by FTSE/Russell, MSCI, and S&PDJI. The indexes are grouped by index provider, alphabetically – FTSE/Russell, MSCI, and S&PDJI. Within each set of index provider's information, their ESG indexes are grouped into three categories that highlight the broad primary objective for using ESG information to construct the index. These include:

Integrate – incorporate ESG criteria to enhance long-term return, and/or manage ESG financial risk

Values – align with investor ethical/social/political values

Impact – generate measurable social or environmental benefits and financial returns

The information for each index includes the index's E, S, and G segment; name; year launched; summary description; and summary construction approach.

FTSE/RUSSELL ESG INDEXES
INTEGRATE

FTSE ESG, 2017. The FTSE ESG index series is designed to help investors align investment and ESG objectives in a broad benchmark whilst maintaining industry neutrality. Company weights are "tilted" using FTSE/Russell's ESG Ratings. Subsequently, industry neutral re-weighting is applied so that the industry weights in each index match the underlying index universe. As a result, the FTSE ESG Indexes are expected to have risk/return characteristics similar to the underlying universe, with the added benefit of improved ESG metrics. Approach: reweight by ESG, maintaining industry and country weights of parent index.

E-FTSE Divest-Invest, 2016. The FTSE Divest-Invest index series is designed to incorporate a combination of rules-based strategies to reduce exposure to companies from certain ICB subsectors associated with a High Carbon Economy and obtain increased exposure to companies engaged in the transition to a Low Carbon Economy ("LCE"). Securities in the following sectors and subsectors of the Industrial Classification Benchmark ("ICB") System which are ineligible for inclusion: Oil & Gas Producers (ICB 0530); Oil Equipment, Services & Distribution (ICB 0570); Coal (ICB 1771); and General Mining (ICB 1775). Excluded companies are replaced, one by one, by the eligible company with the highest Low Carbon Economy Industrial Indicator ("LOWCII") factor until all removed companies are replaced. The constituent weights of replacement companies are calculated in proportion to their LOWCII factors and then scaled to replace the total weight of the excluded securities. The remaining constituents (i.e., non-replacement companies) are weighted by investable market capitalization. Approach: exclude by E, select by E, then reweight.

E-FTSE Green Revenues, 2016. The FTSE Green Revenues index series is designed to obtain increased exposure to companies engaged in the transition to a green economy, based on FTSE/Russell's Green Revenues data model. All constituents of the parent index are included. Constituent weights (where applicable) are based on each constituent's LOWCII factor. A company's LOWCII factor is defined as the ratio of revenues as classified by the Low Carbon Economy Industrial Classification System ("LCE ICS") to total revenues. Approach: reweight by ESG, maintaining industry and country weights of parent index.

E-FTSE Climate, 2017. The FTSE Climate index series is designed to hedge climate risks and gain exposure to upsides that climate change may bring to companies. This index series considers green revenues alongside carbon emissions and fossil fuel reserves. The index series methodology is designed to reflect the performance of a global and diversified basket of securities where their weights are varied to account for risks and opportunities associated with climate change. Approach: reweight by E, maintaining industry and country weights of parent index.

FTSE-ESG FTSE4Good, 2001. The FTSE4Good index series is designed to measure the performance of companies demonstrating strong ESG practices. The FTSE ESG Ratings are used as the core basis to determine the constituents of the FTSE4Good index. Each company in the research universe is given a FTSE ESG Rating ranging from 0 to 5, with 5 being the highest rating. Companies involved in tobacco and controversial weapons are excluded. Approach: exclude by ESG.

FTSE/RUSSELL ESG INDEXES

VALUES

FTSE ex-Fossil Fuels, 2014. This index series is a capitalization-weighted index designed to represent the performance of constituents of the parent index after the exclusion of companies that have a certain revenue and/or reserve exposure to oil, gas, and coal. A company is categorized as an Excluded Company if it satisfies the following conditions: (1) classified as in the ICB subsectors – Exploration & Production (Standard Industrial Code "SIC" 0533), Integrated Oil & Gas (0537), Coal Mining (SIC Code: 1771), and General Mining (SIC Code: 1775); and either have (2) revenues arising from Bituminous Coal and Lignite Surface Mining SIC Code: 1221), Bituminous Coal Underground Mining (SIC code: 1222), Anthracite Mining (SIC code: 1231), Crude Petroleum and Natural Gas (SIC code: 1311), and Natural Gas Liquids (SIC code: 1321) based on the companies' most recent published Annual Report and Accounts; or 93) proved and probable reserves in coal, oil, or gas based on the companies' most recent published Annual Report and Accounts. Approach: exclude.

FTSE ex-Coal, 2014. This index Series is a capitalization-weighted index designed to represent the performance of constituents of the parent index after the exclusion of companies that have a certain revenue and/or reserve exposure to coal. A company is categorized as an excluded company if it satisfies the following conditions: (1) classified as in the ICB subsectors – Coal Mining (1771) and General Mining (1775); and either have (2) revenues arising from Bituminous Coal and Lignite Surface Mining (SIC code: 1221), Bituminous Coal Underground Mining (SIC code: 1222), Anthracite Mining (SIC code: 1231); or (3) proved and probable reserves in coal based on the companies' most recent published Annual Report and Accounts. Approach: exclude.

E-FTSE Environmental Opportunities, 2018. The FTSE Environmental Opportunities All-Share index comprises all companies globally that have at least 20% of their business derived from environmental markets and technologies as defined by the FTSE Environmental Markets Classification System (EMCS). These include Renewable and Alternative Energy, Energy Efficiency; Water Infrastructure and Technology; Waste Management and Technologies; Pollution Control; Environmental Support Services; and Food, Agriculture and Forestry. Approach: select.

MSCI ESG INDEXES

INTEGRATE

ESG-MSCI ESG Universal, 2013. This index series is designed to increase the weightings of companies with robust ESG characteristics, including those that show improvement in the direction of their rating over the most recent 12 months, while reducing the weight of those companies who lag their industry peers in terms of ESG quality. Companies who are involved in controversial weapons and violations of international norms are ineligible for inclusion. Approach: exclude, reweight by ESG, maintain similar sector and country exposures to parent index.

ESG-MSCI ESG Leaders, 2013. The MSCI ESG Leaders index is designed to represent the performance of companies that have high Environmental, Social and Governance (ESG) performance. The MSCI ESG

Leaders indexes aim to target sector weights that reflect the relative sector weights of the underlying indexes to limit the systematic risk introduced by the ESG selection process. Overall the MSCI ESG Leaders indexes target coverage of 50% of the underlying MSCI parent index. Approach: select by ESG, maintain.

ESG-MSCI ESG Select, 2013. The MSCI ESG Select index is designed to maximize its exposure to positive environmental, social and governance (ESG) factors while exhibiting risk and return characteristics similar to those of the underlying market capitalization weighted index. The index is constructed by selecting constituents of a market capitalization weighted index through an optimization process that aims to maximize exposure to ESG factors for a target tracking error budget under certain constraints. The index is sector-diversified and targets companies with high ESG ratings in each sector. Tobacco and Controversial Weapons companies are not eligible for inclusion in the index. Approach: exclude, select by ESG, optimize for low tracking error.

ESG-MSCI ESG Focus, 2013. These indexes are designed to target companies with positive environmental, social and governance (ESG) factors while closely representing the risk and return characteristics of the underlying market. Each index is constructed through an optimization process that aims to maximize its exposure to ESG factors, subject to a target tracking error and other constraints. The indexes are sector-diversified and are designed to over-weight companies with high ESG ratings and under-weight companies with low ratings. Tobacco and Controversial Weapons companies are not eligible for inclusion. Approach: exclude, reweight by ESG, optimize for low tracking error.

E-MSCI Low Carbon Leaders, 2014. This index addresses two dimensions of carbon exposure – carbon emissions and fossil fuel reserves – providing clients with an effective tool for limiting the exposure of their portfolios to carbon risk. By excluding companies with the highest carbon emissions intensity and the largest owners of carbon reserves per dollar of market capitalization, the index aims to achieve at least 50% reduction in its carbon footprint. The index also aims to maintain wide and consistent market exposure by minimizing the tracking error relative to the MSCI ACWI Index. Approach: exclude by E, then optimize for low tracking error.

E-MSCI ACWI Low Carbon Target, 2014. This index is a benchmark for investors who wish to manage potential risks associated with the transition to a low carbon economy. The index aims for a tracking error target of 0.3% (30 basis points) while minimizing the carbon exposure. By overweighting companies with low carbon emissions (relative to sales) and those with low potential carbon emissions (per dollar of market capitalization), the index reflects a lower carbon exposure than that of the broad market. Approach: reweight by E, then optimize for low tracking error.

G-Governance-Quality, 2015. This index aims to reflect the performance of a strategy that is seeking to capture both the financial and corporate governance aspects of Quality investing. The financial aspects of the Quality factor are captured using the same fundamental data as used in the MSCI Quality Index – return on equity, financial leverage and earnings variability. The standard of corporate governance is captured through measures such as independence and diversity of board of directors, ownership and control structure of the company, accounting practices, and auditor opinions. Approach: reweight by G and quality.

MSCI ESG INDEXES

VALUES

ESG-MSCI KLD 400 Social, 1990. The MSCI KLD 400 Social index is a capitalization weighted index of 400 U.S. securities that provides exposure to companies with outstanding ESG ratings and excludes companies whose products have negative social or environmental impacts. This index is designed for investors seeking a diversified benchmark comprised of companies with strong sustainability profiles, while avoiding companies incompatible with values screens. Launched in May 1990 as the Domini 400 Social index, it is one of the first Socially Responsible Investment ("SRI") indexes. Approach: exclude.

ESG-MSCI SRI, 2014. This index is a capitalization weighted index that provides exposure to companies with outstanding ESG ratings and excludes companies whose products have negative social or environmental impacts. The index is designed for investors seeking a diversified SRI benchmark comprised of companies with strong sustainability profiles, while avoiding companies incompatible with values screens. Approach: exclude.

E-MSCI Ex Coal, 2014. This index represents the performance of the broad market, while excluding companies that own coal reserves. It is a benchmark for investors who aim to eliminate coal reserves exposure from their investments due to concerns about the contribution of these reserves to climate change. Approach: exclude.

MSCI ex-Fossil Fuels, 2014. The index represents the performance of the broad market, while excluding companies that own oil, gas, and coal reserves. It is a benchmark for investors who aim to eliminate fossil fuel reserves exposure from their investments due to concerns about the contribution of these reserves to climate change. Approach: exclude.

S-MSCI ex-Controversial Weapons, 2011. This index excludes companies from the parent index that are involved in the production of cluster bombs, landmines, chemical and biological weapons, and depleted uranium weapons. Approach: exclude.

S-MSCI Catholic Values Custom, 2014. Index constituents are selected from the MSCI ESG index, which is made up of securities selected using an ESG Best-in-Class methodology. The index excludes companies involved in the following activities: abortion, abortifacients, contraceptives, stem cells and animal testing as well as adult entertainment, alcohol, tobacco, gambling, civilian firearms, nuclear power, military weapons or genetically modified organisms (GMO). The constituents of the index are weighted according to their free float adjusted market capitalization. Approach: exclude by S and ESG.

S-MSCI Islamic, 2016. The MSCI World Islamic index reflects Sharia investment principles and is designed to measure the performance of the large and mid-cap segments of the 23 Developed Markets (DM) countries that are relevant for Islamic investors. The index applies stringent screens to exclude securities based on two types of criteria: business activities and financial ratios derived from total assets. The methodology for the MSCI Global Islamic index follows Sharia investment principles and does not allow investment in companies that are directly active in, or derive more than 5% of their revenues from, such business activities as alcohol, tobacco, pork-related products, conventional financial services, defense/weapons, gambling, or adult entertainment. In addition, the MSCI Global Islamic index does not allow investment in companies deriving significant income from interest or companies that have excessive leverage. MSCI uses three financial ratios to screen for such companies: (1) total debt over total assets; (2) the sum of a company's cash and interest-bearing securities over total assets; and (3) the sum of a company's accounts receivables and cash over total assets. None of these financial ratios may exceed 33.33%. Finally, if a company derives part of its total income from interest income and/or from prohibited activities, Sharia investment principles state that this proportion must be deducted from the dividends paid out to shareholders and given to charity. MSCI therefore applies a dividend adjustment factor to all reinvested dividends. Approach: Exclusion.

MSCI ESG INDEXES

IMPACT

E-MSCI Global Environment, 2009. The MSCI Global Environment indexes are comprised of securities of companies that derive at least 50% of their revenues from environmentally beneficial products and services. The indexes are based on key environmental themes: alternative energy, sustainable water, green building, pollution prevention, or clean technology. The indexes aim to serve as benchmarks for investors seeking exposure to companies whose primary source of revenues increase the efficient use of scarce natural resources or mitigate the impact of environmental degradation. MSCI calculates the Global Environment index and five thematic sub-indexes. Approach: exclude.

ES-MSCI Sustainable Impact, 2016. The MSCI ACWI Sustainable Impact index is designed to identify listed companies whose core business addresses at least one of the world's social and environmental challenges, as defined by the UN SDGs. The sustainable impact categories include: nutritious products, treatment of major diseases, sanitary products, education, affordable housing, loans to small and medium size enterprises, alternative energy, energy efficiency, green building, sustainable water, and pollution prevention. To be eligible for inclusion in the index, companies must generate at least 50% of their sales from one or more of the sustainable impact categories and maintain minimum ESG standards. Approach: exclude.

G-MSCI Women's Leadership, 2017. The MSCI World Women's Leadership index is based on the MSCI World index, its parent index, which includes large and mid-cap stocks across 23 Developed Markets (DM) countries. The MSCI World Women's Leadership index aims to represent the performance of companies that exhibit a commitment towards gender diversity among their board of directors and among the leadership positions. The index aims to include companies which lead in their respective countries in terms of female representation in board and leadership positions. Approach: exclude.

S&PDJI ESG INDEXES

INTEGRATE

ESG-S&PDJI ESG Factor Weighted, 2016. This index is designed to isolate ESG as its own "factor" and weight the companies in the index according to those factor scores. Constituents are weighted according to their ESG factor score with respect to other companies in their Global Industry Classification ("GIC") sector. Approach: reweight by ESG, maintaining industry weights.

ESG-S&PDJI DJSI Diversified, 2013. This index is designed with a sustainable tilt while minimizing country, industry, and size biases relative to traditional global benchmarks. The top 50% (based on ESG score) of companies in the parent index per GICs sector and country are selected. Approach: exclude by ESG, maintaining country, industry, and size weights of parent index.

ESG-S&PDJI DJSI Diversified Select, 2013. This index is designed with a sustainable tilt and ethical exclusions while minimizing country, industry, and size biases relative to traditional global benchmarks. First, alcohol, tobacco, gambling, armaments and firearms, and adult entertainment are excluded. Then, the top 50% of companies in the parent index are selected based on ESG score. Approach: exclude, then reweight by ESG maintaining country, industry, and size weights of parent index.

G-S&PDJI LTVC, 2016. This index is designed to measure companies that anticipate and manage current and future economic and governance risks. Constituents are selected based on their RobecoSAM Economic Dimension score and their S&P Quality Score. The top 150 ranked stocks are selected as the current year "vintage." The entire portfolio consists of three such "vintages." Approach: select by G and Economic Dimension.

S-S&PDJI CAPEX & Human Capital, 2016. This index is designed to measure the performance of Japanese companies that are proactively making investments in physical and human capital. The top 200 constituents are selected based on their RobecoSAM human capital score, capital expenditures ("capex") revenue effect, and capex R&D growth. Approach: exclude by S and capex.

E-S&PDJI Carbon Efficient, 2015. This index is designed to reduce exposure to carbon inefficient companies by reweighting. Approach: reweight by E, maintain.

S&PDJI ESG INDEXES

VALUES

ESG-S&PDJI DJSI Index,1999. This index is designed to measure the "best-in-class" companies based on RobecoSAM's Sustainability score. The top 10% of companies in the parent index, based on ESG score are selected. Approach: select by ESG.

ESG-S&PDJI DJSI excluding Alcohol, Tobacco, Gambling, Armaments & Firearms and Adult Entertainment, 2008. This index is designed to measure the "best-in-class" companies based on RobecoSAM's sustainability score while applying ethical exclusions. First, alcohol, tobacco, gambling, armaments & firearms, and adult entertainment are excluded; then the top 10% of companies based on ESG score are selected. Approach: exclude.

E-S&PDJI Fossil Fuel Free, 2015. This index is designed to exclude companies that own fossil fuel reserves. Approach: exclude by E.

E-S&PDJI Fossil Fuel Free Carbon Efficient, 2015. This index is designed to exclude companies that own fossil fuel reserves and reduce exposure to carbon inefficient companies by reweighting. Approach: exclude by E, then reweight by E, then maintain.

E-S&PDJI Fossil Fuel Free Carbon Efficient Select, 2016. This index is designed to exclude companies that own fossil fuel reserves and reduce exposure to carbon inefficient companies by excluding the highest emitters. Approach: exclude by E, then optimize.

E-S&PDJI Climate Change Low Volatility High Dividend, 2016. This index is designed to measure the performance of the least volatile, high yielding companies that also have a low carbon footprint. Stocks are first selected on low carbon numbers, then by highest dividend, then by low volatility. Each reason has a set number of stocks in the final index. Approach: select by E, high dividend yield, and low volatility.

S-S&PDJI Catholic Values, 2015. This index is designed to exclude certain activities that are not aligned with the Responsible Investment Guidelines of the United States Conference of Catholic Bishops. The index excludes companies involved in abortion, stem cell research, adult entertainment, controversial weapons, child labor, contraception, nuclear weapons, and military sales. Companies are then reweighted to maintain the sector weights of the parent index. Approach: exclude by S, maintain sector weights of parent index.

S&PDJI ESG INDEXES

IMPACT

E-S&PDJI Carbon Efficient Select, 2015. This index is designed to reduce exposure to carbon inefficient companies by excluding the highest emitters. Approach: exclude by E, optimize.

E-S&PDJI Global Water, 2007. This index is designed to provide liquid exposure to 50 companies from around the world that are involved in water related businesses and is linked to the UN SDGs. The index selects the top 50 qualifying companies based on companies whose primary business is water. Twenty-five companies are selected from 'Water Equipment & Materials' and 25 companies from 'Water Utilities & Infrastructure.' Approach: select by E.

E-S&PDJI Global Clean Energy, 2007. This index is designed to provide liquid exposure to 30 companies from around the world that are involved in clean energy-related businesses and is linked to the UN SDGs. Selects the top 30 qualifying companies based on companies whose primary business is clean energy. Approach: select by E.

ES-S&PDJI Environmental & Socially Responsible, 2015. This index is designed to measure the performance of securities that meet environmental and social sustainability criteria. First, tobacco, military, and fossil fuels stocks are excluded, then the top 75% of market cap by ES score are selected. Approach: exclude, select by ES.

Appendix III: Performance and Risk Data for 1-, 3-, and 5-Year Trailing Periods Ending March 30, 2018

Annualized Performance and Risk Data (periods ending March 30,2018)															
	FTSE Developed					MSCI World					S&P 500				
Name of Index	**FTSE Developed**	**4Good**	**ex-Fossil Fuels**	**Green Revenues**	**Divest Invest 200**	**MSCI World**	**ESG Leaders**	**ex-Fossil Fuels**	**Low Carbon Target**	**Women Leadership**	**S&P 500**	**ESG Factor Weighted**	**Fossil Fuel Free**	**Carbon Efficient**	**Fossil Fuel Free Carbon Efficient**
Annualized Return*															
1-Year Return	14.76%	14.29%	14.93%	14.73%	13.54%	13.59%	13.11%	13.81%	13.10%	13.34%	13.99%	14.65%	14.76%	14.05%	14.72%
3-Year Return	8.38%	8.26%	9.12%	8.85%	9.91%	7.97%	7.46%	8.39%	7.88%	NA	10.78%	10.03%	11.44%	11.15%	11.73%
5-year Return	10.37%	10.33%	11.07%	10.34%	11.95%	9.70%	9.20%	10.58%	9.72%	NA	13.31%	13.71%	14.30%	13.40%	14.42%
Since May 31, 2016 Return						14.25%				13.70%					
Risk (Standard Deviation)															
1-Year Risk	7.71%	8.12%	7.84%	7.91%	8.52%	8.30%	8.11%	8.22%	8.19%	8.48%	8.47%	7.91%	8.42%	8.26%	8.21%
3-Year Risk	10.45%	10.74%	10.46%	10.50%	10.53%	10.62%	10.46%	10.57%	10.63%	NA	10.26%	10.41%	10.29%	10.43%	10.35%
5-Year Risk	10.10%	10.46%	10.02%	10.09%	10.19%	10.19%	10.00%	10.12%	10.22%	NA	9.87%	10.10%	9.91%	10.10%	10.05%
5-Year Tracking Error	na	1.60%	1.09%	0.59%	2.35%	na	0.75%	0.94%	0.40%	1.98*	na	2.22%	0.85%	0.82%	0.90%
5-Year Max Drawdown	-12.05%	-12.67%	-10.92%	-11.74%	-9.57%	-17.95	-17.26	-16.74	-17.93	NA	-8.36%	-10.97%	-8.37%	-8.66%	-8.59%
5-Year Return/Risk	102.7%	98.8%	110.5%	102.5%	117.3%	95.2%	92.0%	104.5%	95.1%	NA	134.9%	135.7%	144.2%	132.7%	143.5%
5-Year Sharpe Ratio	**0.99**	**0.96**	**1.06**	**0.99**	**1.12**	**0.91**	**0.88**	**1.00**	**0.91**	**NA**	**Na**	**NA**	**NA**	**NA**	**NA**
Since May 31, 2016- Sharpe Ratio						**1.72**				**1.50**					
No. of Constituents	2,141	878	2,051	2,141	205	1,649	805	1,577	1,277	570	505	501	478	500	477
Avg Mkt Cap ($Billions)	$19.0	$26.8	$10.6	$19.0	$70.1	$24.1	$24.3	$23.7	$27.2	$36.0	$46.72	$46.99	$47.03	$47.06	$47.10

Sources: FTSE/Russell, MSCI, and S&PDJI.

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Vermont Pension Investment Committee

CLIMATE RISK DIVESTMENT DISCUSSION

February 8, 2017

PCA PENSION CONSULTING ALLIANCE

Sarah Bernstein, Ph.D., FSA

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Acknowledgements

In PCA's opinion, VPIC stands among the leaders of U.S. public pension funds in its efforts to consider and to address potential climate change risks and their potential impacts on the VPIC portfolio. PCA is honored that VPIC retained our firm to examine the potential impact on the VPIC portfolio of divestment from one or more of the following: a) coal, b) ExxonMobil, and c) fossil-fuel investments, and to work with the Treasurer, VPIC staff and NEPC LLC to try to seek consensus recommendations for consideration by VPIC.

We thank the VPIC, the Vermont Treasurer, and VPIC staff for their inputs throughout this process; the 26 U.S. public pension funds that responded to PCA's survey of VPIC peers on climate change related investing strategies (Appendix 1); MSCI for providing lists of fossil fuel and thermal coal securities derived from the MSCI ACWI IMI universe, which PCA distributed to all VPIC managers for the sole purpose of preparing information for this report; every VPIC investment manager for their time and effort in contributing information for this report; FTSE/Russell, MSCI, SPDJI for providing information on new ESG indexes; MSCI, Northern Trust, Rhumbline, and SSGA for providing information on potential new passive ESG investment vehicles; CERES/INCR and the Sustainable Accounting Standards Board ("SASB") for their input; and Allan Emkin, PCA founder and Managing Director, for his insights and support.

VPIC's process for this report included outside review of PCA's report by a group designated by VPIC. We thank these individuals, each representing their respective organizations, for their thoughtful involvement: Margaret Belmondo and Chris Levell, Vermont's Investment Consultants, NEPC, LLC.; Andrew MacLean, ExxonMobil ("Exxon" or "XOM"); Austin Davis, 350.org Vermont; Eric Becker, Clean Yield; Guy Page, Divestment Facts; Joe Choquette, who represents the American Petroleum Institute in Vermont; Robb Kidd, Sierra Club, Vermont Chapter; and Sarah Wolfe, VPIRG.

Forward

Eighteen of the past 19 years have been the hottest on record. In our opinion, whether or not you are convinced of humanity's role in climate change, there is a preponderance of evidence for climate change and its potential risks. We believe climate risks to investments, including potentially stranded assets, have become a potentially material investment issue to the degree that the question has become: why would you not seek to understand and manage these risks? We believe VPIC should continue its effort to address and manage climate and other ESG risks and opportunities, and stay abreast of ever-changing assessments of risks and approaches to managing them. In our opinion, divestment of fossil fuels for VPIC is one possible strategy to mitigate one, potentially significant, climate risk – possible stranded assets of fossil fuel suppliers.

This report addresses the impact on the VPIC investment portfolio of divestment from fossil fuels, thermal coal, and ExxonMobil. We analyze these divestment strategies' potential impact on the expected returns, risks and costs to the VPIC investment portfolio, and the potential impacts of divestment phased in over time; consider divestment within the context of the VPIC's governance structure, including its asset allocation, investment strategy within public equities, proxy voting and engagement policy, and in the context of other investment management tools available to VPIC.

By the numbers, the larger the scope of any divestment, the larger the expected potential impact on returns and risk to the portfolio. For this report we employed a narrower definition of fossil fuels and of coal than was analyzed by VPIC staff in its 2015 study of divestment. We include only companies that own fossil fuel reserves rather than the full GICS energy sector; thermal coal rather than all coal; and we exclude utilities. VPIC invests in commodities via futures. Thus commodities are not relevant to this definition of fossil fuels. As a consequence of these differences in definition, this report finds a smaller fossil fuel and coal exposure and a smaller potential risk-return impact on the VPIC portfolio than the results reported by staff. A second consequence is that our report is less consistent than the VPIC staff report with the underlying general themes – divest from all fossil fuels and divest from all coal. In our opinion, our results and conclusions are consistent with those found by VPIC staff.

Second, VPIC's overall investment strategy is designed to diversify among asset classes to balance overall market risks. In our opinion, fossil fuel supplier divestment can be a tool primarily in public equities to remove exposure to potentially stranded fossil fuel owner assets. In our opinion, other portfolio-wide potentially material financial risks and opportunities posed by climate change are not addressed by fossil fuel divestment. Divestment does not: address climate change material risks (including technological, policy, and physical) evident in other industries from agriculture and forestry to infrastructure, buildings and insurance. Divestment does not provide enhanced exposure to companies involved in energy efficiency and renewable energy. Publicly held equity divestment only transfers ownership of fossil fuel securities; it cannot provide fossil fuel alternatives with any new financial resources. In our opinion, addressing potential climate change risks and opportunities in the VPIC portfolio is best accomplished through a bottom up analysis within each asset class.

Third, within VPIC's equity asset class, we find that divestment adds ongoing costs to portfolio management that are proportionally greater the smaller the fossil fuel divestment strategy (i.e., it is most expensive relative to the market value of the assets divested, to divest from ExxonMobil). We find that divestment conflicts with VPIC's equity asset class governance structure, including its investment strategy, and proxy voting and engagement approach. VPIC allocates its publicly held equity assets primarily towards passively managed funds to gain inexpensive overall market exposure. VPIC complements these investments with actively managed investments in discrete market segments where VPIC believes active management can increase its risk-adjusted returns, net of fees. Divestment constrains active managers in their mandate to: find the best investment opportunities; distinguish among differing magnitudes of risk by type of fossil fuel; weigh stranded asset risks at each company with other risks in security selection; and time buy/sell decisions.

For passively managed, market-wide equity investments, the risk of stranded assets is one of many potential long-term risks that VPIC must consider, including other climate risks. VPIC's passive equities are managed against market-cap weighted indexes. These indexes do not separately account for potentially stranded asset risks, over and above any stranded asset risk embedded in a company's market cap. These indexes include other biases. There exists a multitude of market-wide benchmarks that seek to offer investors better overall risk-adjusted returns than market-cap weighted indexes. These include fundamental, equal-weighted, smart-beta, and a burgeoning plethora of Environmental, Social and Governance ("ESG") indexes. We believe benchmarks other than ex-fossil fuel, or ex-coal can better balance potential stranded asset risk with the multitude of climate, ESG and macro risks (an ex-Exxon benchmark must be custom developed). Divestment of fossil fuels, thermal coal, or ExxonMobil, even within the equity asset class, requires costly restructuring of investments from inexpensive comingled funds, to higher cost separately managed accounts ("SMA"). In our opinion, divestment from fossil fuels or ExxonMobil would negate a critical element of VPIC's proxy voting efforts on these matters - VPIC's voting and co-sponsoring of shareholder proxies at fossil fuel companies (Appendix 2).

We believe that VPIC's significant proxy voting and engagement efforts on climate risk issues at fossil fuel companies, including ExxonMobil, and investment strategies other than divestment, are better suited than divestment for VPIC to manage risks and opportunities posed by climate change within its role as fiduciary of a U.S. public pension fund.

Executive Summary

Conclusions

- **We find that divestment from fossil fuels, thermal coal, or ExxonMobil could**:
    - increase costs
    - add diversification and technological change risks to VPIC's portfolio,
    - only effect potential stranded assets risk, not other material climate change risks and opportunities,
    - leave unaffected the financial situation of companies offering alternatives to fossil fuels,
    - conflict with VPICs governance in its asset allocation, equity investment strategy, and proxy voting and direct corporate engagement, and
    - introduce a slippery slope of potential for other restrictions on VPIC's investment universe whose potential benefits have not been shown to outweigh the potential harm to the VPIC portfolio.

  Each of the three divestment tracks carry different degrees of these central concerns.

    - Fossil fuel divestment may introduce meaningful diversification risk, increase costs - including cost to restructure the VPIC portfolio from commingled funds into to SMAs, higher management fees, and operational costs, reduce VPIC's proxy voting and engagement opportunities across an entire sector of the economy, introduce a slippery slope potential for other restrictions, particularly for other aspects of today's carbon economy. Fossil fuel divestment does not reduce the global economic dependence on, or demand for, fossil fuels, or impact the financing of the targeted companies.
    - Thermal coal divestment would entail higher proportional costs to VPIC than fossil fuel divestment, because the full costs of transitioning out of inexpensive commingled funds and paying the ongoing management fees of more expensive SMA's would be incurred for a much smaller divestment.
    - ExxonMobil divestment would entail the highest costs proportional to the size of the assets divested and reinvested, and would introduce a single company precedent for exclusion that would dramatically widen the opportunities for demands for exclusion from VPIC's investment universe despite increased costs to the plan. Exxon divestment would negate the proxy voting and engagement efforts at Exxon that VPIC and the Vermont Treasurer undertake (Appendix 2), and thereby potentially work against the broader institutional investor climate change related efforts that have gained traction among Exxon shareholders.

- **Markets now offer meaningful tools to address climate risk other than divestment**, from coordinated proxy voting and corporate and public policy engagement, to passive and active low carbon alternatives that avoid the broad market exit risk inherent in near-term divestment approaches.

- **Divestment conflicts with VPIC governing policies:** Given the financial and governance costs that come with fossil fuel divestment, in PCA's opinion, divestment of fossil fuels, thermal coal, or Exxon has not been shown to be in the best interests of VPIC pension beneficiaries, and conflicts with VPIC governance structure.

Recommendations

- **Be an active shareowner of fossil fuels in the VPIC portfolio.**

- **Continue VPIC's active shareowner proxy voting, and engagement** with both companies and public policy regulators regarding climate risk matters; maintain ongoing manager monitoring of climate change risk and opportunity management. Consider integrating distinctions between material and immaterial ESG risks, such as those defined by the Sustainable Accounting Standards Board ("SASB"), into VPIC's manager monitoring, and decisions over which shareholder proposals to invest VPIC's corporate engagement time and resources.

- **Continue VPIC's active engagement in institutional investor organizations** such as Ceres, INCR and SASB to further leverage VPIC's efforts.

- **Conduct a thorough review of VPIC's passive equity manager's proxy voting.** In the event that VPIC conducts a search for a passive equity manager, include consideration of managers' proxy voting policies and actual votes on climate change and other ESG issues to potentially further broaden VPIC's alignment of interests with the proxy voting done on VPIC's behalf by passively managed equity managers.

- **Reach out to other state public pension funds to explore possibility of creating a new passive equity investment vehicle that VPIC could potentially seed, designed to more closely align with VPIC's proxy voting** and engagement. The investment vehicle could be designed for VPIC and other U.S. public pension funds that do not have the resources to bring their passive equity investing in-house. Such a vehicle would offer long-term ongoing opportunity, regardless of market change, including long-term transformations in global energy. There appear to be options that could keep costs in line with VPIC's current passive equity comingled fund cost structure. Depending on how a fund was implemented, a new investment vehicle may involve higher management fees or costs than VPIC's current passive equity commingled funds.

  As of June 30, 2016, 53% of VPIC equities were passively managed ($806.5 million). PCA requested information from VPIC's current passive equity manager – SSGA, and from Northern Trust ("NT") on a potential new comingled vehicle. SSGA responded that it is not an option at this time for SSGA to launch a fund that implemented either custom public fund proxy voting guidelines, or guidelines of a third party proxy voting entity, as SSGA believes that their corporate policy is strong on ESG/climate issues (Appendix 3).

  Northern Trust offered a few options: VPIC could invest in NT's existing R3000 Labor Select Index Fund, which votes proxies according to ISS's Taft Hartley proxy voting guidelines and outsources the proxy voting to ISS; NT could open a new commingled passive equity fund for public fund investors to either invest according to a specialized proxy voting guideline from a proxy service provider, (such as the ISS' or Glass Lewis' public fund or ESG guidelines), or to invest in a new vehicle that votes proxies according to a new public fund custom proxy voting guideline developed by VPIC (or developed jointly with other public funds). The preliminary fee schedules for these options are set forth in Appendix 4. They assume a minimum of $250 million in assets to launch a new fund. The fee schedule is 3 basis points per annum for an S&P 500 (with securities lending) index fund, dropping to 2 basis points per annum for any investment $500 million or more. Implementation of a non-U.S. fund is more expensive. A final alternative might be for VPIC and other funds to set up their own investment management entity, such as a limited partnership, then retain the appropriate resources for legal, custody to operate the fund, conduct an RFP for a manager to passively invest the new entity's assets in a comingled fund, and conduct a search to retain a proxy service provider to implement the custom proxy voting guidelines.

For the custom public proxy voting guideline option, that utilizes NT, rather than going through a new entity, the participating funds would not need to establish a more expensive independent investment partnership. In PCA's opinion, a challenge may be reaching agreement on a new custom public fund proxy voting policy among enough public funds to seed a new passive commingled equity fund. The participating pension plans could consider establishing an entity to manage their collective process and collaborations.

- **Work with VPIC custodian to explore custodial reporting on ESG factors in VPIC portfolio compared to market,** possibly including ESG corporate ratings, and carbon footprint analysis to further support VPIC manager monitoring efforts.

- **Consider shifting a portion of VPIC assets to strategies that are expected to stimulate and benefit from long-term shifts to a low-carbon economy.**

  - Public equities - consider shifting a portion of VPIC's passively managed assets to a fund benchmarked to an index such as MSCI's Low Carbon Index, or FTSE's Green Revenue Index. Neither index divests from fossil fuels. Instead, they reweight securities in the underlying benchmark to either reduce the economy-wide carbon footprint, or increase the green exposure, while optimizing to maintain a close tracking to their core underlying benchmarks. Today, low carbon indexes provide meaningful reduction in exposure to carbon emissions. Over time, we expect low carbon indexes to more closely resemble the carbon exposure of the underlying market cap weighted benchmark as the world moves towards a low carbon economy. At this point in time, a VPIC investment in such a passive equity fund would increase VPIC's management fees. There are not yet commingled passive equity funds in which VPIC could invest based on either benchmark. An ETF does exist based on MSCI's Low Carbon Index.

    PCA requested information from SSGA, Rhumbline (specializes in passive index funds) and MSCI on potential management fees to establish a new comingled low carbon fund. We used MSCI's Low Carbon Target Index as an example. Potential fee schedules are listed in Appendix 3 (SSGA), and Appendix 4 (Rhumbline). Any fund of this sort would include additional fees compared to VPIC's current passive equity, including index fees wrapped in due to the additional three to four basis points that MSCI currently charges for their custom ESG indexes.

  Private equities - consider shifting a portion of VPIC's allocation to a strategy that includes a higher portion of clean technology investments. The costs involved in this strategy include the staff and Board time to determine a strategy, the costs and time of issuing an RFP, and may involve ongoing higher private equity management fees because VPIC's current sole private equity manager does not have an offering of this type.

<u>**Findings**</u>

As of June 30, 2016, VPIC held 3.6% of its $3.74 billion total portfolio in fossil fuels. This percentage is based on the MSCI ACWI IMI universe (broader than the VPIC MSCI ACWI reference benchmark because it includes securities for small cap companies, while the MSCI ACWI focuses on the large/mid cap universe), and defines fossil fuel companies as any company with proven fossil fuel reserves. Coal companies are defined using the California list of thermal coal companies, as provided by MSCI.

Fossil fuels:	3.6% ($134 million)
Thermal coal:	0.6% ($22 million)
ExxonMobil ("XOM"):	0.3% ($10 million)

At 3.6%, VPIC's actual exposure to fossil fuels was significantly lower than the benchmark. VPIC fossil fuel exposure was approximately half (54%) the 6.6% exposure of the MSCI ACWI exposure. Similarly, VPIC's Exxon exposure was 0.3% of its total portfolio, compared to 1.1% of the MSCI ACWI. VPIC's 0.6% exposure to thermal coal companies was below the 0.8% of the MSCI ACWI.

Equities represented the largest VPIC asset class:

Equities:	40%
Fixed Income:	32%
Absolute Return:	17%
Alternatives:	11%

The VPIC equity asset class held the vast majority VPIC's fossil fuel exposure:

VPIC share of fossil fuels in VPIC Equity Asset Class:	79%
VPIC share of thermal coal in VPIC Equity Asset Class:	92%
VPIC share of ExxonMobil in VPIC Equity Asset Class:	92%

VPIC commingled funds (which includes all passively managed and many actively managed funds) held the largest share of VPIC's exposure to fossil fuels:

VPIC commingled funds share of VPIC fossil fuels:	58%
VPIC commingled funds share of VPIC thermal coal:	78%
VPIC commingled funds share of VPIC ExxonMobil:	97%

Active managers held modest to zero fossil fuel and thermal coal positions, and zero Exxon.

VPIC's total percentage exposure to fossil fuels, thermal coal and Exxon were each less than that of an equity reference benchmark presented in VPIC performance reports – the MSCI ACWI.

Risk and Return: Divestment reduces diversification and thus increases risk. Going forward rates of return differences between VPIC's actual portfolio and its hypothetical portfolios under divestment cannot be estimated. Future returns cannot be forecast by historic returns. Macro and industry experts have failed to predict dramatic shifts, such as shale production. In our opinion, the potential to accurately predict the timing, industry and company return impacts for VPIC is low, given the high uncertainty in policy, winning technologies, and which companies may successfully adapt. PCA analyzed VPIC managers' hypothetical historic rates of returns for trailing one-year and five-year periods under the three divestment scenarios. The VPIC manager's estimates were self-reported. All managers were asked to use the fossil fuel and thermal coal lists of companies provided by MSCI for all data responses. The results show that under divestment, VPIC managers would have had mixed results compared to their actual performance for VPIC – some marginally better and some marginally worse rates of return than their actual returns.

Costs: The largest measurable explicit costs of divestment to VPIC would be ongoing increased management fees. **Management fees would increase under each of these three divestment scenarios** because VPIC commingled funds, where the bulk of VPIC's fossil fuel were held, would have to be restructured into materially higher-cost SMA funds. The ongoing higher fees are proportionally higher for the divestment scenario with the lowest amount of assets to be divested - Exxon - because the fee changes would be the same, whether VPIC restructured and set up an SMA to divest just from ExxonMobil, or to divest from all fossil fuels. For two of VPIC's four commingled equity funds, the commingled fund manager, SSGA, responded that VPIC cannot be moved to an SMA for those funds because the current level of AUM in those two accounts is too small, and such a transition would be cost prohibitive. VPIC's current SMA managers that held any fossil fuels reported that management fees would remain largely unchanged. **Transaction costs:** VPIC's commingled fund managers, which held the vast majority of VPIC's fossil fuel positions, cannot divest VPIC from individual securities, because VPIC does not hold direct ownership of individual securities in a commingled fund. Thus, these funds would have to be closed and restructured as SMAs. In addition to the ongoing higher management fees of a new SMA, the costs to close these funds and reopen SMAs, where possible, would include the administrative costs of opening an SMA, new custodial costs to allow VPIC to hold the individual securities, and transaction costs to buy in VPIC's name the full set of ex-fossil fuel, ex-thermal coal, or ex-Exxon securities. The fossil fuel companies in the MSCI ACWI IMI trade in highly liquid markets. Consistent these market dynamics, and reflecting the small exposure to fossil fuels and thermal coal in VPIC SMAs, the combined transaction costs to divest (sell) were estimated by VPIC SMA managers: VPIC SMA fossil fuels, $185,422, and VPIC SMA thermal coal, $35,914.

VPIC private equity fossil fuel divestment would require selling all holdings on the secondary market, likely at a significant discount to Net Asset Value (NAV). **Monitoring costs** would increase to insure compliance throughout the portfolio of VPIC manager's compliance with VPIC-specific divestment lists. **Opportunity costs** are expected to vary depending on the manager's target market, and timing.

Phase-in: A short-term divestment phase-in would incur essentially the same magnitude of costs, including transaction costs and management fees, as immediate divestment, and may be at a poor time in the energy market**. A long-term divestment period,** could be designed to divest more in line with a long-term technological shift to a lower carbon economy. For example, Vermont's energy policy sets forth a 30-year period for the state to transition to 90% reliance on renewable energy. A 30-year divestment period might harmonize better with a shift from global dependence on fossil fuels to a degree that renewables become a larger share of global energy consumption. Such a long-term divestment period, if implemented in incremental steps throughout the portfolio, with regular review and reassessment, could smooth out divestment impacts and reduce the impact of near-term market timing. The increases in management fees required to dismantle VPIC's inexpensive commingled funds, and restructure those assets into more expensive SMA's would still be borne by VPIC, but would be spread out over time, if VPIC did not dismantle and restructure all commingled funds at one time. In our opinion, extending divestment over five-to-seven-year business cycle would do little to address the key underlying global dependence on fossil fuels, although, depending on timing, it could potentially contribute to smoothing out return impacts somewhat.

Additional divestment from VPIC's commodity asset class would allow VPIC to completely exit all fossil fuel related exposure. We agree with VPIC's staff analysis that such divestment would undermine the strategic benefits including inflation protection and diversification that the asset allocation to commodities brings VPIC and require a reassessment of VPIC's asset allocation strategy.

Divestment would negate VPIC's and the Vermont Treasurer's considerable efforts in proxy voting at fossil fuel companies, even as climate change related shareholder proxies are expanding in voting share. VPIC's efforts went beyond voting their proxies and included in 2016 co-filing six proxy proposals at major oil companies, including Exxon. Engagement at the regulatory level, and through general letters with broad institutional investor organizations of which VPIC is a member could still be undertaken.

Climate change risk is ubiquitous. Divesting from fossil fuels can reduce stranded asset risk, but does not address other climate change risks. Divesting from fossil fuel suppliers:

- Has little proven impact on fossil fuel corporate policies, or on government policies.
- Increases investments in: sectors whose products and services generate demand for fossil fuel energy including utilities and transportation, sectors that generate significant CO2 emissions, such as construction, sectors that finance fossil fuel development, and sectors facing material physical risks of climate change including real estate and consumer goods.
- Retains investments in oilfield services and equipment, necessary to fossil fuel production.
- Does not overweight VPIC's exposure to companies potentially stimulating and benefitting from low-carbon and renewable energy solutions.

Divestment from fossil fuels sets a 'slippery slope' precedent for VPIC to restrict its manager's stock selection based on criteria that are not proven to benefit VPIC. Divesting Exxon, as a single company, and then excluding it going forward from VPIC's securities universe, would open VPIC to an entirely new degree of precedent setting for demands for individual companies to be excluded for many varieties of reasons.

Introduction

VPIC's mandate to PCA for this project was to review potential divestment and its potential impacts on the VPIC portfolio, and to work with Treasurer staff and NEPC LLC to seek to come to consensus recommendations, for consideration by the VPIC subcommittee that was formed to examine the potential impact of divestment from one or more of the following: a) coal, b) ExxonMobil, and c) fossil-fuel investments from equities, fixed income, commodities, and other investment classes. For this report, VPIC requested that: "Specifically, this study would look at all three tracks (coal, ExxonMobil, and fossil fuels) and would consider a) the impacts, if any, on the return and risk characteristics of the VPIC portfolio, b) impact on costs, if any, including transaction costs, c) impacts on the governance structure of VPIC, including construction, management and oversight, and d) impacts that phase-in of various divestment strategies could have on the previously identified considerations."

In our review of the considerable prior work and discussion by VPIC on potential divestment of fossil fuels, we found the reports by VPIC Staff to provide thorough and thoughtful analysis of the potential impacts of fossil fuel divestment. We find the related memorandums and comments by NEPC well-reasoned. PCA's findings are consistent with the findings and recommendation of VPIC staff. As summarized in the July 28, 2015 staff report to VPIC: "*Staff recommends that proposals for fossil-fuel/energy divestment be rejected. Staff believes that analysis demonstrates that such divestment fails to satisfy the criteria set forth in the VPIC ESG Policy, presents significant governance challenges, and is not in the best interest of the pension beneficiaries.*"

For this report, we seek to expand on the existing VPIC body of research by analyzing additional input from VPIC's managers on their estimates of return, risk, transaction costs, opportunity costs and management fees under three different scenarios: divestment from fossil fuels, thermal coal, and ExxonMobil. Managers were asked to estimate what hypothetical changes in their historic returns to VPIC under divestment, using their June 30, 2016 assets, and using June 30, 2016 as the endpoint for historic analysis. Similarly, managers were asked to estimate potential costs of potential divestment.

We further analyze divestment within the context of comparison to VPIC peer public pension funds actions regarding climate change issues. This report also assesses divestment strategies compared to other market alternatives available to institutional investors to address climate change issues, highlighting key parameters for institutional investors.

The VPIC Regulatory Framework

The framework for PCA's review is the legal and regulatory framework that guides VPIC. VPIC and its investment managers are required to make VPIC's investments in accordance with the standards of care established by the prudent investor rule under 14A V.S.A. 902. As noted in staff reports, the VPIC is "required to consider general economic conditions, the possible effect of inflation or deflation, the total role that each investment or course of actions plays within the overall trust portfolio, the expected total return from income and the appreciation of capital, and an asset's special relationship or special value, if any, to the purposes of the trust or to one or more of the beneficiaries.

The State retirement plans are subject to Section 401(a) of the Internal Revenue Code which provides that the plans must be maintained and the trustees must act for the exclusive benefit of the plan's beneficiaries. The exclusive benefit rule is codified in Vermont state law as follows:

> Under any trust or custodial account, it shall be impossible at any time prior to the satisfaction of all liabilities with respect to members and their beneficiaries for any part of the corpus or income to be used for, or diverted to, purposes other than the exclusive benefit of members and their beneficiaries (3 V.S.A. 472a(b)).

VPIC's ESG policy, adopted November 2013, further states that: the Committee may choose to consider ESG Initiatives, provided they are consistent with the Committee's obligations to the members and beneficiaries of the participating retirement systems and with the standard of care established by the prudent investor rule. In cases where investment characteristics, including return, risk, liquidity, and compliance with the allocation policy are appropriate for the Portfolio, the Committee may consider ESG Initiatives that have a substantial, direct and measurable benefit to the interests of the Portfolio.

The VPIC ESG Policy states that ESG Initiatives will be evaluated according to five specific factors:

1) Any ESG Initiative must add to or complement and not dilute or compromise the overall Portfolio strategy. ESG Initiatives will be evaluated within the context of the Portfolio as a whole and not in isolation. The Committee is a long-term investor that strives to maximize investment returns without undue risk of loss.
2) The ESG Initiative must target risk-adjusted, market-rate returns and provide net returns equivalent to or higher than other available investments at commensurate levels of risk. Social benefits of the ESG Initiative will not justify lower risk adjusted returns or higher investment risk for the Portfolio or any asset class within the Portfolio.
3) ESG Initiatives must not exceed a reasonable weighting in the Portfolio, or skew a reasonable weighting in the Portfolio as a result of investment in or divestment from any one investment strategy, sector or geographic locations. ESG Initiatives should maintain the overall Portfolio's compliance with its asset allocation strategy. Social benefits of an ESG Initiative will not justify deviation from the Asset Allocation Plan adopted by the Committee.
4) ESG Initiatives requiring an investment should be managed by qualified discretionary investment managers. The Committee will not make any direct investments. Similarly, any divestment of Portfolio assets should be accomplished by a qualified discretionary investment manager in a manner designed to minimize transactional costs and minimize losses to the Portfolio.
5) Any benefits of ESG Initiatives should be able to be quantified, reviewed and monitored by the Committee, State Treasurer's staff and third-party consultants without inappropriate expenditure of time and resources. A review of both the investment performance and the collateral benefits will be undertaken for the purpose of determining whether the Committee will maintain and ESG Initiative. The collateral benefits of an ESG Initiative shall be measured, in terms of foregone return, transaction costs and monitoring costs, alongside the estimated return of the ESG Initiative.

Reductions in expected returns to VPIC, whether from investment return downturns or increased costs, could increase the unfunded liability of the pension plans managed by VPIC, and potentially negatively affect the plans' funded status. As of June 30, 2016, the funded status of the State Employees', State Teachers' and Municipal Employees' plans were 75%, 58%, and 86% respectively. Vermont State Employees' and Teachers' plans are considered mature pension plans. For example, the ratio of retirees and beneficiaries to active employees was reported at 78% for the Vermont State Employees, and 88% for the Teacher's as of June 30, 2016. The Vermont Municipal Employees Retirement plan ratio of retirees and beneficiaries to active employees was 39% as of June 30, 2016. The more mature a plan, the less flexibility it typically has to recover from any market downturn.

The Numbers: Defining Fossil Fuels, Coal and ExxonMobil

VPIC allocates the largest share of its assets to the Equities asset class (40%), followed by Fixed Income, Absolute Return, Real Estate, Commodities, and Private Equity, as indicated below.

VPIC Asset Allocation (June 30, 2016)

Asset Class	Assets Under Management	
	(%)	($Millions)
Total Plan	100.0%	$3,743.2
Equities	40.0%	$1,507.7
Fixed Income	32.0%	$1,194.4
Absolute Return	17.0%	$647.8
Alternatives	11.0%	$393.2
Real Estate	6.4%	$239.9
Commodities	2.8%	$104.4
Private Equity	1.3%	$48.9

A reference portfolio for VPIC's Composite portfolio, as presented in NEPC's 2Q2016 Performance Report for VPIC, is 60% MSCI All Country World Index ("MSCI ACWI"), and 40% Barclay's Global Aggregate. To analyze manager estimates of divestment impacts based on consistent definitions of the set of securities to be divested, this analysis relies on an MSCI ACWI IMI ex-fossil fuel list of fossil fuel companies, and the MSCI ACWI IMI ex-thermal coal list of thermal coal companies.

The data analyzed in this report differs from that employed by staff in its 2015 analysis of the impact of divestment from fossil fuels and from coal. Staff's report identifies VPIC holdings by the Global Industrial Classification Standard ("GICS") codes. The GICS codes included in the VPIC study were energy (ex-Coal), Coal, and Utilities. Today's report concentrates on a narrower set of holdings, as outlined above. This study identifies fossil fuel holdings as only those companies that hold fossil fuel reserves, rather than the full GICS energy sector; we focus on thermal coal holdings, rather than the full GICS coal sector. Thermal coal is the coal used to produce energy, and generates high CO2 emission, as compared to metallurgical coal, which is used primarily in the production of steel, and generates relatively little carbon emissions. The thermal coal list from MSCI is the list adopted by California pension fund CalSTRS in its restriction on domestic U.S. thermal coal companies from the CalSTRS portfolio. Third, we identify utilities as users of fossil fuels, rather than suppliers, and include utilities as major contributors to carbon emissions, but exclude them from this analysis of divestment, focusing on suppliers of fossil fuels. The narrower definitions in this report result in smaller estimates of VPIC total exposure to fossil fuels and coal than staff reports. In our opinion, these studies are consistent with each other.

We note a few differences that result in differences in the number of fossil fuel companies excluded from the MSCI ACWI compared to the MSCI ACWI IMI related list that was shared with VPIC managers. First, the MSCI ACWI index is composed of large/mid cap stocks and had 2,468 constituents. The ACWI IMI list includes large/mid/small cap and had 8,616 constituents (as of Nov. 30). With the more comprehensive list, we queried VPIC managers that may have held small cap names in their portfolios.

Second, the list of fossil fuel companies sent to VPIC managers, and those that are excluded from the MSCI ACWI IMI in the MSCI ACWI ex-Fossil Fuels Index can differ due to the type of fossil fuel reserves. The MSCI ACWI IMI ex-Fossil Fuels Index removes companies that have *proven fossil fuel reserves used* *for energy purposes.* There are companies that have reserves but don't use them for energy. This broader list, based on all proven fossil fuel reserves, was sent to VPIC managers.

Both MSCI ACWI IMI fossil fuel and thermal coal divestment lists relate to investable equity benchmarks. MSCI does not publish an index that just excludes ExxonMobil. No comparable fossil fuel divestment lists of securities exist for the Barclay's Global Aggregate. MSCI provided PCA with the relevant equity and bond security identifiers for all of the companies included in its fossil fuel lists, so that we could request comparable information from VPIC's equity and fixed income managers, and from any absolute return managers that invest in company-level securities. The lists were distributed to all VPIC managers, for the sole purpose of preparing materials for this report.

The divestment analysis in this report is constrained to company-level securities of publicly traded securities. Thus, MSCI fossil fuel lists were not applicable to VPIC's Commodities asset class, which is invested through commodities futures. VPIC's Real Estate asset class holds no fossil fuel securities. VPIC's private equity asset class holds none of the publicly traded companies on the fossil fuel divestment lists used here. However, VPIC's private equity manager, Harbourvest, reviewed all eight of its funds in which VPIC is invested, and provided information on the market value of any private equity securities that might be deemed fossil fuels. We incorporate Harbourvest's estimates into our overall analysis of VPIC's exposure to fossil fuels.

VPIC Exposure to Fossil Fuels

To measure the VPIC exposure to ExxonMobil ("XOM", or "Exxon"), Thermal Coal ("ThC") and Fossil Fuel ("FF") holdings, we used the securities in the MSCI ACWI IMI Index of companies that held proven reserves of fossil fuels. All information is as of June 30, 2016 and provided by each VPIC manager. In total, VPIC held 3.6% ($134 million) of its $3.74 billion in assets under management ("AUM") in fossil fuel securities, 0.6% ($24 million) in thermal coal securities, and 0.3% ($11 million) in Exxon securities.

VPIC Total Plan Exposure to XOM, Thermal Coal and Fossil Fuel Holdings

(June 30, 2016)

	VPIC Assets Under Management							
	Total Plan		XOM		ThC		FF	
	$Millions	% of Total Plan	$millions	% of Total Plan	$millions	% of Total Plan	$Millions	% of Total Plan
Assets Under Management	$ 3,743	100%	$11	0.3%	$24	0.6%	$134	3.6%

As shown below, equities comprise the vast majority of VPIC's fossil fuel, thermal coal, and Exxon investments. Equities accounted for 79% of VPIC's total fossil fuel investments. In both thermal coal and Exxon, 92% of VPIC's investments were in the Equity asset class. Commingled funds made up the bulk of these investments. Equities in commingled funds garnered 50% of the total FF investments, 71% of the thermal coal exposure and 89% of VPIC's investments in Exxon.

VPIC Asset Class Exposure to XOM, Thermal Coal and Fossil Fuel Holdings

(June 30, 2016)

	VPIC Assets Under Management							
	Total Plan		XOM		ThC		FF	
	$Millions	% of Total Plan	$millions	% of Total Plan	$millions	% of Total Plan	$Millions	% of Total Plan
Total Plan	$3,743	100%	$11	0.3%	$24	0.6%	$134	3.6%
	VPIC Assets Under Management							
	$Millions	% of Total Plan	$Millions	% of Total XOM	$Millions	% of Total ThC	$Millions	% of Total FF
Total Plan	$3,743	100%	$10.9	0.3%	$23.9	0.6%	$134.0	3.6%
Asset Class								
Equities	$1,508	40%	$10.0	92%	$21.9	92%	$106.1	79%
Equities Commingeled	$878	23%	$9.7	89%	$17.0	71%	$66.9	50%
Fixed Income Total	$1,194	32%	$0.9	8%	$2.0	8%	$19.3	14%
Fixed Income Commingled	$694	19%	$0.9	8%	$0.4	2%	$12.7	9%
Absolute Return	$648	17%	$0.0	0%	$0.0	0%	$7.8	6%
Alternatives	$393	11%	$0.0	0%	$0.0	0%	$0.7	1%

The fixed income asset class held 8% of VPIC's positions in Exxon and thermal coal companies, and accounted for 14% of VPIC's exposure to fossil fuel companies. Absolute return strategies held no positions in Exxon or thermal coal companies. The absolute return asset class held $7.8 million, or 6% of VPIC's exposure to fossil fuel companies. Among the alternative investments – commodities, real estate and private equity, none of these asset classes held any of the fossil fuel companies under review. VPIC's private equity manager, Harbourvest, estimated that across all VPIC private equity funds, there were investments in private fossil fuel companies estimated at approximately $0.7 million of the total $48 million allocated to private equity within the $393 million allocated to Alternatives. Private equity accounted for approximately 1% of VPIC fossil fuel exposure. The commodities strategies do not invest in companies, but in commodities futures. VPIC's Real Estate managers only invest in real estate, not fossil fuel companies.

Due to the concentration of VPIC's fossil fuel investments in equities, SSGA holds the largest share of VPIC's fossil fuel investments. SSGA manages five passive equity funds for VPIC, and one passive bond fund. Combined, SSGA manages approximately 25% of VPIC's total assets, and held 100% of VPIC's exposure to XOM, 36% of the exposure to thermal coal, and 44% of its exposure to fossil fuel securities.

VPIC's total percentage exposure to fossil fuels, thermal coal and Exxon were each less than that of an equity reference benchmark presented in VPIC performance reports – the MSCI ACWI. At 3.6%, VPIC's actual exposure to fossil fuels was significantly lower than the benchmark. VPIC fossil fuel exposure was approximately half (54%) the 6.6% exposure of the MSCI ACWI exposure. Similarly, VPIC's Exxon exposure was 0.3% of its total portfolio, compared to 1.1% of the MSCI ACWI. VPIC's 0.6% exposure to thermal coal companies was below the 0.8% of the MSCI ACWI 0.8%.

VPIC Manager Exposure to XOM, Thermal Coal and Fossil Fuel Holdings

(June 30, 2016)

VPIC Total Actual Exposure to Fossil Fuels (June 30, 2016)			
	Total number of ACWI IMI companies	VPIC Market Value ($millions)	Percent of VPIC Market Value
VPIC Total		$3,743.2	100%
	Number of companies removed from ACWI	**Assets reallocated within ACWI ($millions)**	**Percent of VPIC Market Value Reallocated**
MSCI ACWI ex-Exxon	1	$10.0	0.3%
MSCI ACWI ex-Thermal Coal		$ 22.2	0.6%
MSCI ACWI ex-Fossil Fuels		$ 134.0	3.6%

VPIC Equity Reference Benchmark Exposure to Fossil Fuels (June 30, 2016)			
	Total number of companies	VPIC Market Value ($millions)	Percent of VPIC Market Value
MSCI ACWI	2,481	$2,433.0	100%
VPIC Equity Reference Fossil Fuel Divestment Scenarios			
	Number of companies removed from ACWI	**Assets reallocated within ACWI ($millions)**	**Percent of VPIC Market Value Reallocated**
MSCI ACWI ex-Exxon	1	$ 26.5	1.1%
MSCI ACWI ex-Thermal Coal	42	$ 20.0	0.8%
MSCI ACWI ex-Fossil Fuels	128	$ 161.3	6.6%

Source: MSCI and VPIC managers.

VPIC passive equity funds, consistent with their mandates, hold the greatest number of fossil fuel and thermal coal companies (Appendix 5). XOM, a U.S. large cap security, was held by the two VPIC large cap mandated passive accounts. VPIC had no assets allocated to large cap U.S. active managers, a highly efficient market. Thus, no active equity managers held Exxon securities.

The VPIC S&P500 index account held the largest dollar amount of fossil fuel investments. The SSGA MSCI ACWI ex-US passive account held positions in 147 fossil fuel companies, the highest number of fossil fuel companies. The two SSGA S&P500 accounts held the second highest number of fossil fuel companies - 27 in each portfolio.

VPIC active managers held modest to zero fossil fuel and thermal coal positions. No active equity manager held over 12 fossil fuel companies or over four thermal coal companies. Commingled Emerging Market active manager, Aberdeen, held the largest assets in fossil fuels among active equity managers, with $24.3 million aggregate invested in six fossil fuel holdings (0.65% of VPIC total portfolio AUM), and $9.8 million in three thermal coal companies. Among the active fixed income managers, Guggenheim high yield held the most (eight) fossil fuel companies with combined $4.4 million in fossil fuel assets.

Potential Impacts of Divestment

The information presented below on the potential financial impacts of divestment seeks to incorporate each individual VPIC manager's assessment of these impacts. This approach allowed us to analyze estimates of a hypothetical impact on historic returns had VPIC mandated divestment, and estimate costs based on each manager's detailed information on their mandate and strategy for VPIC. We confine our financial estimates to the impacts reported by VPIC's managers. Thus, this report excludes estimates of potential returns foregone due to the future value of costs or return losses that cannot be reinvested.

Financial Risk and Returns

Divestment reduces diversification and thus increases risk. Divestment of a broad set of securities typically introduces a greater reduction in diversification. Among the three divestment tracks, fossil fuels carry the greatest diversification risk, followed by thermal coal, then ExxonMobil. Because of the minimal exposure to thermal coal and ExxonMobil in the VPIC portfolio, in our opinion, the impact of increased diversification risk of either of divestment strategy is not material.

Most of the information we received from the VPIC managers on risk and returns that we found comparable enough to report, concentrated on each manager's historical actual return results compared to the hypothetical results had they excluded fossil fuels, thermal coal, or ExxonMobil from their VPIC investment portfolios.

In our opinion, going forward, rates of return differences between VPIC's actual portfolio and its hypothetical portfolios under divestment cannot be estimated. Future returns and the timing of different returns cannot be projected based on historic returns, either for the fossil fuel industry, or for individual companies, such as ExxonMobil. In our opinion, carbon prices are heavily influenced by government policies. Without consistent international policy frameworks that support a transition to a low carbon economy, we will face continued uncertainty in fossil fuel markets generally. Within that, thermal coal most likely faces the most immediate risks from a global transition to a low carbon economy.

PCA analyzed VPIC managers' hypothetical historic rates of returns for trailing one-year and five-year under the three divestment scenarios. The results show that under divestment VPIC managers would have had mixed results compared to their actual historic performance for VPIC – some marginally better and some marginally worse rates of return than their actual returns.

The VPIC managers provided estimates of the impact on returns under the three different divestment scenarios for the trailing one year and five years ending June 30, 2016 (Appendix 6). The equity managers each had a five-year track record for VPIC. Few managers had 10-year or longer track records with VPIC for the current strategies. The fixed income, absolute return, and alternatives managers often had shorter VPIC track records.

Because each manager determined their hypothetical return estimates under divestment based on assumptions that they felt made the most sense for the fund/s they manage for VPIC, an aggregate total VPIC portfolio return estimate is not available. To provide some VPIC-wide portfolio estimates of divestment returns, we used the VPIC reference portfolio for its overall equity exposure from all asset classes – MSCI ACWI. As shown below, trailing one-year returns ending June 30, 2016 for the MSCI ACWI were -3.7%. The MSCI ACWI ex-thermal coal and ex-fossil fuel indexes generated marginally better returns than the underlying benchmark during this period.

MSCI ACWI Trailing Returns Compared to MSCI ACWI ex-Thermal Coal and ex-Fossil Fuel Indexes

Asset Class	Account	Assets Under Mgt		Trailing Returns							
				1-Year				5-Year			
		(%)	(Millions)	ACWI	x-XOM	x-ThC	x-FF	ACWI	x-XOM	x-Thc	x-FF
Total Plan		**100.0%**	**$3,743.2**								
MSCI ACWI (65% of VPIC Reference Portfolio)				-3.7	-	-3.5	-3.4	5.4	-	5.7	8.0

Source; MSCI

For the five-year period ending June 30, 2016, the ex-thermal coal and ex-fossil fuel indexes show better returns than the underlying benchmark, with the ex-fossil fuel outperforming by over 2.5 percentage points during this period which was marked by a dramatic drop in oil prices.

The table below identifies the number of VPIC managers that estimated under divestment that they would have generated trailing rates of return below the actual rate of return they generated for VPIC. For the trailing one-year period, both passive managers holding XOM estimate that the returns had they excluded XOM would have been below the actual rates of return for VPIC. Two of the three managers holding thermal coal, and four of the 10 equity managers that held fossil fuels, estimate their returns would have been reduced had they excluded the thermal coal companies they held during that period.

Number of Managers with Trailing x-XOM, x-ThC or x-FF returns below actual						
	1 Year			5-Year		
	x-XOM	x-ThC	x-FF	x-XOM	x-ThC	x-FF
Equities						
Total Number of funds	10	10	10	10	10	10
Number of funds holding some FF securities	2	6	10	2	6	10
Number of funds with x-FF below actual return	**2**	**4**	**4**	**0**	**2**	**3**
Fixed						
Total Number of funds	9	9	9	5	5	5
Number of funds holding some FF securities	0	3	5	0	1	2
Number of funds with x-FF below actual return	**0**	**2**	**2**	**0**	**1**	**0**
Absolute Return						
Total Number of funds	4	4	4	4	4	4
Number of funds holding some FF securities	0	1	1	0	1	1
Number of funds with x-FF below actual return	**0**	**0**	**1**	**0**	**0**	**1**

The trailing five-year estimates by VPIC managers show that during this trailing period, a minority of managers would have hypothetically generated returns under these divestment scenarios below their actual returns.

We note that the estimates of fixed income securities historic returns can be more challenging than that for equities because bonds have specific maturity dates and issue dates. We confirm that VPIC's passive core bond manager, SSGA, which held fossil fuel securities historically during the trailing five-year period, conducted the additional analysis to identify corporate bonds by the fossil fuel companies identified for this report that may have expired before June 30, 2016, but that were part of the VPIC portfolio during the trailing 1-year or 5-year period.

In PCA's opinion, the hypothetical return estimates based on historic divestment scenarios cannot be used to project future returns. Overall market dynamics can shift the performance of fossil fuel stocks compared to the broader economic index and would affect all managers, passive and active. Potential performance going forward of active managers, without fossil fuel restrictions, and with fossil fuel security restrictions by VPIC will also be affected by how their security selection without restrictions will compare to a restricted portfolio.

Costs

Management Fees from Portfolio Restructuring

Based on the structure of the VPIC portfolio, the largest measurable explicit costs of divestment for the VPIC portfolio are expected to be ongoing increased management fees. Management fees would increase under any of these divestment scenarios because VPIC commingled funds held the bulk of VPIC's fossil fuel. VPIC cannot divest from individual securities in commingled funds. VPIC's commingled funds would have to be closed, and the assets reallocated into materially higher-cost SMA funds. The ongoing higher fees would be proportionally higher for divestment scenarios with the lowest amount of assets to be divested because the fee changes would be the same, whether VPIC restructured to divest just from ExxonMobil, or to divest from all fossil fuels.

VPIC held fossil fuel securities in a total of nine commingled funds that held public securities. VPIC's private equity portfolio also held fossil fuel assets. Among the nine commingled funds with publicly held securities, manager responses indicate that three of the funds would be cost prohibitive to move to an SMA structure, due to the relatively small AUM in each fund (Appendix 7). These commingled funds were the SSGA S&P Mid Cap, SSGA MSCI ACWI ex-US, and SSGA Barclays Aggregate. The managers of five other commingled funds indicate that fees would be meaningfully increased under a SMA structure. In addition to higher management fees, VPIC would have to pay its custodian to open and maintain custody of any securities held in an SMA that, in comingled funds, are part of the manager fees. Not all VPIC managers offered estimates of fee changes for this report.

As an example, VPIC's largest exposure to fossil fuels in a single account was $27.4 million (20% of VPIC's total fossil fuel exposure) held in the SSGA S&P500 comingled passively managed account. In total, this account held $453 million VPIC assets on June 30, 2016. SSGA's preliminary fee estimates indicate that, should VPIC restructure this comingled account into an SMA, the annual fee increase per annum would be approximately $65,000, added to VPIC's current annual fee of $137,500 per year. Over 30 years, divestment from VPIC's largest fossil fuel holding would result in $1.95 million net additional fees that would be costs rather than invested.

VPIC's largest exposure to thermal coal in a single account was $9.8 million (44% of total thermal coal exposure) was found in Aberdeen's Emerging Market Equity commingled fund. Aberdeen managed $247 million VPIC assets in this account. Aberdeen's preliminary fee estimates indicate that, should VPIC restructure this comingled account into an SMA, the annual fee increase per annum would be approximately $132,500, added to VPIC's current annual fee of $1,867,000 per year. Over 30 years, divestment from VPIC's largest thermal coal holding would result in $3.98 million net additional fees that would be costs rather than invested. These management fees do not include the additional ongoing cost to open and maintain a separate account at VPIC's custodian to house these emerging market securities. Emerging market custodial fees are meaningfully higher than those for large developed markets.

One commingled fund, (GAM fixed income unconstrained portfolio), suggested that the cost would be minimal to move VPIC to a different class without fossil fuels. GAM, which managed 3.5% of VPIC assets, held no XOM, and such a minimal exposure to thermal coal and fossil fuels that they responded that the exposure would be de minimis. VPIC's SMA managers reported that fees would remain largely unchanged.

VPIC's private equity manager, Harbourvest, indicated that fossil fuel divestment would require selling all holdings on the secondary market, likely at a significant discount to Net Asset Value (NAV). To reinvest those assets without fossil fuel exposure, Harbourvest suggested that VPIC would have to move their assets to a co-investment fund with opt-out provisions to opt out of any fossil fuel related securities.

<u>Transaction Costs</u>

For this report, we identify transaction costs strictly as the costs to sell (divest) securities that were in the VPIC portfolio. This definition differs from the broader use of transaction costs in the VPIC staff divestment report. The VPIC report includes direct security transaction costs and the portfolio restructuring costs discussed above in transaction costs. Transaction costs as defined here are not relevant to VPIC's comingled fund managers, where the vast majority of VPIC's fossil fuel positions were held because they cannot divest individual securities.

VPIC could divest from its SMAs, so transaction costs for selling these securities are relevant to VPIC's SMAs. VPIC SMA managers estimated the transaction costs to divest. Combined for all VPIC SMA managers, the transaction costs for SMA divestment were estimated at, $185,422 for fossil fuels, $35,914 for thermal coal, and $68 for ExxonMobil divestment (Appendix 8). In our opinion, these small numbers are consistent with the small exposure to fossil fuels in VPIC SMAs and the market dynamics for the fossil fuel companies in the MSCI ACWI. These securities IMI trade in highly liquid markets.

We note that estimating transaction costs for corporate bonds is more difficult than estimating these costs for equities. Bonds trade based on the bid-ask spread at any given moment, thus, depending on when the manager assumes the divestment would occur, the estimate can vary. In total, we find that SMA manager estimates of transaction costs to divest from VPIC fossil fuels, thermal coal or Exxon would be de minimis.

In addition to restructuring and transaction costs, VPIC monitoring costs would increase under divestment scenarios to insure compliance throughout the portfolio of VPIC manager's compliance with VPIC-specific divestment lists. Opportunity costs are expected to vary depending on the manager's target market, and timing.

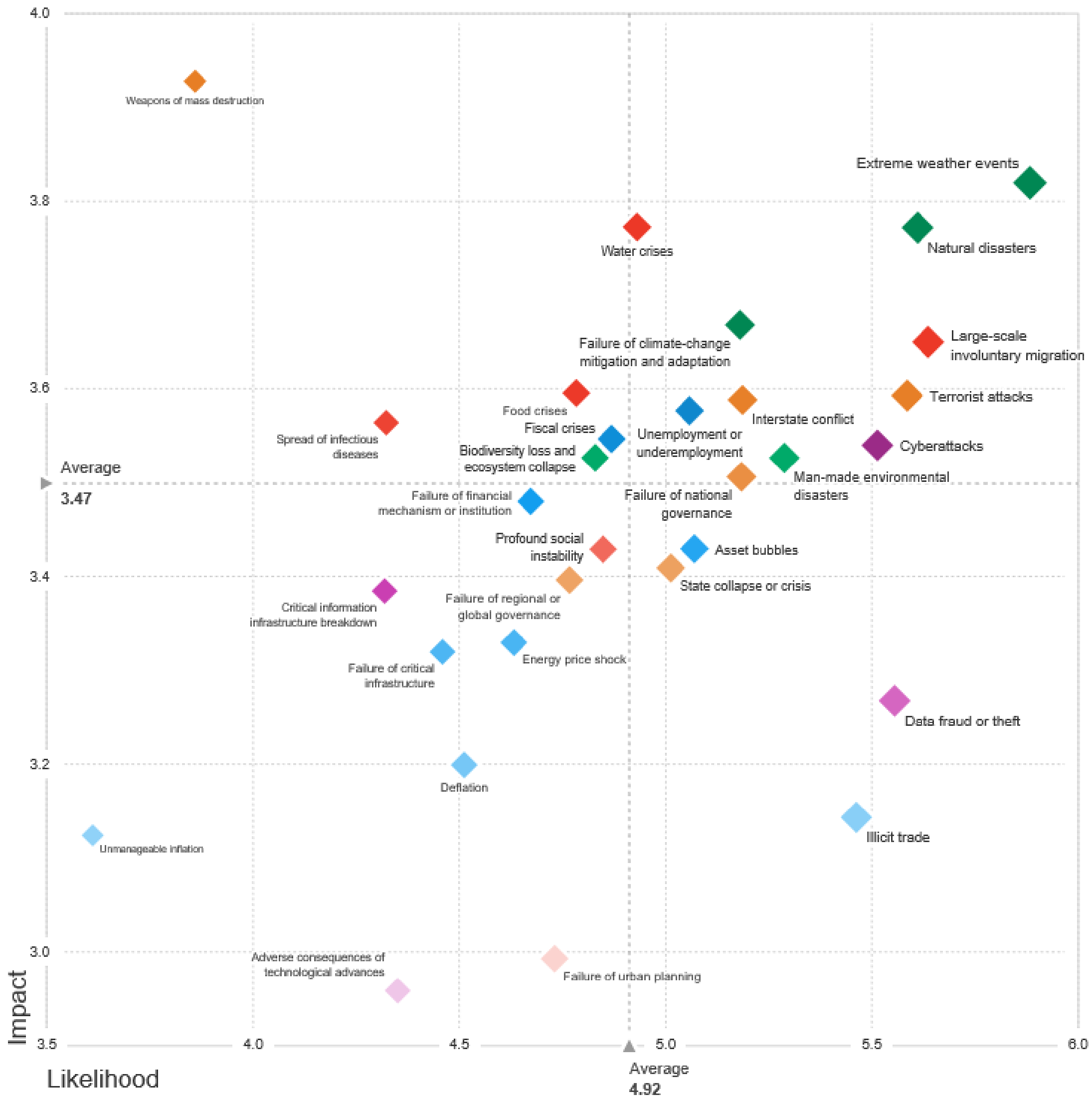
Climate Risks

The above analysis focused on divestment impacts, including costs, returns and diversification risk. In this section, we provide background on the climate risks that motivate portfolio management efforts to assess, monitor and manage these risks, including fossil fuel divestment. We then consider the potential impact of divestment in managing these risks.

There is growing evidence that significant risks face the global economy and investors from climate change. As reported in "Assessing the Global Climate in 2016" by the NOAA National Centers for Environmental Information ("NCEI"): "the globally averaged temperature over land and ocean surfaces for 2016 was the highest since record keeping began in 1880,"…" surpassing the previous record set the previous year".

In January 2017, ahead of its annual meeting of global political and business leaders in Davos, Switzerland, the World Economic Forum ("WEF") reported climate change is growing in prominence as "humanity's biggest threat". The WEF surveyed 750 experts on what the most likely and impactful risks facing humanity are in 2017. Extreme weather events ranked as the highest likelihood, second only to weapons of mass destruction in severity of impact. Three of the 2017 top five risks in terms of impact were environmental related: extreme weather events, water crises, and failure of climate-change mitigation and adaptation.

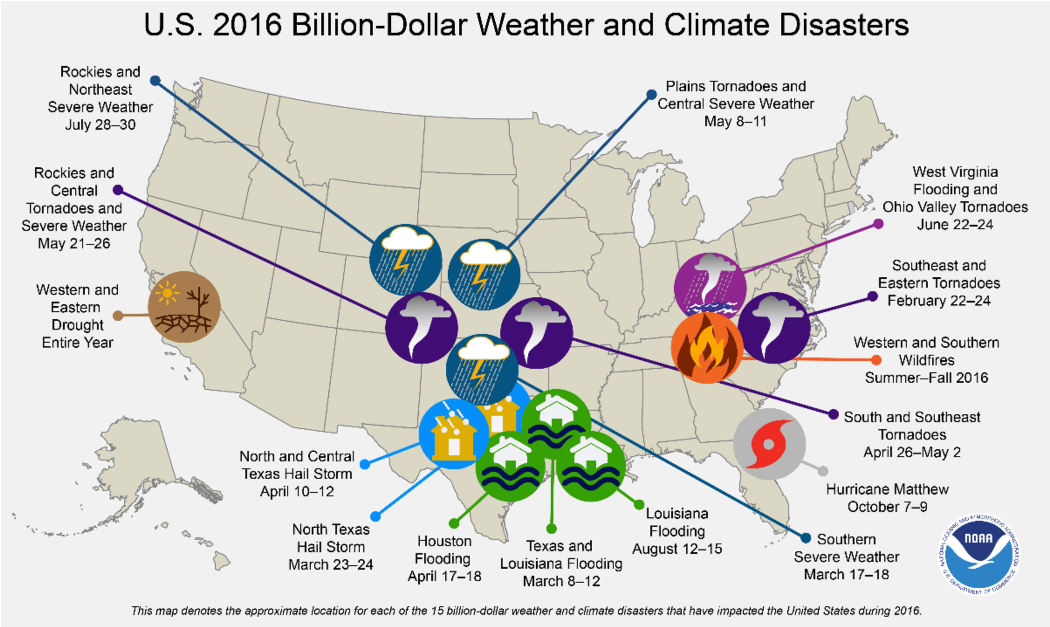
World Economic Forum: 2017 Global Risks Landscape



Source: World Economic Forum

Data reported from the United States shows the recorded physical effects of weather and climate disasters are increasing. The NCEI reported in "Assessing the Global Climate in 2016":

> "In 2016, there were 15 weather and climate disaster events with losses exceeding $1 billion each across the United States. These events included a drought event, 4 flooding events, 8 severe storm events, a tropical cyclone event, and a wildfire event...The U.S. 4 billion-dollar inland flood events during 2016, doubled the previous record, as no more than 2 inland flood events have occurred in a year since 1980… Overall, these events resulted in the deaths of 138 people and had significant economic effects on the areas impacted. The 1980–2016 annual average is 5.5 events (CPI-adjusted); the annual average for the most recent five years (2012–2016) is 10.6 events (CPI-adjusted)."



Source: National Centers for Environmental Information

The information above illustrates that there appears to be a growing consensus, and increasing factual information indicating that global climate-related risks are increasing. In a paper published in *Nature* in 2015, Marshall Burke, Solomon Hsiang, and Edward Miguel, economists based at Stanford and the University of California Berkeley, presented a new analysis that found that:

> business as usual emissions throughout the 21st century will decrease per capita GDP by 23% below what it would otherwise be, with the possibility of a much larger impact. Secondly, they conclude that countries with an average yearly temperature greater than 55°F will see decreased economic growth as temperatures rise. For cooler countries, warming will be an economic boon. This non-linear response creates a massive redistribution of future growth, away from hot regions and toward cool regions, with countries like those in Scandinavia likely experiencing substantial benefits, while those in hot regions through Asia, Africa, and the Americas, as well as island nations, facing potentially huge losses.

Research from different perspectives illustrates that climate change may impact many industries, but in different ways. For example, SASB's October 2016 Climate Risk Technical Bulletin finds that climate risk is ubiquitous. SASB identified material financial impacts from climate change for companies in 72 out of 79 industries, representing $27.5 trillion, or 93% of the U.S. equity market. In the forward to the SASB bulletin, Henry M. Paulson, 74th United States Secretary of the Treasury, Co-Chair, Risky Business Project, and Robert E. Rubin, 70th United States Secretary of the Treasury, Member, Risky Business Project highlight that: "As this new report from SASB makes clear, no matter what actions we take tomorrow, there are real, material climate risks that have already been "baked in" to the economy." Paulson and Rubin cite three examples out of the many areas SASB found to be vulnerable to climate risk.

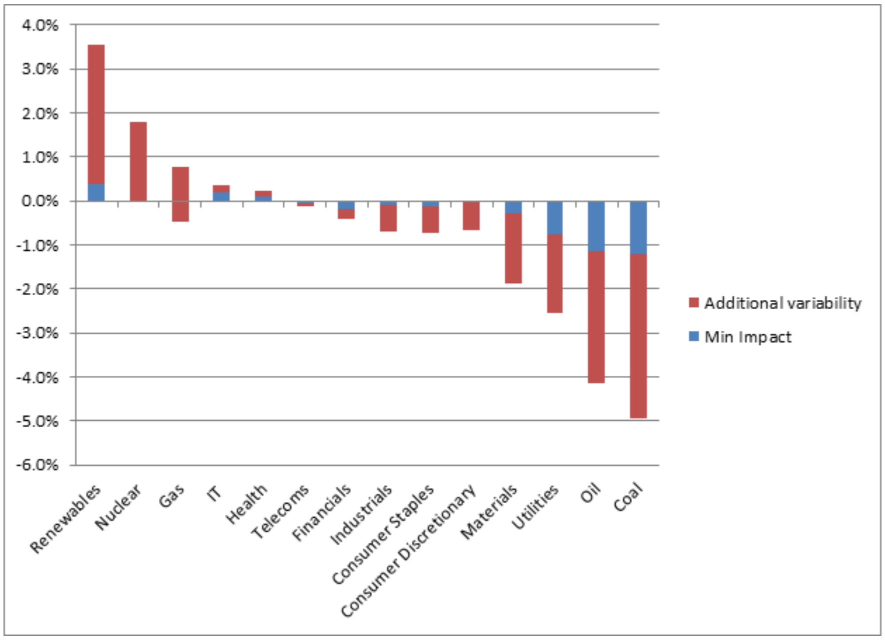
> Agricultural companies: Extreme weather events, heat, and humidity can materially affect the industry's production efficiency and supply chain.
>
> Commercial and residential real estate: Sea level rise and increased storms are expected to have significant consequences on coastal property and infrastructure.

Manufacturing industry: Dangerous levels of extreme heat and rising seas may cause large disruptions in supply chain operations and labor productivity--especially as many manufacturing plants are in high-risk areas such as the Southeast.

The non-renewable energy sector can be materially affected by a global shift toward renewables. Government energy policies can exert a material influence on energy markets. Governments are adopting different energy policy approaches to potential climate risks. Some governments are actively moving to support a transition to a low carbon economy. For example, France passed a law mandating that investors and banks report on the carbon risks and climate friendliness of their portfolios, with disclosures separated between carbon risk and friendliness objectives. In December 2016, France inaugurated the world's first 'solar highway', a road paved with solar panels that are expected to provide enough energy to power the street lights of the small Normandy town of Tourouvre. According to Bloomberg, Colas SA, a subsidiary of France's construction firm, Bouygues Group, has plans to test the technology across four continents at 100 sites in 2017. Saudi Arabia, one of the world's biggest oil producers is seeking up to USD 50 billion of investment in solar and wind energy. U.S. policy may support fossil fuels longer than other countries. In that event, U.S. fossil fuel companies may fare better, and U.S. low carbon technologies may fare worse in the near to medium term than their respective non-U.S. counterparts from countries that provide a policy framework aimed at supporting a transition to a low carbon economy. Over the long term, if the global markets transition to low carbon energy, U.S. companies may be less competitive than counterparts from countries whose governments developed clear energy transition policies.

Mercer finds in its 2015 report "Investing in a Time of Climate Change", that:

> climate risk impacts may vary considerably among industries…The figure below shows the potential climate impact on median annual returns for industry sectors over the next 35 years… The energy sector is broken into its sub-sectors, as one of the most negatively impacted industries in Mercer estimates.



Source: Mercer

Results such as Mercer's can be used as reinforcement of an argument for sector-wide fossil fuel divestment based on the potential for stranded fossil fuel assets. UBS's 2016 paper, "Stranded Assets:

What lies beneath" provides an analytical framework for thinking about the stranded assets debate, based on a study led by Dr. Dinah Koehler and Bruno Bertocci of the UBS Sustainable Investors team. Using scenario analysis, they isolate how publicly traded oil and gas companies may be affected by a steep drop in future consumption of oil and gas.

The author's key conclusions include:

> "Any analysis of the investment implications of the stranded assets hypothesis must take market pricing and dynamics into account; Not all asset value associated with reserves are automatically lost. It depends on whether the price of oil justifies the effort to extract and produce a barrel of oil; at any moment in time a certain amount of known oil and gas reserves cannot be economically produced; even under the most extreme scenarios of reduced oil/gas consumption, many oil/gas companies in the MSCI World Index retain value in the next 10-20 years; There are some oil/gas companies that are not an attractive investment today, and continue to lag behind their peers at various future scenarios; If divestment is chosen as an investment strategy, it should be targeted at those oil/gas companies where the investment is unlikely to be recovered or exceeded in the next 10-20 years."

In our opinion, climate risks to investments, including potentially stranded assets, have become a potentially material investment issue. We believe divestment of fossil fuels, based on the definition employed here, could directly address the risk of potentially stranded assets, primarily in public equities. Divestment of thermal coal could directly address potential stranded asset risk within the sub-sector of fossil fuels that is perhaps at highest risk of becoming stranded. Thermal coal is viewed as a type of fossil fuel that is at highest risk of becoming stranded due to its relatively high carbon emissions. Divestment from Exxon would not significantly reduce VPIC's total exposure to stranded assets.

We believe divestment of all fossil fuels is a blunt tool to apply across a large industry that exhibits varied outlooks for each type of fossil fuel. As one VPIC manager stated "with regard to the stranded asset thesis, Mondrian does not believe the risk of stranded assets applies equally across the fuels as the world must consider the substitutability of each fuel, and the cost to implement substitution. Mondrian believes coal is most at risk, given its higher carbon intensity and the ease of substituting its use in generating electricity. Oil, while next in line in terms of carbon intensity, is primarily used in transportation, and despite multi-year investments in alternatives, the world still has not found an economically viable substitute. Finally, gas, with its lower carbon intensity, would appear to have the lowest risk of stranded reserves."

Divesting from a single fossil fuel company, in this case ExxonMobil, in our opinion, raises additional company-level investment questions. In our opinion, it is not already determined which energy companies will become obsolete, and which will manage to transition to a new energy economy over time. It is conceivable that a dominant fossil fuel company of the 20th century transitions to become a powerful force in a 21st century (or beyond) low carbon energy global economy.

For example, in January 2017, oil and gas majors, Royal Dutch Shell and Total SA announced, along with Toyota Motor Corp. and four of its biggest car-making peers, plans to invest a combined $10.7 billion in hydrogen-related products within five years. In all, 13 energy transport and industrial companies are forming a hydrogen council to consult with policy makers and highlight its benefits to the public as the world seeks to switch from dirtier energy sources, according to a joint statement issued from Davos, Switzerland. The wager demonstrates that batteries aren't the only way to reduce pollution from cars, homes and utilities that are contributing to climate change.

On another front, Royal Dutch Shell, SABIC and Dow/DuPont have made strategic moves to change how petroleum is used, from mostly combustion, which generates carbon emissions, to mostly materials (polymers). Shell's chief oil and gas scientist, Joe Powell, told colleagues at Massachusetts Institute of

Technology that there is no reason the industry could not completely flip the ratio, with 80 percent of oil and gas going to material feedstocks. Such a move could, on the one hand, make use of a stranded resource (oil and gas), and on the other fill a resource vacuum (low carbon building materials). Buildings account for about 30 percent of emissions, about half of which comes from the "embodied" carbon emissions of the building itself -the energy it takes to make the building materials, transport them and build the building. Portland cement alone accounts for five percent of all carbon emissions worldwide. Steel and aluminum require intense industrial heat to manufacture. Lumber, in general, needs to stay in the ground as trees to sequester as much atmospheric carbon as possible. With the world undergoing an unprecedented period of urbanization, and three billion people set to enter the global middle class in the coming decades, emissions from construction are at an all-time high.

In our opinion, divestment from a single fossil fuel company does little to reduce VPIC's stranded asset risk overall, and raises company selection risks in a period of enormous energy transition. In our opinion, because of the global dependence on fossil fuels, divestment of all fossil fuels could expose VPIC to technological shift risks if divestment is not phased in over a long, for example, 30-year period.

Phasing in Various Fossil Fuel Divestment Strategies

A short-term divestment phase-in would likely incur essentially the same magnitude of costs as immediate divestment, and may be at a poor time in the energy market**.** In our opinion, divestment of fossil fuels over a business cycle time frame would not address the key long-term divestment risk of global dependence on fossil fuel energy. A long term, for example, 30-year divestment, geared toward implementation over a technological change cycle that was taken in incremental steps throughout the portfolio, with regular review and reassessment, could smooth out divestment impacts. The increases in management fees required to dismantle VPIC's inexpensive commingled funds and restructure those assets into more expensive SMA's would still be borne by VPIC, just spread out over time. However, a long-term strategy might increase VPIC's asset allocation analyses costs and staff and Board review time.

Financial analysts vary on near-term prospects for fossil fuel companies, as they do on other market investments and the total market. For example, VPIC International Equity manager Mondrian responded to this survey with the overview perspective that "Our analysis indicates that fossil fuel companies, despite low long-term growth, are undervalued. We believe the portfolio would lose exposure to the potential real returns offered by these companies, should they be divested". Macquarie Research (October 13, 2016) held a different opinion: "The [integrated oil] sector still looks expensive versus global markets, with forward PERS [price earnings ratios] at historical highs relative to normal levels despite the recent sharp fall (the integrateds traditionally trade at 20-30% discounts to the key indices)."

Long term outlooks for the carbon energy market also range widely. The U.S. Energy Information Administration, International Energy Outlook 2016 estimates fossil fuels to have accounted for 84% of world energy consumption in 2012, nuclear 4%, and other, which includes renewables, at 12%. Overall world energy consumption is projected to grow at an annual average rate of 1.4% through 2040. By 2040, fossil fuels, combined (liquids, natural gas and coal) are projected to account for 78% of total world energy consumption.

World Energy Consumption			
	History	Projections	
Fuel	2012	2040	Average Annual Percent Change, 2012-40
Liquids	33%	30%	1.1
Natural Gas	23%	26%	1.9
Coal	28%	22%	0.6
Nuclear	4%	6%	2.3
Other (renew)	12%	16%	2.6
Total	**100%**	**100%**	**1.4**

Source: U.S. Energy Information Administration

Optimistic predictions, such as in the International Energy Association's ("IEA") 30-year forecasts expect continued strong global demand for oil and gas, based on increasing population, and expected inability of the global economy to meet those demands with renewables and energy efficiency.

Because PCA's mandate for this research involved discussion of potential divestment from a single company – ExxonMobil, for this report, we asked ExxonMobil and three competing integrated oil and gas majors (Chevron, Royal Dutch Shell and BP) to provide us with answers to specific questions regarding the potentially material risks regarding environmental concerns. Specifically, we asked each firm to provide data according to SASB's accounting standards and metrics for this industry sector. We received no response from Chevron, Shell or BP. Exxon's responses to our questionnaire for this report echo the long-term optimistic assumptions of the IEA (Appendix 9).

At the other extreme, as reported by Responsible Investor, Lou Allstadt, former Executive Vice President at Mobil Oil involved in the ExxonMobil merger in 1999, and current town trustee of Cooperstown, N.Y. which divested its de minimis exposure to fossil fuels, questions the survival of the oil majors "I don't think they are going to survive, I personally divested from ExxonMobil three years ago and reinvested in renewables. Allstadt also referred more broadly to the weak financial conditions that fossil fuels companies are facing. He stated they are being "squeezed from all sides", low prices which force them to increase borrowing, reduce share buybacks, dividends and investments in new projects, OPEC's ability to destroy their profitability by driving down oil prices through output fluctuation, or increasing government regulation and competition from cleaner sources of energy, among other factors.

Some observers feel that the reason the 2015 Paris Agreement succeeded was because the technological advances and potential competitiveness of renewables make them economically viable in a way they were not even five years prior. From this latter perspective, Carbon Tracker Executive Director Mark Campanale argues that from an engagement perspective, shareholders and regulators should put fossil fuel companies into an 'orderly wind down' while increasing investment in renewables.

More generally, the Risky Business November 2016 report, "From Risk to Return: Investing in a Clean Energy Economy" finds that "seriously addressing climate change requires reducing greenhouse gas emissions by at least 80 percent by 2050 in the U.S. and across all major economies". The report finds that this goal is "technically and economically achievable using commercial or near-commercial technology". The report is a product of the Risky Business Project, co-chaired by financial leaders involved in efforts to reduce climate change risks - Michael Bloomberg, Henry M. Paulson, Jr. and Thomas Steyer. The 2014 inaugural report "Risky Business: The Economic Risks of Climate Change in the United States" found that the economic risks from unmitigated climate change to American business and long-term investors are large and unacceptable. This second report turns to the question: how to respond to those risks. Risky Business modeled four different potential approaches, without endorsing any approach, including: 1) Rely heavily on renewable energy, 2) Significantly expand reliance on nuclear energy, 3) Include a substantial amount of fossil fuel power plants with carbon capture and storage, and 4) generate electricity from a relatively even mix of these three zero- and low-carbon resources. "Given an appropriate policy framework, we expect these investments to be made largely by the private sector and consumers, and to yield significant returns." The report argues that "the large investment needs of a transition to a clean energy economy are manageable, especially when compared to the costs that would be imposed by unmitigated climate change and continued fossil fuel dependence, and comparable to other recent investments, such as in unconventional oil and gas production, and in computers and software. Those investments have transformed the American economy, yielding huge returns to those businesses that led in the development of new technologies and products."

In our opinion, a long-term divestment strategy would likely bear less market risk than an immediate fossil fuel divestment strategy that cannot incorporate longer-term changes in technology and global policy.

Divestment within the Context of VPIC Governance Structure

Divestment of fossil fuels, thermal coal, or ExxonMobil should be considered in relation to the VPIC's governance structure, including its relation to VPIC's asset allocation, its equity investment strategy, and VPIC's approach to proxy voting and engagement.

VPIC Asset Allocation

As discussed above, divestment from fossil fuels, thermal coal, or ExxonMobil would require significant restructuring of the VPIC investment manager structure because of the dominant share of fossil fuel, thermal coal, and ExxonMobil exposure in commingled funds. To divest from fossil fuels, VPIC would likely have to conduct an asset allocation analysis that addressed how VPIC would restructure to accomplish divestment in its SSGA S&P Mid Cap 400 fund, its SSGA MSCI ACWI ex-U.S. fund, and its SSGA Barclays Aggregate Bond Index fund that each hold too few assets for VPIC to be able to transition to a SMA.

VPIC's overall investment strategy is designed to diversify among asset classes. As discussed above, we believe divestment of fossil fuels can be a tool primarily in public equities to remove exposure to potentially stranded fossil fuel assets. Divestment does not help VPIC manage other climate change material risks evident in other industries, or provide enhanced exposure to companies involved in energy efficiency and renewable energy. Divestment within VPIC's public equity asset class adds diversification risks if all fossil fuels are divested, and introduces technological shift risks if stocks are not divested over a long period. In our opinion, VPIC's limited exposure to thermal coal and to ExxonMobil would result in minimal diversification or technological changes risks from either of these divestment paths. Thermal coal and ExxonMobil divestment offer equally limited reduction in exposure to potentially stranded assets, compared to VPIC's overall investment portfolio.

In our opinion, divestment, with a proportional reallocation to non-fossil fuel companies increases investments in economic sectors:

- whose products and services generate demand for fossil fuel energy including utilities and transportation;
- that generate significant CO2 emissions, such as construction;
- that finance fossil fuel development; and

- face material physical risks of climate change including agriculture, real estate and consumer goods.

Divestment does not overweight VPIC's exposure to companies potentially stimulating and benefitting from low-carbon and renewable energy solutions.

Divesting from fossil fuel suppliers, in our opinion, has limited direct impact on fossil fuel corporate policies. PCA's 2014 review of the impacts of divestment found that studies suggest that the measurable financial impact on the companies targeted for divestment has been largely minimal. A comprehensive review (Oxford, 2013) found that divestment campaigns' successes have not been through the direct impact on the company's financials, but through a larger 'stigmatization' impact which resulted in successful lobbying of governments for restrictive legislation, which in turn could have meaningful effects on the business practices of targeted companies/industries. This study does not compare engagement strategies with divestment strategies.

Divestment from fossil fuels in the publicly listed bond market can be expected to have the same types of benefits and constraints as in equities. Because of VPIC's minor fixed income exposure to fossil fuel, thermal coal, or ExxonMobil, divestment impacts would be more muted than in equities. One difference between equities and bonds is that because new bonds are regularly issued, while divestment doesn't increase green bond exposure, investments in new green bonds can directly help provide financing for green initiatives.

Real Estate holds no fossil fuels as defined in this report. Divestment from fossil fuels does nothing in the real estate market to address the real physical risks that have become of increasing concern with climate change. Divestment and restrictions on future fossil fuel investments in private equity markets could protect VPIC from any stranded asset risk in its private equity portfolio. Divestment does not increase investments in green privately held companies. Unlike public equity, investment in green companies could directly provide financing to green initiatives.

VPIC's commodities asset class exposes VPIC to fossil fuel commodity markets through commodity futures investments. Divestment based on the definitions of used here for fossil fuels and thermal coal, is not relevant because the VPIC commodities asset class gains exposure through commodities futures, not holdings of any individual securities that own fossil fuel reserves. Any divestment from VPIC's commodities asset class would necessitate eliminating this asset class from VPIC's portfolio. Such an action would conflict with VPIC's current asset allocation strategy.

VPIC's absolute return asset class exposure to stranded assets, and to broader climate change risks, cannot be easily assessed. These assets are invested in some cases through fund of funds, and often through derivatives rather than direct holdings of securities of individual companies. In our opinion, the estimates that result from this study provide little insight into the potential risks to VPIC's absolute return managers in the event of any significant disruptive climate change risk.

In our opinion, addressing potential climate change risks and opportunities in the VPIC portfolio is best accomplished through a bottom up analysis within each asset class.

VPIC Equity Investment Strategy

VPIC allocates its publicly held equity assets primarily through passive investments to gain overall market exposure. As of June 30, 2016, 53% of VPIC equities were passively managed ($806.5 million). VPIC complements these investments with actively managed investments in discrete market segments where VPIC believes active management can increase its risk adjusted returns.

In our opinion, the risk of stranded assets is one of many potential long-term risks that VPIC must consider, including other climate risks in its passively managed equity funds, as discussed above. Today, VPIC's equities are managed against market-cap weighted indexes. These indexes do not explicitly account for potentially stranded asset risks. Market cap weighted indexes also include other biases. There exist a multitude of market wide benchmarks that seek to improve the overall risk adjusted return to investors over market-cap weighted indexes, including fundamental, equal-weighted, smart-beta, and a burgeoning plethora of ESG indexes. We believe other benchmarks may better balance potential stranded asset risk with other macro risks than can divestment.

Divestment constrains active managers in their mandate to find the best opportunities to invest. Thus divestment conflicts with the underlying reason VPIC pays active managers higher management fees than passive management. In the responses from VPIC equity managers, examples of this conflict with a divestment of fossil fuels were evident. For example, one manager, that held only a few fossil fuel stocks for limited periods during the trailing five-year period reports that, its 17-month overweight holding of one fossil fuel stock contributed 74 basis points to the VPIC portfolio, and its 22-month overweight holding of another fossil fuel stock contributed 46 basis points to the VPIC portfolio. In general, if VPIC active managers were prohibited from owning fossil fuels, rather than being allowed to selectively choose geographic, sector, and company weights, and buy/sell timing of each security, VPIC could not receive the full benefits of its active manager's selection expertise.

VPIC Monitoring, Proxy Voting and Engagement

VPIC monitors its investment active managers for exposure to climate change risks. VPIC acts as an active shareholder, and has developed robust governance efforts focused on climate change as part of its overall approach to governance. This includes development of VPIC's custom proxy voting guidelines which bring a strong and coherent approach to voting its proxies, co-filing shareholder proxy proposals, and corporate and public policy and regulatory engagement actions. Appendix 2 lists VPIC engagements in 2015 and 2016. These included actions at XOM and other oil majors, coal companies, and efforts to effect regulatory change around climate change risks and disclosure. VPIC's most recent activity regarding Exxon was in November 2016 when it co-filed with NY State an Exxon Mobil Resolution 2 degree reporting for the 2017 annual meeting.

In our opinion, divestment from fossil fuels would materially undermine VPIC corporate governance strategies. VPIC's actions to promote regulatory and policy changes regarding climate change risks could remain intact. However, divestment would negate VPIC's shareholder governance voting efforts in fossil fuel companies. In our opinion, VPIC and the Vermont Treasurer, supported by the VPIC staff, stand out as a leader in climate change proxy voting and engagement. Through such actions, VPIC has exerted influence beyond its size, in our opinion.

Market Options for Institutional Investors to Manage Climate Change Risks

Divestment as a strategy for exerting political influence to bring about social change has been influential in the modern economy back to the anti-apartheid campaigns that began in the 1970s. The anti-apartheid divestment campaigns, like today's fossil fuel divestment campaigns, began on university campuses, and influenced many endowments and foundations. U.S. public pensions plans today are subject to the same fiduciary obligations that they were during the anti-apartheid movement forty years ago. However, public pension plans have undergone major transformations, along with the U.S. economy. In the 1970s, Vermont pension plans, and most U.S. public pension plans were confined to investing in high quality (not high yield) bonds, and were younger, growing plans. Today, Vermont and many U.S. public plans are mature plans that face many funding challenges. Like other plans, VPIC's asset allocation is now diversified to equities, globally, and across private investments, commodities, and absolute return strategies that didn't exist in the 1970s.

The institutional investment market and the organizations that exist to foster collaboration among like-minded institutional investors has evolved significantly since the well-known divestment movement surrounding South African Apartheid. In the 1970's, institutional investors, specifically U.S. public pension funds did not have the benefit of collaborative organizations to work together for common investment goals. Forty years ago, there was minimal coordinated effort by U.S. public pension funds on proxy voting or engagement with the companies in which they may have been invested. In our opinion, the organizational capacity of institutional investors has advanced materially since then. To mention a few examples, the U.S. Council of Institutional Investors was founded in 1985. In 2006, the Principles for Responsible Investment joined institutional investors globally. CERES was launched in 1989, with a mission to "mobilize investor and business leadership to build a thriving, sustainable global economy". Institutional investor organizations have grown surrounding accounting standards and reporting on ESG issues, including the Global Reporting Initiative. In the U.S., SASB incorporated in 2011 to develop and disseminate sustainability accounting standards.

Alongside these changes, financial markets developed multiple tools for institutional investors to address Environmental, Social and Governance ("ESG") concerns, including climate change risks and opportunities. Market forces continue to rapidly evolve the approaches available to address climate change risks. In our opinion, VPIC should consider divestment of fossil fuels, thermal coal, and Exxon within the context of the full set of options available. Each approach offers its own usefulness and limits, and each approach can reinforce other strategies to varying degrees. We consider the following approaches applied to climate change risks:

- divest
- monitor investment managers
- vote proxies
- engage with companies
- engage on regulatory issues
- invest in index funds or active managers

Peer Pension Plan Climate Change Survey Results

PCA surveyed VPIC peer U.S. public pension funds on climate change related investing strategies. We received twenty-six responses, representing a combined $887 billion AUM. The respondents range in size from $1.2 billion AUM to $195 billion AUM as of June 30, 2016, including nine plans under $5 billion AUM, 14 plans with between $5 -$100 billion AUM, and three plans over $100 billion AUM. The plan's dedicated investment staff range from 0 to 150. Fourteen respondents were state public employee plans.

Survey of VPIC Peers on Climate Change					
	VPIC	Under $5B AUM	$5-$100B AUM	Over $100B AUM	All Peer Plans
Number of Plans	1	9	14	3	**26**
Assets Under Management ($Billions)	$4	$1.2B-$4	$8-$68	$179-$195	**$1.2-$195**
Combined AUM ($Billions)	$4	$18	$315	$554	**$887**
Dedicated Investment Staff	2	0-4	Jan-52	59-150	**0-150**
	Number of Plans that responded 'Yes'				
Divested in relation to Climate Change Risk?	0	0	0	1	**1**
Exxon	0	0	0	0	0
Thermal Coal	0	0	0	1	1
Fossil Fuel	0	0	0	0	0
Stranded Assets	0	0	0	0	0
CO2 Emissions	0	0	0	0	0
Climate Risk	0	0	0	0	0
Measured Climate Change Risk and/or Opportunity of Total or Part of Portfolio?	0	1	0	2	**3**
Monitor Managers on Climate Change Risk and/or Opportunity of Total or Part of Portfolio?	1	1	1	2	**4**
Voted Proxies to Mitigate Climate Change Risk and/or increase Opportunity of Total or Part of Portfolio?	1	1	1	3	**5**
Engagement with individual companies on Climate Change Risk and/or Opportunities?	1	0	0	2	**2**
Action to make recommendations to regulators on Climate Change Risk and/or Opportunities?	1	1	0	2	**3**
Member of Institutional Investor organization/s that include a focus on climate change?	1	2	3	2	**7**
Adopted Climate Change Related Benchmark for Total or Part of Portfolio?	0	0	0	1	**1**
Invested in low carbon portfolio	0	0	0	2	**2**
Invested in Climate Change Opportunity	0	1	2	2	**5**

None of these pension plans have divested from Exxon individually, all fossil fuel companies, companies based on high stranded carbon reserve assets, high carbon emissions, or broader climate risk. One plan reported that under their Iran/Sudan policy they had a few fossil fuel related divestments. One plan with over $100 billion in AUM reported divestment from U.S. thermal coal companies.

We found a greater number of plans pursue proxy voting and/or investments in green/climate change opportunities than divest from any definition of fossil fuels. Five plans report voting proxies to mitigate climate change risk (three plans larger than $100 billion in AUM, one plan between $5 billion and $100 billion AUM, and one plan under $5 billion AUM). Five plans reported investments in green/climate change opportunities within different asset classes that include public securities, private equity and infrastructure, while two plans over $100 billion AUM have invested in a low carbon portfolio.

Seven of the 26 plans noted that they are members of institutional investor organizations that address climate risk related topics –including CERES/INCR, Council of Institutional Investors, Sustainable Accounting Standards Board ("SASB"), and UN Principles for Responsible Investing.

The September 2016 survey by the North Carolina Department of the State Treasurer entitled: "Long Term Stewardship: A pragmatic Approach for ESG Integration for Institutional Investment", included responses from 61 U.S. public pension plans ranging in size from less than $5 billion to greater than $100 billion. The survey concentrated on institutional approaches to ESG. The results closely align with the results of this VPIC peer survey. Among the 61 public pension plans in the North Carolina study, 15% were found to be active on ESG factors, 26% were categorized as work in progress, and 59% were inactive. An investor was categorized as being "active" if it had an established ESG policy, incorporated ESG factors into either its investment or risk management process or had a systematic approach to corporate governance issues such as shareholder activism. One of the key observations based on the responses of the U.S. public pension plans touched on divestment, and reported similar results as this VPIC peer survey:

> "For most of the active plans, engagement with companies on ESG issues is viewed as being more impactful than divestment. This viewpoint is supported by empirical studies and the pensions' direct experience. Impactful corporate engagement is both time and staff intensive. Consequently, smaller plans are interested in collaborating with larger ones on certain shareholder resolutions. Plans may also outsource this activity to external firms that provide corporate engagement services." (Long Term Stewardship, page 9).

Divestment

To supplement our survey on divestment of fossil fuels by U.S. public pension funds, we reviewed other sources of U.S. public pension fund divestments. The December 2016 Arabella Advisors report: "The Global Fossil Fuel Divestment and Clean Energy Movement" made headlines in December 2016 by stating that the value of assets represented by institutions and individuals committing to some sort of divestment from fossil fuel companies has reached $5 trillion". The report states that "pension funds and insurance companies now represent the largest sectors committing to divestment, reflecting increased financial and fiduciary risks of holding fossil fuels in a world committed to stay below 2 degrees Celsius warming". PCA sought to identify which U.S. public pension plans were included in these numbers. We secured the list of U.S. pension plans from one of Arabella's partners who is credited with helping gather and analyze the data for the Arabella report – the Divest/Invest Network. The Divest/Invest organization identified seven U.S. public pension plans that have divested from some version of fossil fuel securities. We checked the information on each of the seven plans and found that only four of those seven plans have divested from any version of fossil fuels. For example, CalPERS, the largest plan among the seven, and the largest U.S. public pension plan, was included as having divested. To date, CalPERS has not divested from any fossil fuels, and has the issue under review. The largest U.S. public pension plan in the Divest/Invest list that has made any fossil fuel divestments is CalSTRS – a respondent to our survey.

The total market value of the fossil fuel divestments made by the four plans identified by Divest/Invest that have in fact made a fossil fuel divestment has been approximately $24 million, or 0.013% of their combined total plan assets of $193 billion. The plans include:

1) CalSTRS divested approximately $1.5 million in U.S. thermal coal, or 0.0008% of its $186 billion portfolio. CalSTRS is now analyzing whether non-US thermal coal divestment makes sense,

including looking at whether in some areas of developing countries, the only alternative to coal is even worse polluting wood burning fuels).

2) The District of Columbia divested roughly $21 million from the "Carbon Underground Top 200", or 0.03% of its $6.4 billion portfolio.
3) Providence, Rhode Island divested about $1.5 million in direct investments, or 0.6% of its $282 million portfolio, from the "Filthy 15" (mostly companies that own coal-burning power plants or coal mining companies).
4) The Village of Cooperstown, N.Y. reallocated approximately $8,386, or 0.9% of their total $900,000 AUM, when they moved their $140,000 investment in an S&P500 index fund to the SPYX ETF, which drops 29 fossil fuel stocks from the S&P500.

We conclude that divestment from fossil fuels is a sparsely used strategy among U.S. public pension plans, including by those plans, large and small, that are active on potential climate change risks to their investment portfolios.

In our opinion, divestment as a strategy is most closely aligned with traditional socially responsible investing (which often rests on 'negative' screening out of specific social outcomes) to impact investing. Negative screening seeks to achieve a social impact, and can seek both market or below or above market performance. While all investors typically prefer a competitive return, not all are legally bound to seek such returns. For example, individuals may decide they prefer investing in stocks that meet their social criteria, even with the expectation that their portfolio may generate below market investment returns. U.S. endowments and foundations are not bound by the same fiduciary framework as U.S. public pension funds.

As a strategy, in our opinion, divestment undermines institutional investor's ability to exercise their right to proxy votes and engagement with individual companies. For institutional investors actively voting proxies and/or engaging corporations, divestment's lack of consistency with such efforts can be meaningful. In cases where it is determined that proxy voting and engagement strategies are not useful, divestment may not pose a conflict with other institutional investor efforts. Such a determination can only be made, in our opinion, on a case by case basis, looking at the long-term potential for engagement. As with investment strategies, such a determination can and should be expected to differ among different institutional investors.

Invest in Low Carbon or Green Tilted Index Fund(s)

Index providers and investment managers are developing new products to address climate change concerns of investors. Most major index providers now offer ex-fossil fuel indexes. The major index providers also created low carbon and green indexes, and broader ESG indexes that incorporate governance and social factor ratings alongside environmental ratings. Instead of removing specific stocks from an underlying benchmark, these indexes seek to reduce the tracking error of the climate change related index to its underlying benchmark by reweighting the stocks in the index to reduce, for example, carbon emissions exposure, or increase, for example, exposure to non-carbon and carbon reduction energy products, while maintaining a narrow tracking error to the underlying benchmark.

We use as an example below, MSCI's climate risk related indexes as compared to the MSCI ACWI, an equity reference benchmark for VPIC. As shown below, the MSCI ACWI Low Carbon Index maintained a 0.4 tracking error to the MSCI ACWI during the trailing five-year period ending June 30, 2016, while the MSCI ACWI ex-Fossil Fuel deviated from the underlying passive benchmark by 1%. During this five-year period, the MSCI ACWI ex-Fossil Fuels index outperformed both the MSCI ACWI and the MSCI ACWI Low Carbon indexes in returns, as oil prices plummeted. In periods of rising oil prices, such as began in 2016 and are anticipated to continue in 2017 and 2018, the removal of fossil fuels may well be a drag on the portfolio returns.

For passive investments seeking market wide exposure, a key advantage of low carbon indexes such as MSCI's is that deviations from the underlying benchmark are kept within a narrow range by design. MSCI's ESG Index ranks companies based on ESG scores and key ESG controversies, and also sets a range for deviation from the underlying benchmark. The tracking error for MSCI's ESG index is designed to be somewhat wider than that of its Low Carbon Target Index. The MSCI ACWI ESG outperformed the ACWI and ACWI Low Carbon Target during this period.

Performance and Risk Data (periods ending June 30, 2016)					
Name of Index	**ACWI**	**ACWI ESG**	**ACWI LOW CARBON TARGET**	**ACWI ex COAL**	**ACWI ex FOSSIL FUELS**
Annualized Return Gross of License Fees)					
5-year Return	5.95%	6.71%	6.28%	6.28%	7.15%
Volatility (Standard Deviation)					
5-Year Risk	13.54%	13.07%	13.53%	13.42%	13.19%
5-Year Tracking Error	0.00%	1.10%	0.41%	0.26%	1.03%
5-Year Sharpe Ratio	47.85%	54.54%	50.15%	50.50%	57.32%
5-Year Maximum Drawdown	17.33%	15.98%	17.19%	17.06%	16.75%
No. of Constituents	2,481	1,221	1,786	2,439	2,353
Average Mkt Cap	$14,397	$14,667	$17,629	$14,525	$14,174
Comparative Carbon Exposure					
Carbon Emissions (tons CO2e/$M invested)	184		45	170	145
Carbon Reserves as Potential Emissions	2094		19	1438	0
ExxonMobil Share of Index	2nd (1.1%)	Below top 50	86th (0.6%)	2nd (0.1%)	Excluded

Source: MSCI

MSCI also publishes carbon metrics for its MSCI ACWI, MSCI ACWI Low Carbon Target Index, and its MSCI ACWI ex-Fossil Fuels Index. As shown, MSCI's ACWI Low Carbon Target Index reduces carbon emissions per million dollar invested by 76%, as compared to the ex-fossil fuel reduction of 5%. Measuring potential carbon emissions per million dollar invested, the MSCI ACWI Low Carbon Index reduces the MSCI ACWI exposure by 99%, as compared to the ex-Fossil Fuel Index reduction of 100%. When measuring fossil fuel reserves, the Low Carbon Index generated a 60% reduction from the MSCI ACWI, as compared to 78% for the ex-Fossil Fuels Index.

The reweighting of individual securities can be significant when comparing the MSCI low carbon and ESG indexes to the underlying MSCI ACWI. For example, for the period ending June 2016, ExxonMobil's was the second largest holding in the MSCI ACWI. This compares to ranking 86th in the MSCI ACWI Low Carbon Target Index, and below the top 50 largest holdings among MSCI's ACWI ESG Index.

Institutional investors, including U.S. public pension funds, have invested a portion of their passive equity allocations in funds benchmarked to such indexes. For example, in July 2016, CalSTRS, the second largest pension fund in the US, committed up to $2.5 billion to low-carbon strategies in U.S., non-U.S. developed and emerging equity markets based on MSCI's ACWI Low-Carbon Target Index. The passive index portfolio will be internally managed by the CalSTRS Global Equity investment staff and implementation will be phased in beginning with U.S. equity followed later by developed markets and then eventually emerging markets.

The $185 billion New York State Common Retirement Fund ("NYSCRF") is the third largest pension fund in the US. NYSCRF intends to double its exposure to $4 billion in a low carbon index strategy that it launched with Goldman Sachs Asset Management (GSAM) just prior to the Paris COP21 conference in 2015, after what it said were positive environmental and financial results. The NYSCRF low carbon passive equity investment is based on index data from FTSE Russell. Peter Grannis, the First Deputy Comptroller in the Office of the New York State Comptroller, noted in December 2016 that performance so far had been encouraging: "It's been in line with our expectations and with a tracking error of 0.25%. On the environmental side we've reduced the carbon emissions of this asset portion by 70%.

In June 2016, FTSE released a new FTSE Green Revenue Index that seeks to increase the exposure to green product and services in all companies large and small, even should those products and services be sold by fossil fuel companies, while maintaining a close tracking error to the underlying benchmark. This index measures the green product exposures in companies in an underlying benchmark, and then reweights constituents based on their green weighting. As with the low carbon indexes, no securities are excluded. However, some companies can go to a 'zero weight', thus effectively being reduced to a zero weight as compared to the underlying benchmark.

As shown below, the FTSE Russell 1000 Green Revenue Index closely tracked the underlying Russell 1000 benchmark on risk and return metrics, the number of constituents, and average market cap for the period ending December 31, 2016. The Green Revenue index shows 2.17% exposure to green revenue, up from 1.47% in the Russell 1000.

FTSE Russell 1000 Green Revenue Index Compared to Underlying Benchmark (Periods ending December 31, 2016)

Name of Index	Russell 1000 Green Revenue	Russell 1000
Annualized Return Gross of License Fees		
1-Year Return	2.95%	2.93%
5-year Return	11.74%	11.88%
Volatility (Standard Deviation)		
1-Year Risk	14.56%	14.62%
5-Year Risk	12.36%	12.33%
5-Year Tracking Error	0.16%	
5-Year Sharpe Ratio	0.94	0.96
5-Year Maximum Drawdown	-14.89%	-14.68%
No. of Constituents	1001	1001
Average Mkt Cap	$20,318MM	$20,271MM
Measure of Green Revenue Exposure	2.17	1.47
Measure of ESG (0-5, highest)	2.79	2.79

Source: FTSE Russell

FTSE designed the Green Revenue Index to make modest changes based on green revenue exposure, so typically, an individual company's share of the R1000 doesn't change dramatically based on the reweighting for their Green Revenue Index.

The underlying concept – that green revenues are being generated by very large companies, that often have wide-ranging product lines in addition to green revenues, including publicly listed companies, and even oil and gas companies. For example, SASB states that industrial conglomerates General Electric (U.S.) and Siemens (Germany) each generated 7.3% of their revenues ($9 billion and $6.1 billion respectively) from the renewable energy segment as defined by SASB in 2016. Archer Daniel

Midland, U.S. agricultural product processing and trading company generated 9.3% of its revenue ($6.3 billion) from 'bio-products' ethanol segment in 2016. Valero, an energy oil and gas refining company, generated 3.9% of its revenue ($3.4 billion) from ethanol biofuel in 2015.

Climate related, and ESG benchmarks first emerged in equities. Barclay's December 2016 report shows that:

- ESG need not be an "equity-only" phenomenon and can be applied to credit markets without being detrimental to bondholders' returns.
- A positive ESG tilt resulted in a small but steady performance advantage.
- No evidence of a negative performance impact was found.
- ESG attributes did not significantly affect the price of corporate bonds. No evidence was found that the performance advantage was due to a change in relative valuation over the study period.
- When applying separate tilts to E, S and G scores, the positive effect was strongest for a positive tilt towards the Governance factor, and the weakest for social scores.
- Issuers with high Governance scores experienced lower incidence of downgrades by credit rating agencies.
- Broadly similar results were observed using ratings from the two ESG providers considered in this report (MSCI and Sustainalytics) despite the significant differences between their methodologies.

Barclay's research findings underscore the potential importance of systematic biases that can be introduced when developing any ESG benchmark compared to its underlying market wide benchmark, and the potential negative impacts of exclusion of entire industries. As reported:

> "In research conducted in 2015, Barclays Research analyzed the historical returns of both its Socially Responsible ("SRI") corporate bond index that is based on negative screening, and Barclays Sustainability index that uses a 'best-in-class' approach based on ESG ratings to choose the best-rated subset of index bonds within each industry.
>
> While both had underperformed in terms of nominal returns, some of that underperformance was traced to systematic biases unrelated to ESG criteria. Once they were corrected, we found that the return impact due specifically to the ESG tilt in security selection was positive for the Sustainability index, but negative for the SRI one. We concluded that the wholesale exclusion of entire industries from the investment universe, while it may be desirable based on ethical considerations, is not justified based on purely financial criteria."

Low carbon, green revenue and broader ESG Indexes are relatively new products that offer institutional investors alternatives to simple divestment and the related tracking error complications of divestment strategies that can be critical to passive investment strategies. In our opinion these strategies complement proxy voting and engagement efforts in that they do not reduce the shareowner's position in fossil fuel companies to zero. Thus, shareholders maintain a vote on proxy proposals. We note that low carbon indexes will often reduce the shareowner position in fossil fuel companies, thus reducing the investor's weight in any given fossil fuel company proxy vote. Currently, passive investments vehicles that track an ESG index, including low carbon/green revenue indexes, have higher management fees than those of widely used standard benchmarks. The higher all in management fees will include slightly higher index licensing fees than the licensing fees for core benchmarks.

Invest in Active Manager(s) Emphasizing Climate Risks/Opportunities

The active manager institutional investment market has evolved to include both managers explicitly targeting renewables, or low carbon markets, and managers who incorporate ESG metrics into their stock selection, including climate change material risks. These efforts encompass both fundamental and quantitative management strategies. Most recently, active managers began more systematically incorporating ESG risk factors alongside traditional financial factors seeking to improve active management returns, labeled below as ESG Integration.

ESG Active Investment Management Approaches

Investment Approach to ESG Factors	Description	Social Outcome	Competitive Performance Outcome
Negative Screening	Exclude companies based on non-financial concerns such as tobacco, firearms, more recently, fossil fuels.	REQUIRED	NOT ALWAYS REQUIRED
Impact Investing	Incorporate social outcome and seek to make a market return.	REQUIRED	VARIED
Positive Screening	Select a portfolio of companies with desirable characteristics to form an investment universe.	REQUIRED	VARIED
ESG Integration	Integrate ESG material risks into traditional financial analysis, independent of seeking any specific social/environmental outcome to improve portfolio performance.	NOT EXPLICITLY REQUIRED	REQUIRED

The growth in ESG investment demand is fueling an expansion of the ESG investment manager universe. Historically ESG was primarily the purview of specialized ESG managers, and some managers that offered both traditional investment products and ESG products. Today, large global investment firms are developing ESG products, both through acquisition and increased hiring and reorganization. In some cases, a new ESG profile means emphasizing what a manager believes they have always done regarding these risks.

Similar to the passive investment market, active management around climate risk concerns grew first in equity markets. Today green bonds are being measured, rated, and targeted for specific investment strategies to boost their share in an overall bond portfolio.

In our opinion, active manager products that integrate climate risks or broader ESG risks into their security selection, bear the same active selection risks of the broader active manager market. Typically, the risk increases as the manager's universe of securities narrows. Such products are compatible with monitoring, proxy voting and engagement. To the degree that such a strategy replaces a strategy that doesn't account for climate risks, including stranded asset risk, the move to an ESG strategy incorporating these risks may reduce or remove the investor's proxy voting weight in such companies. ESG active manager fees are typically in range of fees charged by comparable non-ESG active managers.

Monitoring

Monitoring of a portfolio for ESG, including climate change, risks can be undertaken portfolio wide and by monitoring of individual managers. The tools for such analysis are rapidly being developed and marketed in response to institutional investor demand. There is widespread evidence of a concerted push for disclosure, standardization, quantification and systematic risk analysis to integrate sustainability into risk/return analysis across the market.

The December 2016 release of the recommendations from the Task Force on Climate-related Financial Disclosures ("TCFD") marked a prominent step in seeking consistent disclosure, without which investors cannot appropriately assess and price the risks involved. The TCFD's, which was assembled by Mark Carney as Chairman of the Financial Stability Board, and chaired by Michael Bloomberg, aims to help integrate better understanding of the risks and opportunities presented by climate change into investment and insurance underwriting decisions. There are four key features to the TCFD's recommendations:

- Adoptable by all organizations.
- Included in financial filings rather than other reports such as corporate social responsibility reports.
- Designed to solicit decision-useful, forward looking information on financial impacts.
- A Strong focus on risks and opportunities related to the transition to a lower-carbon economy.

Crucially, the report recommends that companies use different scenarios to report on governance, strategy, risk management, and metrics and targets, including a 2degree scenario.

Portfolio-wide monitoring might involve looking at a plan's overall carbon footprint, or assessing a plan's overall exposure, compared to its benchmark, to E, S and or G, or combined ESG ratings of companies in their portfolio. Carbon footprint analysis today contains many inconsistencies and holes due to lack of consistent data reported by companies, but is improving as reporting improves. Firms such as MSCI and Sustainalytics provide ESG company ratings. ESG ratings can provide meaningful insights into individual company risks. These ratings are not quantitative metrics, such as a standard deviation that can be aggregated and reported as an overall portfolio risk exposure metric. All ESG ratings involve the judgement of the researchers conducting the analysis. Ratings can and do differ meaningfully among providers. For example, Northern Trust observed in January 2017 that they found MSCI and Sustainalytics gave similar ESG ratings for approximately 60% of the companies that they both rated.

Broader, portfolio-wide climate risk frameworks are being developed. Mercer sought to measure climate risk by asset class, and identify differing industry impacts in its ongoing work. Towers Watson announced in January 2017 that it is rolling out a new sustainability framework that seeks to link sustainability analysis with investment returns. As reported by Responsible investor, a pillar of their analysis is:

> "industry level research to determine how business profit pools are likely to change and how private and public capital will be allocated. When its complete, the framework will allow investors to seamlessly integrate the same financial, sustainability and ESG metrics into all aspects of portfolio management. i.e., from risk management, through portfolio construction, all the way down to security selection."

The prominence of concerns over environment-related risks is generating new quantitative metrics too, that did not exist a decade ago. For example, a decade ago, a typical institutional investor interested in the energy sector would not necessarily consider a firm's track record on environmental issues. Today, regulatory changes facing the energy sector make such non-financial issues potentially material. Investment consultants to institutional investors have increased their efforts to monitor managers on environmental, social, and governance ("ESG") issues, including climate change risks, incorporating such questions into regular monitoring activities, and into requests for proposals when new managers are being considered.

Recent research indicates that distinguishing between material and immaterial ESG issues can be meaningful in capital allocation. Khan, Serafeim and Yoon's 2015 analysis:

> "Corporate Sustainability: First evidence on Materiality", finds that "firms with good ratings on material sustainability issues significantly outperform firms with poor ratings on these issues. In contrast, firms with good ratings on immaterial sustainability issues do not significantly outperform firms with poor ratings on the same issues. These results are confirmed when we analyze future

changes in accounting performance. The results have implications for asset managers who have committed to the integration of sustainability factors in their capital allocation decisions."

Manager monitoring on ESG issues including climate risk can often be accomplished by a pension plan's investment consultant, without adding costs to the plan's overhead. Monitoring can signal managers that these issues concern their institutional clients and can complement proxy voting and regulatory activities. Monitoring is often a first step in understanding the climate change issues facing the portfolio, without taking specific actions through voting, engagement, investment or divestment. As noted above, only a handful of U.S. public pension funds in the survey currently monitor their investment managers on climate change related risks. VPIC does monitor its managers on ESG issues. For example, VPIC reported the manager responses to staff's survey of managers on ESG integration in the State of Vermont Treasury Staff Divestment Memo, July 28, 2015.

Proxy Voting

As shown below, the number of shareholder proposals on environmental issues, and the average number of votes for shareholder proposals on environmental and environmental disclosure related issues, including climate change, trended upward for the Russell 3000, energy stocks, and for XOM since 2000. During the first 10 years of the 21st century (2000-2009), Russell 3000 stocks averaged 23 environmental-related shareholder proposals each year. During the most recent period (2010-16), this number more than doubled to an average of 57 environmentally related shareholder proposals each year. Similarly, during these periods, the average number of votes for environmentally related shareholder proposals among the Russell 3000 companies rose from 13% to 22%.

Shareholder Proposals on Environmental issues, 2000-2016*								
	Num. Went to Vote			Num. Passed		Avg Votes For		
Period	R3000	Energy	XOM	R3000	XOM	R3000	Energy	XOM
2000-2009	23	8	1.8	0.2	0	13%	16%	8%
2010-16	57	12	2.9	0.6	0	22%	22%	13%

Sources: CalSTRS and CII information based on ISS data.

Institutional investors anticipate re-filing a high profile shareholder resolution for the 2017 proxy season at ExxonMobil, which was filed in 2016 to urge Exxon to publish an annual assessment of the long-term portfolio impacts of public climate change policies. In 2016, this shareowner proposal got the support of 38% of shareholders, as part of a campaign of similar high-scoring resolutions at oil majors around the world, many of which received majority support.

Recent research finds that the impact of shareholder proxy voting proposals on material environmental and social issues have affected corporate financial performance. Grewal, Serafeim and Yoon's 2016 report "Shareholder Activism on Sustainability Issues" finds (based on SASB's industry level definitions of materiality) that:

"42 percent of the shareholder proposals in their sample were filed on financially material issues. We document that filing shareholder proposals are related to subsequent improvements in the performance of the company on the focal environmental or social issue, even though such proposals nearly never received majority support. Improvements occur across both material and immaterial issues. Proposals on immaterial issues are associated with subsequent declines in firm valuation, while proposals on material issues are associated with subsequent increases in firm value. We show that managers increase performance on immaterial issues in companies

> with agency problems, low awareness of the materiality of sustainability issues, and poor performance on material issues."

Shareholder proxy proposals that are not explicitly related to carbon may exert influence at fossil fuel companies on carbon-related issues. A key example is the rising support for proxy access. At Exxon in 2016, a shareholder proposal passed that gives shareholders greater power to propose director candidates. Institutional investors anticipate using these steps to advocate for Exxon board members who are "climate competent". As reported by Sidley Austin LLP, in "Sidley Corporate Governance Report" (January 3, 2017):

> "In late December 2016, proxy access reached the tipping point in terms of adoption by large companies – just over 50% of S&P 500 companies have now adopted proxy access. Through the collective efforts of large institutional investors, including public and private pension funds, and other shareholder proponents, shareholders are increasingly gaining the power to nominate a portion of the board without undertaking the expense of a proxy solicitation. By obtaining proxy access (the ability to include shareholder nominees in the company's own proxy materials), shareholders will have yet another too to influence board decisions."

Proxy voting can complement manager and portfolio monitoring, engaging with companies and regulators. In a targeted low carbon fund, proxy voting at fossil fuel companies can still be useful, but to a smaller degree because the exposure to fossil fuel companies is reduced compared to a market wide fund. Divestment would negate VPIC's proxy efforts at fossil fuel companies because fossil fuel companies would be eliminated from the portfolio.

Summary of Market Options in Relation to Divestment

The table on the following page seeks to summarize key parameters for institutional investors of various tools available to control the climate change risks and opportunities. As shown, straight divestment strategies, by excluding companies from any given fund or universe, make a strong public statement and rely on a transparent and simple methodology.

Divestment does not consider short-term financial risks or long-term diversification risks, which increase as the universe of divested stocks increases. Divestment from fossil fuels, suppliers of fossil fuel energy, will, if simply reweighting the rest of the portfolio, result in an increased exposure to companies on the demand side of fossil fuel energy, and in the companies financing fossil fuels. Transaction, restructuring and opportunity costs may vary according to the assets being divested, and the fund structure from which they are being divested. Divestment removes an institution's ability to influence corporate behavior by voting proxies and engagement.

Approaches to Addressing Climate Risk Key Parameters for Institutional Investors*					
Approach	**Short-term Financial Risk***	**Long-term Investment Thesis***	**Costs**	**Shareholder Communication***	**Public Stance***
Divest	Not-considered	Based on individual security selection; or long-term stranded assets thesis; diversification risks not considered	Transaction costs, portfolio restructuring, and opportunity costs vary with assets being divested and with fund structure.	Transparent and simple methodology	Makes strong public statement; but cannot directly influence corporate behavior; removes proxy and engagement access to influence companies.
Monitor funds	None	Alert managers	Minimal	Highlight concerns	Shows concerns
Vote Proxies	None	Improve underlying fundamentals of individual public equity investments	Staff and board time; proxy service provider costs. Requires costly in-house or SMA passive management to control all votes.	Generally simple; specific proxies can be complex	Voting proxies makes public statement; can directly influence corporate behavior
Engage with Companies	None	Improve underlying fundamentals of individual public equity investments	Requires minimal to high staff and board time depending on the number and complexity of issues.	General simple; specific efforts can be private process; communication can be detailed	Makes statement. Often private during engagement process; can directly influence corporations
Engage on Regulatory Issues	None	Improve regulatory fundamentals	Requires minimal to high staff and board time.	Generally simple. Specific issues can be complex.	Makes statement and can influence regulatory environment
Invest in Low carbon or green tilted index funds	Optimizes to reduce tracking error to parent index	Optimize to reduce carbon increase green, and retain full opportunity set	Typically, a few basis points more in fees than underlying benchmark.	Sophisticated methodology, could be more difficult to explain	Makes statement for low carbon/high green economy. Allows voting proxies, engagement.
Invest in active focus on climate risks/ opportunities	Risk depends on fund strategy	Relies on active manager skills to outperform	ESG active manager fees in line with non-ESG active manager counterparts	Transparent and simple to explain	Makes statement for low carbon/high green economy. Allows voting proxies; engagement;

** PCA developed this chart of approaches to climate change risk from MSCI's March 2015 key parameters for institutional investors for assessing different public equity index options. PCA's adaptation including adding the cost parameter.*

Conclusion

In our opinion, divestment of fossil fuels, thermal coal, or Exxon is one possible approach for VPIC to mitigate a potentially significant climate risk – possible stranded assets of fossil fuel suppliers. Given the financial and governance costs that come with fossil fuel divestment, in PCA's opinion, divestment of fossil fuels, thermal coal, or Exxon has not been shown to be in the best interests of VPIC pension beneficiaries, and conflicts with VPIC governance structure. In our opinion, markets now offer meaningful tools to address climate risk other than divestment, from coordinated proxy voting and corporate and public policy engagement, to passive and active low carbon alternatives that avoid the broad market exit risk inherent in near-term divestment approaches. We believe VPIC should continue its effort to address and manage climate and other ESG risks and opportunities. In our opinion, VPIC should continue to stay abreast of, and consider, the ongoing changes in assessments of climate risks, and approaches to managing these risks.

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Appendix 1) List of Peer Pension Plans that Responded to Climate Risk Survey

We thank the pension plans listed below for participating in this survey. The plans are listed according to their total assets under management.

2016 Climate Change Survey of VPIC peer U.S. Public Pension Plans	
Name of Pension Plan	**Assets Under Management ($ Billions)**
Total	$887
East Bay Municipal Utility District Retirement System	$1
San Luis Obispo County Pension Trust	$1
Louisiana Public Employees Retirement System	$2
Municipal Fire and Police Retirement System of Iowa	$2
San Joaquin County Employees Retirement Association	$2
Seattle City Employees Retirement System	$2
Sonoma County Employees Retirement Association	$2
Fresno City Employees' Retirement System	$3
Fresno County Employees' Retirement Association	$4
Employees' Retirement System of Rhode Island	$8
Arkansas Public Employees Retirement System	$9
Municipal Employees Retirement System of Michigan	$9
Oklahoma Public Employees Retirement System	$9
Los Angeles City Employees Retirement System	$14
Employees' Retirement System of Georgia	$15
Employees' Retirement System of the State of Hawaii	$15
West Virginia Investment Management Board	$17
Kansas Public Employees' Retirement System	$18
Los Angeles Fire and Police Pension Fund	$19
South Carolina Retirement Systems	$29
Public School & Education Employee Retirement Systems of Missouri	$39
Maryland State Retirement and Pension System	$45
Oregon Public Employees' Retirement System	$68
New York State Common Retirement Fund	$179
Florida State Board of Administration	$180
California State Teachers Retirement System	$195

Appendix 2) VPIC and Vermont Treasurer Climate Change Engagement Activities

VPIC and Vermont Treasurer Engagement Activities on Climate Change (April 2015 - December 2016)	
4/16/2015	BP resolution that VPIC co-filed on received 98.28% of the vote to get better disclosure and get an A from CDP
4/17/2015	TRE & VPIC signed-on to letter to the SEC on better disclosure regarding climate change risks
4/21/2015	TRE signed-on to letter to the SEC to strengthen disclosure of corporate political contributions.
5/5/2015	Declare vote for the XOM resolution for GHG reduction targets
5/21/2015	Signed on to Letter: The New York State Common Retirement Fund and Green Century Capital Management, together with over $1.5 trillion AUM from signatories, are calling on the Roundtable on Sustainable Palm Oil (RSPO) to strengthen its standards to support deforestation-free and exploitation-free palm oil.
5/27/2015	Treasurer attended XOM AGM. Beth introduced resolution and spoke in capacity as treasurer
7/6/2015	Signed on to letter to SEC re: proxy access
7/10/2015	Treasurer sent letter on behalf of VPIC & TRE to SEC re: proxy access proposal rulings 14a-8(i)(9) for proxy access (if mgmt brings similar resolution shareholder's is thrown out)
7/13/2015	TRE signed on to SEC letter asking for stronger private equity fee disclosure to public pension LPs. RI Treasurer was lead on letter
7/21/2015	TRE meets with ISS to discuss policy on Environmental resolutions and how we can get their support re: Exxon
7/22/2015	TRE meets with INCR members to create a work plan for the 2016 proxy season
7/27/2015	VMERS votes to reject divestment of fossil fuels
7/27/2015	Vermont Retired Teachers Association votes to reject divestment of fossil fuels
7/28/2015	VPIC votes unanimously to reject divestment of fossil fuels
7/29/2015	Follow-up with Investment Managers re: their UN PRI grade on fulfilling the principles
7/29/2015	Follow-up with Australia's SuperEnergy Fund re: PE disclosure laws, research, requests, etc
8/5/2015	Call with Exxon to discuss questions regarding transparency
9/4/2015	Treasurer hosted an informational session about Pensions and included an ESG session in the afternoon where Ceres presented to legislators
10/30/2015	Treasurer signed on to a letter to the Indonensian President urging him to support private-sector forest conservation policies (part of the Palm Oil deforestation movement)
1/27/2016	Treasurer Pearce is serving as a Convener of the 2016 Investor Summit on Climate Risk at the UN Headquarters in NYC
12/2/2015	VPIC co-files with As You Sow and Calvert on resolution with FirstEnergy requesting they create a report quantifying the potential financial losses associated with stranding of its coal generation facilities under a range of climate change driven regulation scenarios mandated by the Clean Power Plan.
12/11/2015	VPIC co-filed with Tri-State Coalition on a resolution at Chevron requesting they create GHG targets for the long-term.
12/14/2015	VPIC co-filed with NY State Common Retirement Fund and the Endowment of the Church of England at Exxon on a CAR resolution
2/10/2016	Treasurer Pearce, on behalf of VPIC, participated in a filer call with Exxon to discuss the resolution along with NYState, Church of England, Boston Trust, UC Davis and CDA
3/28/2016	Director of Investments sends Dear Colleague letter on Beth's behalf to Investment Managers, Vendors (NEPC, JPM, ISS, etc), and public fund sponsors requesting they declare their support publicly for CAR resolutions.
3/30/2016	ISS and Glass Lewis call with investors to discuss supporting the Chevron Resolution
4/5/2016	Vermont State Treasurer and VPIC sign on to "Declaration of Support" for 2D resolutions
4/6/2016	Staff attended webinar on EU Non-Financial reporting Directive (reporting on ESG factors requirement for companies)
4/21/2016	OT sent on behalf of VPIC a memo to ISS & Glass Lewis in support of the Exxon Resolution Item No. 12
4/21/2016	Dear Treasurer's Memo sent from Treasurer Pearce requesting their support for Exxon, Chevron & FirstEnergy proposals on the proxy vote.
6/13/2016	Signed on to a letter through CII directed to Honorable Maxine Waters (Ranking Member) and Honorable Jeb Hensarling (Chairman) of the House Committee on Financial Services to voice our concern with HR 5311. TRE then sent a letter to VT Congressional delegation to tell them we are not happy with section g of this bill and that we have signed on to CII letter concerning HR 5311.
7/8/2016	CII sends letter to SEC for comment period "Business and Financial Disclosure Required by Regulation S-K".
7/20/2016	State of VT Treasurer sends letter to SEC during their request for Comment period for "Business and Financial Disclosure Required by Regulation S-K".
9/1/2016	TRE signed on to a Ceres letter sent to House and Senate party leadership and relevant Appropriations Committeee leadership to help preserve the Climate Risk Disclosure text that is under attack due specifically to Amendment #44 to the House of Represetnatives' Financial Services and General Government (FSGG) Appropriations bill, which passed on July 7, 2016.
9/2/2016	TRE signed on to Trillium/CalSTRS/NYComptroller/Croatan Institute letter regarding the NC HR2 bill
11/10/2016	VPIC co-files with Mercy Investment Services at Marathon Petroleum on resolution 2 degree reporting
11/21/2016	VPIC co-files with NY State on Dominion Resources resolution 2 degree reporting
11/30/2016	VPIC co-files with NY State on Exxon Mobil resolution 2 degree reporting
12/7/2016	VPIC co-files with Wespath Investment Management & Hermes EOS on Chevron resolution 2 degree reporting
12/7/2016	VPIC co-files with As You Sow and Arjuna Capital on Chevron resolution low carbon transition
12/7/2016	VPIC co-files with the Community of the Sisters of St. Dominic of Caldwell, NJ on Southern Company resolution 2 degree reporting

Appendix 3) SSGA preliminary estimates for possible commingled fund recommendations

Please note that the information below is preliminary, and for general information, not to be considered an official response to a request for proposals.

Option 1 – Launch commingled fund with custom proxy voting policies

- Not an option at this time. We believe our policy is strong on ESG/Climate issues. Happy to discuss our policy and approach to engagement.

Option 2 – Launch commingled fund that utilizes a 3rd party's proxy voting policies

- We will not be able to launch a commingled fund that utilizes a 3rd party proxy voting policy.

Option 3 – Transfer $500M from SP500 Commingled to SP500 Ex Fossil Fuel Separately Managed Account

- Fee Schedule – 5 bps Flat fee
- $65k would be added to current relationship minimum
- Vermont provide screens for SSGA to implement and would also be responsible for sending updates to SSGA
- Proxy options at this fee level: (1)Vermont votes or (2) SSGA votes in accordance with the SSGA policy
- Additional fees: Any additional index licensing fees may also apply

Option 4 – $500mm MSCI ACWI Low Carbon Target Index or MSCI ACWI Low Carbon Target IMI Index Separately Managed Account

- Fee Schedule – 12 bps for ACWI based benchmark, 15 bps for an ACWI IMI benchmark
- Minimum annual fee of $125,000 per account to be added to current relationship minimum
- Proxy options at this fee level: (1) Vermont votes or (2) SSGA votes in accordance with the SSGA policy
- Additional fees: Any additional index licensing fees may also apply

Option 5 – SSGA opens an MSCI ACWI Low Carbon Target Index or MSCI ACWI Low Carbon Target IMI Index Commingled Fund

- Seed Capital - ~$200M for an ACWI benchmark and ~$300 mm for an ACWI IMI benchmark
- Fee Schedule – 10 bps for ACWI, 13 for ACWI IMI (not inclusive of licensing fees)
- Minimum annual fees of $25,000 per commingled fund
- Proxies would follow SSGA policies and SSGA would vote – no custom voting would be available

Option 6 – SSGA opens an S&P 500 using MSCI Low Carbon Target for Index Commingled Fund

- Seed Capital - ~$500M for a $S&P500 benchmark
- Fee Schedule – 4 bps (subject to potential additional licensing fees)
- Minimum annual fees of $25,000 per commingled fund
- Proxies would follow SSGA policies and SSGA would vote – no custom voting would be available

Appendix 4) Northern Trust and Rhumbline estimates for commingled fund recommendations

Please note that the information below is preliminary, and for general information, not to be considered as an official response to a request for proposals.

Northern Trust

Comingled vehicle to vote proxies along ISS specialized (such as Public Fund, or ESG) guidelines.

Northern Trust provided a few options for a commingled fund structure that might offer better alignment with VPIC proxy voting guidelines than their current passive equity investments offer. For each option, Northern Trust would manage the assets; outsource the proxy voting to ISS according to one of ISS's specialized guidelines. The pricing presented below is for lending options. Northern Trust notes that the fees quoted are for asset management services, and any operating expenses such as administration, audit, and ISS fees will be born within the fund NAV.

Option 1) Use NT's existing Russell 3000 Labor Select index fund. The primary objective of the Northern Trust Labor Select Russell 3000 Index Fund is to approximate the risk and return characteristics of the Russell 3000 Index. This Index is commonly used to represent the broad U.S. equity market. Proxies for securities held in the fund shall be voted in accordance with the AFL-CIO proxy voting guidelines. The proxy voting for this fund is outsourced to ISS and follows ISS Taft Hartley guidelines. This fund currently manages approximately $500 million. The fee schedule is 3.5 basis points per annum for $25 million to $100 million; 2 basis points per annum for a $100 - $500 million; or 1.5 basis points per annum for $500 million or above investment.

Option 2) Seed a commingled vehicle tracking the S&P500 and engage ISS to report proxies along their Public Fund (or other) guideline. NT could launch a new vehicle with a minimum of $250 million. The fee schedule would be 4 basis points per annum for $25 million to $100 million; 3 basis points per annum for a $100 -$500 million; or 2 basis points per annum for $500 million or above investment.

Option 3) Seed a commingled vehicle tracking the MSCI World-ex US Index (could use Low Carbon) and engage ISS to report proxies along their Public Fund policies. NT could launch a new vehicle with a minimum of $250 million. The reason Northern Trust suggests the World Ex-US here rather than World only is to give your clients more flexibility in weighting between US and non-US by combining these two funds. The fee schedule would be 8 basis points per annum for $25 million to $100 million; 6 basis points per annum for a $100 -$500 million; or 4 basis points per annum for $500 million or above investment.

Option 4) Seed a commingled vehicle to vote in line with a custom public fund proxy voting framework. Northern Trust offered the following thoughts for VPIC to consider if they were to establish their own board/governance structure for voting proxies jointly with other public pension plans through a commingled fund.

Custom Option a) The client could launch their own vehicle in a LP format, hire a sub-advisor to manage the investment portfolio, retain service providers to administer and conduct the legal and audit work around pooling investor assets. They could then hire a proxy service provider such as ISS or Glass Lewis to implement a custom proxy voting policy that the client/board governing this pool would establish and monitor.

Custom Option b) A second, less expensive path, would be to gather a collection of public funds who, together, wish to develop and adopt a public fund custom proxy voting framework; have them agree on a custom proxy voting policy; agree to request the same passive equity investment manager to invest their assets according to this custom public fund proxy voting policy; and direct an agreed upon proxy voting service provider to vote and report the proxies according to their custom public fund proxy voting framework.

Under this option, each public pension fund would invest directly in the new vehicle that a passive equity manager establishes for this custom public fund proxy voting framework, similar to the process undertaken to launch NT's R3000 Labor Select Index Fund. For Northern Trust, the minimum assets to launch such a fund would be $250 million, with fee schedules in line with those stated above, where a U.S. domestic fund is less expensive to implement than a non-U.S. or world.

Rhumbline

To open an additional passive comingled fund, it would take approximately 30-60 days for the legal work to be completed. The summary features and costs for launching a new fund with the objective of tracking the **MSCI ACWI Low Carbon Index** are as follows:

- Estimated Portfolio size - $100 million.
- Estimated holdings – 1,500 companies across 46 countries.
- Number of trades per year – 500 to 1,000 depending on index turnover, corporate actions, liquidity needs, etc.
- Daily NAV and daily liquidity.
- Investment Management Fee – 10 basis points on the first $100 million, 9 bps on next $200 million, 7 bps on excess (inclusive of MSCI index licensing fee).
- $25,000 minimum annual fee.
- Custody and Administration Fee (State Street) – 3 to 5 basis points depending on trading volume.

Appendix 5) VPIC Manager Exposure to XOM, Thermal Coal and Fossil Fuel Holdings (June 30, 2016)

Asset Class/Investment Mana	Account Type		Assets Under Mgt		Exposure to								
					XOM		ThC		FF		# of Firms		
			(%)	($Millions)	% of Total	$millions	% of Total	$millions	% of Total	$Millions	XOM	ThC	FF
Total Plan			**100.0%**	**$3,743.2**	**0.27%**	**$10.0**	**0.59%**	**$22.2**	**3.12%**	**$117.0**			
Equities	**Total**		**40.0%**	**$1,507.7**	**0.27%**	**$10.0**	**0.58%**	**$21.9**	**2.83%**	**$106.1**			
Equities	**Commingled**		**23.5%**	**$877.9**	**0.26%**	**$9.7**	**0.45%**	**$17.0**	**1.79%**	**$66.9**			
SSGA S&P 500 Cap Weighted	Commingled	Passive	12.1%	$453.4	0.26%	$9.7	0.07%	$2.6	0.73%	**$27.4**	1	4	27
Aberdeen Emerging Mkt Equi	Commingled	Active	6.6%	$247.1	0.00%	$0.0	0.26%	$9.8	0.65%	$24.3	0	3	6
Mondrian Intl Equity	Separate	Active	4.0%	$149.6	0.00%	$0.0	0.07%	$2.5	0.42%	$15.8	0	1	4
SSGA MSCI ACWI ex-US	Commingled	Passive	4.2%	$156.4	0.00%	$0.0	0.12%	$4.5	0.39%	**$14.7**	0	56	147
Acadian Intl Equity	Separate	Active	4.0%	$149.1	0.00%	$0.0	0.04%	$1.6	0.34%	$12.8	0	4	12
SSGA S&P500 Eq. Wtd Ex Toba	Separate	Passive	4.2%	$158.7	0.01%	$0.3	0.02%	$0.8	0.23%	**$8.8**	1	3	27
Wellington Smal Cap Value	Separate	Active	2.0%	$73.9	0.00%	$0.0	0.00%	$0.0	0.03%	$1.1	0	0	1
SSGA S&P Mid Cap 400	Commingled	Passive	0.6%	$21.0	0.00%	$0.0	0.00%	$0.2	0.02%	**$0.6**	0	3	12
Champlain Mid Cap	Separate	Active	2.2%	$81.5	0.00%	$0.0	0.00%	$0.0	0.01%	$0.5	0	0	1
SSGA Russell 2000 ex-Tobacco	Separate	Passive	0.5%	$17.0	0.00%	$0.0	0.00%	$0.0	0.00%	**$0.1**	0	0	7
Fixed Income	**Total**		**32.0%**	**$1,194.4**	**0.00%**	**$0.0**	**0.01%**	**$0.3**	**0.06%**	**$2.3**			
Fixed Income	**Commingled**		**18.5%**	**$694**	**0.00%**	**$0.0**	**0.00%**	**$0.0**	**0.05%**	**$1.7**			
SSGA Barclays Aggregate Inde	Commingled	Passive	3.1%	$117.7	0.00%		0.00%		0.00%				
Guggenheim High Yield	Separate	Active	4.0%	$147.9	0.00%	$0.0	0.03%	$1.2	0.12%	$4.4	0	2	8
Wellington EMD	Commingled	Active	5.1%	$192.7	0.00%	$0.0	0.00%	$0.0	0.05%	$1.7	0	0	1
PIMCO Core Plus	Separate	Active	5.8%	$216.3	0.00%	$0.0	0.00%	$0.0	0.03%	$1.2	0	0	2
PIMCO Unconstrained Bond	Separate	Active	2.5%	$92.9	0.00%	$0.0	0.00%	$0.0	0.01%	$0.3	0	0	1
KDP High Yield	Separate	Active	1.1%	$39.7	0.00%	$0.0	0.01%	$0.3	0.02%	$0.8	0	1	3
Wellington DAS Plus Beta 10y	Commingled	Active	2.9%	$108.9	DU	DU	DU	DU		DU	DU	DU	DU
GAM Unconstrained Bond	Commingled	Active	3.5%	$130.8	0.0%	$0.0	de mini	de minimus		de minimus	DU	DU	DU
BlackRock TIPS	Commingled	Passive	3.8%	$144.0	NA	NA	NA	NA	NA	NA	NA	NA	NA
Absolute Return	**Commingled**		**17.0%**	**$647.8**	**0.0%**	**$0.0**	**0.0%**	**$0.0**	**0.21%**	**$7.8**			
AQR Glbl Risk Prem Fd Moder	Commingled	Active	8.3%	$309.0	NA	NA	NA	NA	NA	NA	NA	NA	NA
Grosvenor GIPMS HFOF	Commingled	Active	5.2%	$193.0	DU	DU	DU	DU	0.19%	$7.0	DU	DU	DU
Allianz Structured Alpha	Commingled	Active	1.9%	$70.0	NA	NA	NA	NA	NA	NA			
Mellon Global Expanded Alph	Commingled	Active	2.0%	$75.3	0.0%	$0.0	0.0%	$0.0	0.02%	$0.8	0	0	3
Alternatives (Real Estate, Commodities, Private Equity			**11.0%**	**$393.2**	**0.0%**	**$0.0**	**0.0%**	**$0.0**	**0.02%**	**$0.7**			
Total Private Equity- Habourv	Commingled	Active	1.3%	$48.9	0.0%	$0.0	0.0%	$0.0	0.02%	$0.7	0	0	89

Appendix 6) VPIC Manager Trailing Return Estimated Impacts of Divestment

Asset Class/Investment Manager	Account Type	Assets Under Mgt		Trailing Returns									
				1-Year					5-Year				
		(%)	(Millions)	Bnmk	Actual	x-XOM	x-ThC	x-FF	Bnmk	Actual	x-XOM	x-Thc	x-FF
Total Plan		**100.0%**	**$3,743.2**										
Equities		**40.0%**	**$1,507.7**										
SSGA S&P500 Eq. Wtd Ex Tobacco	Separate	4.2%	$158.7	2.5	2.5	2.4	2.4	2.9	11.9	11.9	11.9	11.9	12.6
SSGA S&P 500 Cap Weighted	Commingled	12.1%	$453.4	4.0	4.1	3.7	3.9	4.1	12.1	12.1	12.5	12.4	13.3
Champlain Mid Cap	Separate	2.2%	$81.5	0.6	4.7	-	-	5.3	10.9	12.6	-	-	13.7
SSGA S&P Mid Cap 400	Commingled	0.6%	$21.0	1.3	1.4	-	1.0	1.3	10.5	10.6	-	9.9	10.3
SSGA Russell 2000 ex-Tobacco	Separate	0.5%	$17.0	-70.8	-10.8	-	-	-10.9	8.5	8.5	-	-	8.6
Wellington Smal Cap Value	Separate	2.0%	$73.9	-2.6	-0.8	-	-	-1.4	8.1	11.2	-	-	10.9
Acadian Intl Equity	Separate	4.0%	$149.1	-9.3	-5.4	-	-4.9	-4.6	2.1	4.2	-	4.3	4.6
Mondrian Intl Equity	Separate	4.0%	$149.6	6.5	8.1	-	7.5	6.6	7.4	7.3	-	7.7	8.1
SSGA MSCI ACWI ex-US	Commingled	4.2%	$156.4	-10.2	-10.0	-	-9.7	-9.6	0.5	1.7	-	-2.3	-2.1
Aberdeen Emerging Mkt Equity	Commingled	6.6%	$247.1	-3.7	-2.9	-	-	-1.9	-0.4	0.3	-	-	2.7
Fixed		**32.0%**	**$1,194.4**										
PIMCO Core Plus	Separate	5.8%	$216.3	6.0	5.4	-	-	5.3	3.8	4.1	-	-	4.1
PIMCO Unconstrained Bond	Separate	2.5%	$92.9	-0.4	-0.4	-	-	-0.5	No VPIC 5-Year Track Record				
GAM Unconstrained Bond	Commingled	3.5%	$130.8	0.5	1.0	de minimus			No VPIC 5-Year Track Record				
SSGA Barclays Aggregate Index	Commingled	3.1%	$117.7										
Guggenheim High Yield	Separate	4.0%	$147.9	1.7	0.8	-	0.8	0.9	No VPIC 5-Year Track Record				
KDP High Yield	Separate	1.1%	$39.7	1.6	0.6	-	0.4	2.4	5.8	5.2	-	5.1	5.3
Wellington EMD	Commingled	5.1%	$192.7	10.3	10.0	-	de min	mixed+/ -	No VPIC 5-Year Track Record				
Absolute Return		**17.0%**	**$647.8**										
Mellon Global Expanded Alpha I	Commingled	2.0%	$75.3	0.8	-0.9	-	-0.9	-1.3	4.3	6.1	-	6.1	5.7
Alternatives (Real Estate, Commodities, Private Equit		**11.0%**	**$393.2**										
Total Private Equity- Habourvest		1.3%	$48.9	DU	DU	DU	DU	DU	DU	DU	DU	DU	DU

Appendix 7) Divestment Impacts on Transaction Costs

Asset Class/Investment Manager	Account Type	Assets Under Mgt (%)	Assets Under Mgt ($Millions)	Transaction Costs to Divest: XOM – XOM $M)	XOM – Trnsct ($)	ThC – AUM ($M)	ThC – Trnsct ($)	FF – AUM ($M)	FF – Trnsct $s ($)	# of firms – XOM	# of firms – ThC	# of firms – FF
Total Plan		**100.0%**	**$3,743.2**	**$10.0**	**$68**	**$22.2**	**$51,191**	**$117.0**	**$185,422**			
Equities Total		**40.0%**	**$1,507.7**	**$10.0**	$68	**$21.9**	$8,683	**$106.1**	$132,593			
Equities Commingled		**23.5%**	**$877.9**	**$9.7**	CannotD	**$17.0**	CannotD	**$66.9**	CannotD			
Equities Separately Managed		**16.8%**	**$629.8**	**$0.3**	**$68**	**$4.9**	**$20,638**	**$39.1**	**$132,593**			
SSGA S&P 500 Cap Weighted	Commingled	12.1%	$453.4	$9.7	CannotD	$2.6	CannotD	$27.4	CannotD	1	4	26
Aberdeen Emerging Mkt Equity	Commingled	6.6%	$247.1	$0.0	NA	$9.8	CannotD	$24.3	CannotD	0	3	6
Mondrian Intl Equity	Separate	4.0%	$149.6	$0.0	$0	$2.5	$16,141	$15.8	$103,481	0	1	4
SSGA MSCI ACWI ex-US	Commingled	4.2%	$156.4	$0.0	NA	$4.5	CannotD	$14.7	CannotD	0	56	136
Acadian Intl Equity	Separate	4.0%	$149.1	$0.0	NA	$1.6	$4,187	$12.8	$27,204	0	4	12
SSGA S&P500 Eq. Wtd Ex Tobacco	Separate	4.2%	$158.7	$0.3	$68	$0.8	$310	$8.8	$432	1	3	27
Wellington Smal Cap Value	Separate	2.0%	$73.9	$0.0	NA	$0.0	NA	$1.1	-	0	0	1
SSGA S&P Mid Cap 400	Commingled	0.6%	$21.0	$0.0	NA	$0.2	NA	$0.6	CannotD	0	0	12
Champlain Mid Cap	Separate	2.2%	$81.5	$0.0	NA	$0.0	NA	$0.5	$1,312	0	0	1
SSGA Russell 2000 ex-Tobacco	Separate	0.5%	$17.0	$0.0	NA	$0.0	NA	$0.1	$164	0	0	7
Fixed Income - Total		**32.0%**	**$1,194.4**	**$0.0**	**NA**	**$0.3**	**$15,277**	**$2.3**	**$52,829**			
Fixed Income -commingled w/FF		**11.8%**	**$441.2**	**$0.0**	**CannotD**	**$0.0**	**CannotD**	**$1.7**	**CannotD**			
Fixed Income - SMA - w/FF		**10.9%**	**$ 403.9**	**$0.0**	**NA**	**$1.5**	**$15,277**	**$6.3**	**$52,829**			
SSGA Barclays Aggregate Index	Commingled	3.1%	$117.7									
Guggenheim High Yield	Separate	4.0%	$147.9	$0.0	NA	$1.2	$12,000	$4.4	$44,000	0	2	8
Wellington Emerging Market Debt	Commingled	5.1%	$192.7	$0.0	NA	$0.0	NA	$1.7	CannotD	0	0	1
PIMCO Core Plus	Separate	5.8%	$216.3	$0.0	NA	$0.0	NA	$1.2	$600	0	0	2
GAM Unconstrained Bond	Commingled	3.5%	$130.8	$0.0	NA	$0.0	CannotD	$0.3	CannotD	0	de min	
KDP High Yield	Separate	1.1%	$39.7	$0.0	NA	$0.3	$3,277	$0.8	$8,229	0	1	3
Absolute Return		**17.0%**	**$647.8**	**$0.0**		**$0.0**		**$7.8**	**DU**			
Grosvenor GIPMS HFOF	Commingled	5.2%	$193.0	DU	DU	DU	DU	$7.0	DU	DU	DU	DU
Mellon EB DV Dynamic Growth Fund	Commingled	2.0%	$75.3	$0.0	NA	$0.0	NA	$0.8	CannotD	0	0	3
Alternatives		**11.0%**	**$393.2**	**$0.0**		**$0.0**		**$0.7**				
Total Harbourvest Partners	Commingled	1.3%	$48.9	$0.0	0	$0.0	$0	$0.7	Sell entire portfolios on secondary market, likely at steep discount to NAV, to eliminate about 1% AUM	0	0	89

Appendix 8) Divestment Restructuring Fee Implications

Asset Class/Investment Manager	Account Type	Assets Under Mgt		Divest Retructuring	
		(%)	($Millions)	Possible to divest in current fund	Fee Change to divest
Total Plan		**100.0%**	**$3,743.2**		
Equities		**40.0%**	**$1,507.7**		
SSGA S&P 500 Cap Weighted	Commingled	12.1%	$453.4	NO	Increased fees to move to SMA
Aberdeen Emerging Mkt Equity	Commingled	6.6%	$247.1	NO	SMA operating costs meaningfully higher
SSGA S&P Mid Cap 400	Commingled	0.6%	$21.0	NO	Prohibitively costly to move to SMA- too small $AUM
SSGA MSCI ACWI ex-US	Commingled	4.2%	$156.4	NO	Prohibitively costly to move to SMA- too small $AUM
Wellington Smal Cap Value	Separate	2.0%	$73.9	YES	Requires discussion of fees, benchmark, guidelines.
SSGA S&P500 Eq. Wtd Ex Tobacco	Separate	4.2%	$158.7	YES	Fees unchanged
Champlain Mid Cap	Separate	2.2%	$81.5	YES	Fees unchanged
SSGA Russell 2000 ex-Tobacco	Separate	0.5%	$17.0	YES	Fees unchanged
Acadian Intl Equity	Separate	4.0%	$149.1	YES	Fees unchanged
Mondrian Intl Equity	Separate	4.0%	$149.6	YES	Fees unchanged
Fixed		**32.0%**	**$1,194.4**		
Wellington DAS Plus Beta 10yr	Commingled	2.9%	$108.9	NO	Cost to move out of this pool; create new fund of 1.
Wellington Emerging Market Debt	Commingled	5.1%	$192.7	NO	Work with VPIC on most appropriate SMA
SSGA Barclays Aggregate Index	Commingled	3.1%	$117.7	NO	Prohibitively costly to move to SMA- too small $AUM
GAM Unconstrained Bond	Commingled	3.5%	$130.8	NO	Minimal costs to move to different class without FF.
PIMCO Core Plus	Separate	5.8%	$216.3	YES	Fees unchanged
PIMCO Unconstrained Bond	Separate	2.5%	$92.9	YES	Fees unchanged
Guggenheim High Yield	Separate	4.0%	$147.9	YES	Fees Unchanged
KDP High Yield	Separate	1.1%	$39.7	YES	Fees Unchanged
Absolute Return		**17.0%**	**$647.8**		
Mellon EB DV Dynamic Growth Fun	Commingled	2.0%	$75.3	NO	Requires SMA-meaningfully higher fees
Alternatives		**11.0%**	**$393.2**		
Total Harbourvest Partners	Commingled	1.3%	$48.9	NO	Co-invest fund with opt-out; seek non-Harbourvest.

Appendix 9) Exxon-Mobil Response to Vermont Pension Investment Committee Questionnaire
(November 2016)

Question-1: Gross global Scope 1 emissions, percentage covered under a regulatory program, percentage by hydrocarbon resource

A combined response to Questions 1 and 2 is below

Question-2: Amount of gross global Scope 1 emissions from: (1) combustion, (2) flared hydrocarbons, (3) process emissions, (4) directly vented releases, and (5) fugitive emissions/leaks

In 2015, ExxonMobil's net equity greenhouse gas emissions were 122 million CO2-equivalent metric tons. Relative to our 2014 performance, our 2015 emissions decreased by approximately 1 million CO2-equivalent metric tons. This decrease was primarily driven by energy efficiency improvement and asset divestment. The net equity greenhouse gas metric includes direct and imported greenhouse gas emissions and excludes emissions from exports (including ExxonMobil's interest in Hong Kong power through mid-2014, when it was sold). ExxonMobil reports greenhouse gas emissions on a net equity basis for all our business operations, reflecting our percent ownership in an asset.

Energy efficiency

In 2015, energy used in our operations totaled 1.7 billion gigajoules. Energy consumed in our operations generates more than 80 percent of our direct greenhouse gas emissions and is one of our largest operating costs. As such, we have focused on energy efficiency for several decades. Since 2000, we have used our Global Energy Management System in the Downstream and Chemical businesses, and our Production Operations Energy Management System in our Upstream businesses to identify and act on energy savings opportunities.

Through our commitment to energy efficiency, application of structured processes and continued use of a bottom-up approach, we continue to yield industry-leading results. For example, in 2010, 2012 and 2014 refining industry surveys, ExxonMobil's global refining operations achieved first quartile energy efficiency performance.

Flaring

ExxonMobil has invested more than $3.8 billion at our Upstream facilities around the world on emission reduction efforts, including flare mitigation since 2000. As a result, hydrocarbon flaring volumes from our combined operations in 2015 were 35 percent lower than 2006 levels.

In 2015, flaring volume from our combined Upstream, Downstream and Chemical operations totaled 5.3 million metric tons. This represents an increase of 0.8 million metric tons compared with our 2014 performance.

The increase in flaring was primarily due to operations in Angola, where a third-party-operated liquefied natural gas (LNG) plant was not operating. The increase was partially offset by flaring reductions resulting from the completion of commissioning work at our Papua New Guinea LNG plant and operational improvements at the Usan production field in Nigeria.

ExxonMobil is a charter member of the Global Gas Flaring Reduction Partnership. In addition, we put in place our own parameters, the Upstream Flaring and Venting Reduction Environmental Standard for Projects, in 2005. Our goal is to responsibly avoid routine flaring in new Upstream projects and reduce "legacy" flaring in our existing operations.

For example, our joint venture operations in Qatar have recently begun using a jetty boil-off gas recovery facility to recover natural gas that was previously flared during LNG vessel loading at the marine berths located at the Ras Laffan Port. Approximately 1 percent of the LNG loaded onto the ships evaporates due to the difference in temperature between the LNG and the ship tank. The recovery facility collects the boil-off gas and returns it to the LNG plants to be used as fuel or converted back into LNG. During one year of operation, the facility has recovered more than 500,000 metric tons of gas and reduced LNG vessel loading-related flaring by around 90 percent.

Venting and fugitive emissions

Our venting and fugitive emissions in 2015 totaled 6 million CO2-equivalent metric tons, which is essentially the same as our 2014 performance. While venting and fugitive emissions, most of which are methane, represent approximately 5 percent of our direct greenhouse gas emissions, we recognize the importance of reducing these emissions. We continue to look for ways to reduce methane and other hydrocarbon emissions in our operations, such as replacing high-bleed pneumatic devices with lower-emission technology and conducting green well completions in targeted Upstream operations.

Cogeneration

ExxonMobil has invested more than $2 billion since 2001 in support of Upstream and Downstream cogeneration facilities to more efficiently produce electricity and reduce greenhouse gas emissions.

Cogeneration technology captures heat generated from the production of electricity for use in production, refining and chemical processing operations. Due to its inherent energy efficiency, the use of cogeneration leads to reduced greenhouse gas emissions. ExxonMobil's cogeneration facilities enable the avoidance of approximately 6 million metric tons per year of greenhouse gas emissions.

We have interests in approximately 5,500 megawatts of cogeneration capacity in more than 100 installations at more than 30 locations around the world. This capacity is equivalent to the annual energy needed to power 2.5 million U.S. homes. Over the past decade, we have added more than 1,000 megawatts of cogeneration capacity and continue to develop additional investment opportunities.

For example, ExxonMobil began the construction of a new 84-megawatt cogeneration facility at our Singapore refinery's Jurong site. When this facility is completed in 2017, ExxonMobil will have more than 440 megawatts of cogeneration capacity in Singapore, enabling our integrated refining and petrochemical complex to meet all its power needs.

ExxonMobil provides detailed reporting on our greenhouse gas emissions each year in our Corporate Citizenship Report. The following table is from the 2015 report:

Performance data table*	2006	2007	2008	2009	2010	2011	2012	2013	2014	**2015**	Page #
Managing climate change risks											
[5]Greenhouse gas emissions, absolute (net equity, CO_2-equivalent emissions), millions of metric tons	139	135	126	123	126	128	126	127	123	**122**	35
[6]Direct (excluding emissions from exported power and heat)	129	125	117	114	117	119	118	119	115	**114**	N/A
[7]Emissions associated with imported power	10	10	9	9	9	9	8	8	8	**8**	N/A
Greenhouse gas emission consituents (excludes emissions from exported power and heat), millions of metric tons											
CO_2 (excluding emissions from exported power and heat)	134	131	122	119	122	124	120	119	116	**115**	N/A
Methane (CO_2-equivalent)	4	3	3	3	3	3	5	7	6	**6**	N/A
Other gases (CO_2-equivalent)	1	1	1	1	1	1	1	1	1	**1**	N/A
Emissions from exported power and heat	14	14	13	14	13	15	15	16	7	**4**	N/A
By-region greenhouse gas emissions (net equity, CO_2-equivalent emissions), millions of metric tons											
Africa/Europe/Middle East	50	50	45	43	45	45	44	44	43	**44**	N/A
Americas	69	65	62	62	64	66	68	70	66	**65**	N/A
Asia Pacific	20	20	19	18	17	17	14	13	14	**13**	N/A

By-division greenhouse gas emissions (net equity, CO_2-equivalent emissions), millions of metric tons											
Upstream	57	53	49	47	50	54	56	58	56	**56**	N/A
Downstream	60	59	57	56	55	54	51	49	47	**45**	N/A
Chemical	22	23	20	20	21	20	19	20	20	**21**	N/A
Carbon dioxide — captured for sequestration, millions of metric tons	N/A	N/A	N/A	N/A	N/A	5.0	4.8	5.9	6.9	**6.9**	34
[5]Greenhouse gas emissions, normalized (net equity, CO_2-equivalent emissions), metric tons per 100 metric tons of throughput or production											
Upstream	22.6	21.7	21.0	20.1	20.5	20.7	22.3	22.8	23.4	**23.4**	35
Downstream	21.8	21.5	21.0	21.0	20.8	20.0	19.6	19.7	19.2	**18.9**	35
Chemical	60.9	62.1	59.8	60.7	57.9	57.2	56.3	57.0	53.4	**52.3**	35
Energy use (billion gigajoules)	1.6	1.6	1.5	1.5	1.5	1.5	1.5	1.5	1.6	**1.7**	36
Energy intensity, normalized versus *Global Energy Management System* (GEMS) base year (2002) — refining	94.8	94.2	93.7	92.8	91.8	90.9	90.0	90.5	90.3	**91.2**	N/A
Energy intensity, normalized versus GEMS base year (2002) — chemical steam cracking	90.4	89.6	90.4	88.6	87.6	87.3	88.2	88.8	86.4	**86.6**	N/A
Hydrocarbon flaring (worldwide activities), millions of metric tons	8.2	8.0	5.7	4.4	3.6	4.1	3.6	3.7	4.5	**5.3**	36
[8]Cogeneration capacity in which we have interest, gigawatts	4.3	4.5	4.6	4.9	4.9	5.0	5.2	5.3	5.5	**5.5**	37

[5]The net equity greenhouse gas emissions metric was introduced in 2011 as a replacement for the direct equity greenhouse gas metric. Information has been restated back to 2005 according to the new metric. The net equity greenhouse gas metric includes direct and imported greenhouse gas emissions and excludes emissions from exports (including Hong Kong Power through mid-2014). ExxonMobil reports greenhouse gas emissions on a net equity basis for all our business operations, reflecting our percent ownership in an asset.

[6]The addition of direct emissions and emissions associated with exported power and heat is equivalent to World Resources Institute (WRI) Scope 1.

[7]These emissions are equivalent to WRI Scope 2.

Question-3: Description of long-term and short-term strategy or plan to manage Scope 1 emissions, emissions reduction targets, and an analysis of performance against those targets

As we seek to increase production of oil and natural gas to meet growing global energy demand, we are committed to continuing to take actions to mitigate greenhouse gas emissions within our operations.

ExxonMobil has strong processes designed to improve efficiency, reduce emissions and contribute to effective long-term solutions to manage climate change risks. These processes include, where appropriate, setting tailored objectives at the business, site and equipment levels, and then stewarding progress toward meeting those objectives. Based on decades of experience, ExxonMobil believes this rigorous bottom-up approach is a more effective and meaningful way to drive efficiency improvement and greenhouse gas emissions reduction than through high-level corporate targets. We believe that continuing to use this approach will yield further improvements in all sectors of our business.

In the near term, we are working to increase energy efficiency while reducing flaring, venting and fugitive emissions in our operations. In the medium term, we are deploying proven technologies such as cogeneration and carbon capture and sequestration where technically and economically feasible. Longer term, we are conducting and supporting research to develop breakthrough, game-changing technologies.

Since 2000, ExxonMobil has spent approximately $7 billion on technologies to reduce emissions and in the development of lower-emission energy solutions.

Question-4: Sensitivity of hydrocarbon reserve levels to future price projection scenarios that account for a price on carbon emissions

A combined response to Questions 4 and 6 can be found under Question 6 below

Question-5: Estimated carbon dioxide emissions embedded in proved hydrocarbon reserves

ExxonMobil does not estimate the potential quantity of carbon dioxide that may be created when our proved reserves are produced, converted to finished products and used by consumers. According to the International Energy Agency, approximately 90 percent of petroleum-related greenhouse gas emissions attributable to operations such as ours are generated when customers use our products (indirect emissions) and the remaining 10 percent are generated by industry operations (direct emissions).

Question-6: Discussion of how price and demand for hydrocarbons and/or climate regulation influence the capital expenditure strategy for exploration, acquisition, and development of assets

By 2040, the world's population is projected to reach 9 billion — up from about 7.2 billion today — and global GDP will have more than doubled. As a result, we see global energy demand rising by about 25 percent from 2014 to 2040. In order to meet this demand, we believe all economic energy sources, including our existing hydrocarbon reserves, will be needed. We also believe that the transition of the global energy system to lower-emissions sources will take many decades due to the system's enormous scale, capital intensity and complexity. As such, we believe that none of our proven hydrocarbon reserves are, or will become, stranded.

ExxonMobil's long-range annual forecast, The Outlook for Energy, examines energy supply and demand trends for approximately 100 countries, 15 demand sectors and 20 different energy types. The Outlook forms the foundation for the company's business strategies and helps guide our investment decisions. In response to projected increases in global fuel and electricity demand, our 2016 Outlook estimates that global energy-related CO2 emissions will peak around 2030 and then begin to decline. A host of trends contribute to this downturn — including slowing population growth, maturing economies and a shift to cleaner fuels like natural gas and renewables — some voluntary and some the result of policy.

ExxonMobil believes the long-term objective of effective policy is to reduce the risks posed by climate change at minimum societal cost, in balance with other societal priorities such as poverty eradication, education, health, security and affordable energy.

We fundamentally believe that free markets, innovation and technology are essential to addressing the risks of climate change. Success in developing and deploying impactful technologies will highly depend on governments creating a policy landscape that enables innovation and competition. Policies need to be clear and guard against duplicative, overlapping and conflicting regulations, which send mixed signals to the market and impose unnecessary costs on consumers. We believe that effective policies are those that:

- *Promote global participation;*
- *Let market prices drive the selection of solutions;*
- *Ensure a uniform and predictable cost of greenhouse gas emissions across the economy;*
- *Minimize complexity and administrative costs;*
- *Maximize transparency; and*
- *Provide flexibility for future adjustments to react to developments in climate science and the economic impacts of climate policies.*

Policies based on these principles minimize overall costs to society and allow markets to help determine the most effective and commercially viable solutions.

Given the wide range of societal priorities and limited global resources, all policies, including climate change policy, must be as economically efficient as possible. ExxonMobil believes that market-based systems that impose a uniform, economy-wide cost on greenhouse gas emissions are more economically efficient policy options than mandates or standards. This is because market-based policies more effectively drive consumer behavior and technology innovation, while mandates and standards eliminate consumer choice and can perpetuate ineffective technologies.

Since 2009, ExxonMobil has advocated the view that a properly designed, revenue-neutral carbon tax is a more effective market-based option than a cap-and-trade approach. A carbon tax is more transparent, can be implemented in existing tax infrastructure, avoids the complexity of creating and regulating carbon markets where none exist and reduces greenhouse gas emissions price volatility, thus delivering a clearer, more consistent long-term market price signal.

Only through a sound global policy framework will the power of markets and innovation enable society to find cost-effective solutions to address the risks of climate change, while at the same time continuing to address the many other challenges the world faces.

ExxonMobil addresses the potential for future climate change policy, including the potential for restrictions on emissions, by estimating a proxy cost of carbon. This cost, which in some geographies may approach $80 per ton by 2040, has been included in our Outlook for several years. This approach seeks to reflect potential policies governments may employ related to the exploration, development, production, transportation or use of carbon-based fuels. We believe our view on the potential for future policy action is realistic and by no means represents a "business-as-usual" case. We require all of our business lines to include, where appropriate, an estimate of greenhouse gas-related emissions costs in their economics when seeking funding for capital investments.

We evaluate potential investments and projects using a wide range of economic conditions and commodity prices. We apply prudent and substantial margins in our planning assumptions to help ensure competitive returns over a wide range of market conditions. We also financially stress test our investment opportunities, which provides an added margin against uncertainties, such as those related to technology development, costs, geopolitics, availability of required materials, services and labor. Stress testing further enables us to consider a wide range of market environments in our planning and investment process.

Question-7: Revenues from renewable and alternative energy, average annual during trailing three years ending June 30, 2016

Recognizing the limitations associated with most existing low greenhouse gas emissions energy technologies, particularly in delivering the necessary economy and scale, we are conducting fundamental research to develop low greenhouse gas emission energy solutions that have the potential to be economically feasible without subsidies, standards or mandates. As society transitions to lower greenhouse gas emission energy solutions, technological advancements that change the way we produce and use energy will be instrumental in providing the global economy with the energy it needs while reducing greenhouse gas emissions. ExxonMobil is pioneering scientific research to discover innovative approaches to enhance existing and develop next-generation energy sources.

Question-8: R&D spending on renewable, alternative and low-carbon energy and technologies (including natural gas, carbon capture technologies, and energy efficiency improvements, average annual during trailing three years ending June 30, 2016.

Since our merger with XTO Energy in 2010, ExxonMobil has been one of the largest natural gas producers in the world. Coupled with our leadership in the development and production of liquefied natural gas (LNG), ExxonMobil is well-positioned to meet growing demand for this clean energy source. We spend approximately a quarter of a billion dollars per year on research and development on technologies to enable the safe development of natural gas. In addition, since 2000, ExxonMobil has spent nearly $7 billion on technology to reduce greenhouse gas emissions, including on energy efficiency, cogeneration, flare reduction, carbon capture and sequestration, and to research lower-emission energy solutions.

Question-9: R&D spending on renewable energy technologies, Average Annual during trailing three years ending June 30, 2016

ExxonMobil's Emerging Technologies program brings together executives, scientists and engineers from across ExxonMobil's businesses to identify and evaluate technology research opportunities with a long-term strategic focus. The Emerging Technologies team seeks to understand a wide range of technology options and how they may impact the global energy system in the near term and as far as 50 years into *the future. Our evaluation extends well beyond our base business and near-term focus. If a technology could have a material effect on the future of energy, we insist on knowing about it and understanding the related science. Understanding the fundamental science serves as a basis for our broader research efforts and may lead to further technology development aimed at practical application, such as our work on biofuels. Additionally, this awareness informs our internal analysis of the global energy landscape as reflected and encapsulated in our annual Outlook for Energy.*

At the center of our research is ExxonMobil's Corporate Strategic Research laboratory, a fundamental research institution with approximately 150 Ph.D. scientists and engineers focused on addressing the company's long-range science needs. The laboratory's scientists are internationally recognized experts in their field. Our research portfolio includes a broad array of programs, including biofuels, carbon capture and sequestration, alternative energy and climate science.

In addition to in-house research, the Corporate Strategic Research laboratory conducts strategic research with approximately 80 universities around the world on next-generation technology. For example, in 2014, ExxonMobil signed an agreement to join the Massachusetts Institute of Technology Energy Initiative, a collaboration aimed at working to advance and explore the future of energy. ExxonMobil was also a founding member in 2002 of the Global Climate and Energy Project at Stanford University, which included a $100 million commitment to develop fundamental, game-changing scientific breakthroughs that could lead to lower greenhouse gas emissions and a less carbon-intensive global energy system. Other university collaborations cover a wide range of scientific topics, from understanding the impacts of black carbon and aerosols at the University of California, Riverside to photovoltaics at Princeton University.

Advanced biofuels

ExxonMobil funds a broad portfolio of biofuels research programs including ongoing efforts to develop algae-based biofuels, as well as programs for converting non-food based feedstocks, such as whole cellulosic biomass, algae-based feedstocks and cellulose-derived sugars, into advanced biofuels. We believe that additional fundamental technology improvements and scientific breakthroughs are still necessary in both biomass optimization and the processing of biomass into fuels. Specifically, scientific breakthroughs are needed to ensure that advanced biofuels can be scaled up economically and produced with the desired environmental benefit of lower life cycle greenhouse gas emissions.

Our advanced biofuels research includes joint research collaborations with Synthetic Genomics Inc. (SGI), Renewable Energy Group, the Colorado School of Mines, Michigan State University, Northwestern University and the University of Wisconsin.

There are numerous benefits of using algae for biofuels production. Algae can be cultivated on land unsuitable for other purposes with water that cannot be used for food production. In addition to using non-arable land and not requiring the use of fresh water, algae could also potentially yield greater volumes of biofuels per acre than other sources. We also know that algae can be used to manufacture biofuels similar in composition to today's transportation fuels.

In addition, growing algae can provide an environmental benefit. Algae consume CO_2 and have the potential to provide greenhouse gas mitigation benefits versus conventional fuels. In 2012, researchers from MIT, ExxonMobil and SGI published an assessment of algal biofuels in the peer-reviewed journal Environmental Science and Technology, which concluded that if key research hurdles are overcome, algal biofuels will have about 50% lower life cycle greenhouse gas emissions than petroleum-derived fuel.

In contrast, there is a robust debate in the academic research community regarding the carbon footprint of first generation biofuels, which the EPA defines as those generated from edible crops (such *as corn). Many peer-reviewed papers in the scientific literature suggest that the direct life cycle greenhouse gas emissions are lower than fossil fuels, but that indirect consequences of first generation biofuel development, including changes in forest and agricultural land use change, may result in higher total greenhouse gas emissions than petroleum-derived fuels.*

For these reasons, ExxonMobil is pursuing research into second generation biofuels to determine how they may best fit into our energy future. Second generation biofuels are defined as those produced from non-edible crops, crop residues, or biologically generated gas and therefore do not take away from the total food supply. Examples include algae, corn stover, switchgrass or methane emitted from microbial activity in landfills.

ExxonMobil and SGI are carrying out a basic research program to develop advanced biofuels from algae. Our objective is to develop advanced algae biofuels options and identify the best pathways to make these groundbreaking technologies available to consumers. We have been working with SGI since 2009.

We face some significant technical hurdles before biofuels production from algae will be possible at a significant commercial scale. To overcome these challenges, we are working to answer some basic questions such as:

- *Why do algae utilize a relatively small amount of available light energy?*
- *What tools can be used to improve light utilization efficiency of algae and to improve production characteristics?*
- *How do you develop an organism that will produce significantly more bio oil?*

The central challenge is that algae naturally harvest significantly more light than they can effectively convert to biofuels. Only a fixed amount of light hits the surface of a pond, and our goal is for the algae to use this light as efficiently as possible. The amount of wasted sunlight varies greatly depending on the algae species and growth conditions, but can be as high as 80 percent or more. ExxonMobil and SGI are conducting fundamental research to decrease the amount of wasted sunlight and increase biomass productivity by improving the photosynthetic efficiency of individual algae cells. To achieve this objective, the SGI team is working to engineer algae cells that will absorb only the amount of light that they can effectively use.

Carbon capture and sequestration

Carbon capture and sequestration (CCS) is the process by which CO2 gas that would otherwise be released into the atmosphere is captured, compressed and injected into underground geologic formations for permanent storage. With a working interest in approximately one-third of the world's total CCS capacity, ExxonMobil is a leader in one of the most important next-generation low-carbon technologies. In 2015, we captured 6.9 million metric tons of CO2 for sequestration.

Over the past 15 years, ExxonMobil has invested nearly $400 million in researching, developing and applying carbon capture and storage technology in association with our projects, with significant additional investment expected at our Gorgon project in coming years.

ExxonMobil believes the greatest opportunity for future large-scale deployment of CCS will be in the natural gas-fired power generation sector. While CCS technology can be applied to coal-fired power generation, the cost to capture CO2 from that source is about twice that of natural gas power generation. In addition, because coal-fired power generation creates about twice as much CO2 per unit of electricity generated, the geological storage space required to sequester the CO2 produced from coal-fired generation is about twice that associated with gas-fired generation.

ExxonMobil is conducting proprietary, fundamental research to develop breakthrough carbon capture technologies that have the potential to be economically feasible without government subsidies, standards or mandates.

As an example, ExxonMobil's scientists have been pursuing new technology that could reduce the costs associated with current CCS processes by increasing the amount of electricity a power plant produces while simultaneously delivering significant reductions in carbon dioxide emissions. At the center of ExxonMobil's technology application is a carbonate fuel cell.

Laboratory tests have demonstrated that the unique integration of carbonate fuel cells and natural gas power generation captures carbon dioxide more efficiently than current, conventional capture technology. During the conventional capture process, a chemical reacts with the carbon dioxide, extracting it from power plant exhaust. Steam is then used to release the carbon dioxide from the chemical – steam that would otherwise be used to move a turbine, thus decreasing the amount of power the turbine can generate.

Using fuel cells to capture carbon dioxide from power plants results in a more efficient separation of carbon dioxide from power plant exhaust and an increased output of electricity. Power plant exhaust is directed to the fuel cell, replacing air that is normally used in combination with natural gas during the fuel cell power generation process. As the fuel cell generates power, the carbon dioxide becomes more concentrated, allowing it to be more easily and affordably captured from the cell's exhaust and stored. ExxonMobil's research indicates that a typical 500 megawatt (MW) power plant using a carbonate fuel cell may be able to generate up to an additional 120 MW of power while current CCS technology consumes about 50 MW of power.

ExxonMobil's research indicates that by applying this technology, more than 90 percent of a natural gas power plant's carbon dioxide emissions could be captured. Natural gas is already the least carbon-intensive of the major hydrocarbon-based energy sources.

In addition, carbonate fuel cell technology has the potential to generate significant volumes of hydrogen. Simulations suggest that the new technology can produce up to 150 million cubic feet per day of hydrogen while capturing carbon dioxide from a 500 MW power plant. To put that in perspective, a world-scale steam methane reforming hydrogen plant produces around 125 million cubic feet per day. In addition, synthesis gas, or syngas, composed of hydrogen and carbon monoxide, can be produced that can be upgraded to other useful products such as methanol, olefins, or higher molecular weight hydrocarbons for transportation fuels or lubricants.

In May 2016, ExxonMobil and FuelCell Energy, Inc., announced an agreement to pursue this novel technology in power plant carbon dioxide capture through a new application of carbonate fuel cells, and in October of the same year, we jointly announced the selection of a location to test it at the James M. Barry Electric Generating Station in Alabama. This fuel cell carbon capture solution could substantially reduce costs and lead to a more economical pathway toward large-scale carbon capture and sequestration globally.

University Collaborations

ExxonMobil is working with approximately 80 universities around the world to explore next-generation energy technologies. Since 2002, we have supported long-term collaborative scientific research related to greenhouse gas emissions at Stanford University, and more recently, we have begun collaborations with Princeton University, Massachusetts Institute of Technology (MIT), the University of Texas at Austin, and Georgia Institute of Technology as part of our commitment to finding meaningful and scalable solutions to meet global energy demand.

Stanford University

In 2002, ExxonMobil made a $100 million commitment to Stanford's Global Climate and Energy Project (GCEP), which is focused on identifying breakthrough energy technologies. GCEP's strategy is to take a long view by supporting game-changing research with a 10- to 50-year time horizon; its goal is to keep the innovation pipeline filled with new ideas and new approaches that will ultimately make efficient, environmentally sustainable, low-cost energy available worldwide. Since its launch, GCEP has built a diverse research portfolio of innovative technologies in areas such as solar power, biomass energy, advanced combustion, carbon capture and sequestration, transportation and the electrical grid. GCEP-supported research has led to significant advances in cutting-edge energy technologies ranging from improved light management techniques and nanoscale designs for increasing the efficiency of photovoltaic systems, to novel microbial bioreactors that use renewable energy to produce methane and other fuels. Overall, GCEP has supported 80 scientific programs led by 165 faculty members and 39 research institutions across the globe. GCEP researchers have also published more than 500 papers in leading journals and given more than 700 presentations at conferences.

Massachusetts Institute of Technology

In October 2014, ExxonMobil became a founding member of the MIT Energy Initiative and will contribute $25 million over five years to support research and establish 10 graduate energy fellowship appointments each year. The MIT Energy Initiative is a unique collaboration aimed at working together to advance and explore the future of energy focused on new energy sources and more efficient use of conventional energy resources. Since launching the collaboration with MIT, the joint research program has made inroads into several areas, including bio-inspired catalysts for the petrochemical industry and computational modeling to better understand the properties of iron and iron-based alloys used in pipelines. The program has also enabled ExxonMobil to expand research efforts to emerging areas like photovoltaic and nuclear power, as well as enhance our understanding of energy options and the interactions between them.

ExxonMobil has also joined the MIT Energy Initiative's Carbon Capture, Utilization, and Storage (CCUS) Center, one of eight Low-Carbon Energy Centers first called for in MIT's Plan for Action on Climate Change in October 2015. It was established to advance research on specific, key technologies to address climate change such as electric power systems, energy bioscience, energy storage, materials for energy and extreme environments, advanced nuclear energy systems, nuclear fusion and solar energy, in addition to CCUS.

Princeton University

In September 2016, ExxonMobil and Princeton University announced the selection of five research projects associated with their partnership focused on energy technologies. The projects will center on solar and battery technologies, plasma physics, Arctic sea-ice modeling, and the impact of carbon dioxide absorption on the world's oceans. This announcement followed ExxonMobil's June 2015 commitment to contribute $5 million to Princeton E-ffiliates Partnership, a program administered by Princeton University's Andlinger Center for Energy and the Environment that fosters research in sustainable energy and environmental solutions. E-ffiliates promotes collaboration between industry and academia to search for energy and environmental breakthroughs. ExxonMobil scientists collaborated with Princeton professors to identify areas with the most scientific potential, particularly ones that build on the university's existing strengths and interests in emerging energy.

The University of Texas at Austin

In July 2016, ExxonMobil announced a $15 million investment as a leading member of the University of Texas at Austin Energy Institute to pursue technologies to help meet growing energy demand while reducing environmental impacts and the risk of climate change. The joint research initiative will study transformational energy innovations including integrating renewable energy sources into the current supply mix and advancing traditional energy sources in ways that improve efficiency and reduce impacts on water, air and climate. Research projects are expected to cover a range of emerging *technologies, and will take advantage of the university's capabilities in renewable energy, battery technologies, carbon capture and power grid modeling. Core strengths in advanced computing, environmental management and additive manufacturing may be applied to improve traditional energy sources.*

Georgia Institute of Technology

Scientists from ExxonMobil and the Georgia Institute of Technology (GT) have developed a potentially revolutionary new technology that could significantly reduce the amount of energy and emissions associated with manufacturing plastics. Results of the research were published in the August 19, 2016, edition of the professional journal Science.

The new process uses a form of reverse osmosis to separate similarly sized organic molecules. It effectively relies on a molecular-level filter that separates chemical building blocks for plastics from complex hydrocarbons at low temperatures and pressures. Working with Dr. Ryan Lively, assistant professor in GT's School of Chemical & Biomolecular Engineering, and a GT post-doctoral researcher, the team successfully demonstrated that chemical compounds known as aromatics can be separated by pressing them through a synthetic membrane they developed that acts as a high-tech sieve.
The new process may enable chemical producers to separate aromatics without heating the chemical mixture, greatly reducing the amount of energy consumed and emissions generated during the current commercial manufacturing process. ExxonMobil believes the new membrane has potential for commercialization and integration into industrial chemical separation processes since it is made from common materials, known as polymer building blocks. The technology still faces a number of challenges before it can be considered for commercialization and use at an industrial scale. The membranes used in the process will need to be tested under more challenging conditions, as industrial mixtures normally contain multiple organic compounds and may include materials that can foul membrane systems. The researchers must also learn to make the material consistently and demonstrate that it can withstand long-term industrial use.

This breakthrough could reduce annual carbon dioxide emissions by 45 million tons, which is equivalent to the annual energy-related carbon dioxide emissions of about five million U.S. homes. It could also reduce global energy costs used to make plastics by up to $2 billion a year. As our research into this specific chemical process advances, we hope to learn more about how this technology could be used in other applications to achieve the same type of efficiency and emissions-reductions results, and potentially reduce our manufacturing footprint even further.

For additional information, please see the following:

- *Corporate Citizenship Report – Managing Climate Risks:* *http://corporate.exxonmobil.com/en/community/corporate-citizenship-report/managing-climate-change-risks*
- *ExxonMobil's perspectives on climate change:* *http://corporate.exxonmobil.com/en/current-issues/climate-policy/climate-perspectives*
- *ExxonMobil Outlook for Energy: A View to 2040* *http://corporate.exxonmobil.com/en/energy/energy-outlook*
- *Credit natural gas for falling emissions, rising economy – ExxonMobil blog:* *https://energyfactor.exxonmobil.com/perspectives/natural-gas-falling-emissions/*
- *ExxonMobil's Collegiate Collaboration – ExxonMobil blog:* *https://energyfactor.exxonmobil.com/perspectives/exxonmobil-collegiate-collaboration/*

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Levelized Cost and Levelized Avoided Cost of New Generation Resources in the Annual Energy Outlook 2018

This paper presents average values of levelized costs and levelized avoided costs for generating technologies entering service in 2020, 2022,[1] and 2040 as represented in the National Energy Modeling System (NEMS) for the *Annual Energy Outlook 2018* (AEO2018) Reference case.[2] The costs for generating technologies entering service in 2022 are presented in the body of the report, with those for 2020[3] and 2040 included in Appendices A and B, respectively. Both a capacity-weighted average based on projected capacity additions and a simple average (unweighted) of the regional values across the 22 U.S. supply regions of the NEMS electricity market module (EMM) are provided, together with the range of regional values.

Levelized Cost of Electricity (LCOE)

Levelized cost of electricity (LCOE) is often cited as a convenient summary measure of the overall competiveness of different generating technologies. It represents the per-megawatthour cost (in discounted real dollars) of building and operating a generating plant over an assumed financial life and duty cycle.[4] Key inputs to calculating LCOE include capital costs, fuel costs, fixed and variable operations and maintenance (O&M) costs, financing costs, and an assumed utilization rate for each plant type.[5] The importance of these factors varies among the technologies. For technologies such as solar and wind generation that have no fuel costs and relatively small variable O&M costs, LCOE changes in rough proportion to the estimated capital cost of generation capacity. For technologies with significant fuel cost, both fuel cost and overnight cost estimates significantly affect LCOE. The availability of various incentives, including state or federal tax credits (see text box on page 2), can also affect the calculation of LCOE. As with any projection, there is uncertainty about all of these factors, and their values can vary regionally and temporally as technologies evolve and as fuel prices change.

Note that actual plant investment decisions are affected by the specific technological and regional characteristics of a project, which involve many other factors not reflected in LCOE values. The projected utilization rate, which depends on the load shape and the existing resource mix in an area where additional capacity is needed, is one such factor. The existing resource mix in a region can directly affect the economic viability of a new investment through its effect on the economics surrounding the displacement of existing resources. For example, a wind resource that would primarily displace existing

[1] Given the long lead-time and licensing requirements for some technologies, the first feasible year that all technologies are available is 2022.
[2] AEO2018 reports are available at http://www.eia.gov/outlooks/aeo/.
[3] Appendix A shows LCOE and LACE for the subset of technologies available to be built in 2020.
[4] Duty cycle refers to the typical utilization or dispatch of a plant to serve base, intermediate, or peak load. Wind, solar, or other intermittently available resources are not dispatched and do not necessarily follow a duty cycle based on load conditions.
[5] The specific assumptions for each of these factors are given in the *Assumptions to the Annual Energy Outlook*, available at http://www.eia.gov/outlooks/aeo/assumptions/.

natural gas generation will usually have a different economic value than one that would displace existing coal generation. A related factor is the capacity value, which depends on both the existing capacity mix and load characteristics in a region. Because load must be balanced on a continuous basis, generating units with the capability to vary output to follow demand (dispatchable technologies) generally have more value to a system than less flexible units (non-dispatchable technologies), or than units using intermittent resource to operate. The LCOE values for dispatchable and non-dispatchable technologies are listed separately in the tables, because comparing them must be done carefully.

The direct comparison of LCOE across technologies is, therefore, often problematic and can be misleading as a method to assess the economic competitiveness of various generation alternatives because projected utilization rates, the existing resource mix, and capacity values can all vary dramatically across regions where new generation capacity may be needed.

AEO2018 representation of tax incentives for renewable generation

Federal tax credits for certain renewable generation facilities have the potential to substantially reduce the realized cost of these facilities. Where applicable, the LCOE tables show both the cost with and without tax credits assumed to be available in the year in which the plant enters service, as follows.

Production Tax Credit (PTC): New wind, geothermal, and biomass plants receive 24 dollars per megawatthour ($/MWh); technologies other than wind, geothermal, and closed-loop biomass receive $12/MWh. The PTC values are adjusted for inflation and given over the plant's first 10 years of service if the plants are under construction before the end of 2016. After 2016, wind continues to be eligible for the PTC but at a dollar-per-megawatthour rate that declines by 20% in 2017, 40% in 2018, 60% in 2019, and expires completely in 2020. Based on documentation released by the Internal Revenue Service (IRS, see https://www.irs.gov/irb/2016-23_IRB/ar07.html), EIA assumes that wind plants have four years after beginning construction to bring the plants online and claim the PTC. As a result, wind plants entering service in 2020 will receive the full credit, and those entering service in 2022 will receive $14/MWh (inflation-adjusted).

Investment Tax Credit (ITC): New solar photovoltaic (PV) and thermal plants are eligible to receive a 30% ITC on capital expenditures if the plants are under construction before the end of 2019, after which the ITC tapers off for new starts to 26% in 2020 and to 22% in 2021. ITC expires for residential-owned systems and declines to 10% for business and utility-scale systems in 2022 and each year thereafter. All commercial and utility-scale plants placed in service after December 31, 2023 receive a 10% ITC regardless of the date construction started. Results in this levelized cost report only include utility-scale solar facilities and do not include small-scale solar facilities. In NEMS, EIA assumes a two-year construction lead time for new utility-scale solar PV plants and a three-year construction lead time for new solar thermal plants. EIA assumes that all utility-scale solar plants entering service in 2019 receive the full 30% tax credit. PV plants entering service in 2022 receive 26%, whereas solar thermal plants entering service in 2022, having begun construction a year earlier, receive 30%. Both onshore and offshore wind projects are eligible to claim the ITC in lieu of the PTC. While it is expected that onshore wind projects would choose the PTC, EIA assumes offshore wind projects will claim the ITC in lieu of the PTC because of the high capital costs for those projects.

Levelized Avoided Cost of Electricity (LACE)

Conceptually, an alternative assessment of economic competitiveness between generation technologies can be gained by considering the avoided cost, a measure of what it would cost the grid to generate the electricity that would be displaced by a new generation project. Avoided cost, which provides a proxy measure for the annual economic value of a candidate project, may be summed over its financial life and converted to a level annualized value that is divided by average annual output of the project to develop its *levelized* avoided cost of electricity (LACE).[6] The LACE value may then be compared with the LCOE value to provide an indication of whether or not the project's value exceeds its cost when multiple technologies are available to meet load. Using both the LCOE and LACE in combination provides a better assessment of economic competitiveness than either measure separately.

Estimating avoided costs is more complex than estimating levelized costs because it requires information about how the system would operate without the new option being considered. In this discussion, the calculation of avoided costs is based on the marginal value of energy and capacity that would result from adding a unit of a given technology to the system as it exists or is projected to exist at a specified future date and represents the potential value available to the project owner from the project's contribution to satisfying both energy and capacity requirements. Although the economic decisions for capacity additions in EIA's long-term projections do not use either LACE or LCOE concepts; however, the LACE and net economic values presented in this report are generally more representative of the factors contributing to the build-decisions than looking at LCOE alone. Nonetheless, both the LACE and LCOE estimates are simplifications of modeled decisions, and they may not fully capture all factors considered in NEMS or match modeled results. Finally, although levelized cost calculations are generally made using an assumed set of capital and operating costs, investment decisions may be affected by factors other than the projects value relative to costs—for example, the inherent uncertainty about future fuel prices, future policies, or local consideration for system reliability may lead plant owners or investors who finance plants to place a value on portfolio diversification or other risk related concerns.

EIA considers many of the factors discussed in the previous paragraphs in its analysis of technology choice in the electricity sector in NEMS, but not all of these concepts are included in LCOE or LACE calculations. Future policy-related factors, such as new environmental regulations or tax credits for specific generation sources, can affect investment decisions. The LCOE and LACE values presented here are derived from the AEO2018 Reference case, which includes state-level renewable electricity requirements as of October 2017 and a phase out of federal tax credits for renewable generation.

LCOE and LACE calculations

LCOE values are calculated based on a 30-year cost recovery period, using a real after-tax weighted average cost of capital (WACC) of 4.5%.[7] In reality, the cost recovery period and cost of capital can vary

[6] Further discussion of the levelized avoided cost concept and its use in assessing economic competitiveness can be found in this link: http://www.eia.gov/renewable/workshop/gencosts/.

[7] The real WACC of 4.5% corresponds to a nominal after-tax rate of 7.0% for plants entering service in 2022. For plants entering service in 2020 and 2040, the nominal WACC used to calculate LCOE was 6.2% and 7.0%, respectively. An overview of the WACC assumptions and methodology can be found in the *Electricity Market Module of the National Energy Modeling System: Model Documentation*. This report can be found at https://www.eia.gov/analysis/pdfpages/m068index.php.

by technology and project type. In the AEO20018 Reference case, there is a 3-percentage-point increase to the cost of capital when evaluating investments in new coal-fired power plants and new coal-to-liquids (CTL) plants without carbon capture and sequestration (CCS) and pollution control retrofits. This increase reflects financial risks associated with major investments in long-lived power plants with a relatively higher rate of carbon dioxide (CO2) emissions. AEO2018 takes into account two coal-fired technologies that are compliant with the New Source Performance Standard (NSPS) for CO2 emissions under Section 111(b) of the Clean Air Act. One technology is designed to capture 30% of CO2 emissions and would still be considered a high emitter relative to other new sources; thus, it may continue to face potential financial risk if CO2 emission controls are further strengthened. Another technology is designed to capture 90% of CO2 emissions and would not face the same financial risk; therefore, it does not receive the 3-percentage-point increase in cost of capital. As a result, the LCOE values for a coal-fired plant with 30% CCS are higher than they would be if the same cost of capital were used for all technologies.

The levelized capital component reflects costs calculated using tax depreciation schedules consistent with permanent tax law, which vary by technology.[8] For technologies eligible for ITC or PTC, LCOE is reported both with and without tax credits, which are assumed to phase out and expire based on current laws and regulations. Some technologies, notably solar PV, are used in both utility-scale generation and in distributed end-use residential and commercial applications. The LCOE and LACE calculations presented here apply only to the utility-scale use of those technologies. Costs are expressed in terms of net alternating current (AC) power available to the grid for the installed capacity.

LCOE and LACE for each technology is evaluated based on the associated capacity factor, which generally corresponds to the high end of its likely utilization range. This convention is consistent with the use of LCOE to evaluate competing technologies in baseload operation such as coal and nuclear plants. Some technologies, such as combined-cycle (CC) plants, while sometimes used in baseload operation, are also built to serve load-following or other intermediate dispatch duty cycles. Simple conventional or advanced combustion turbines (CT) that are typically used for peak load duty cycles are evaluated at a 30% capacity factor, which reflects the upper end of their typical economic utilization range.

The duty cycle for intermittent wind and solar resources is not operator controlled, but it is dependent on the weather or availability of sunlight; therefore, it will not necessarily correspond to operator-dispatched duty cycles. As a result, LCOE values for wind and solar technologies are not directly comparable to the LCOE values for other technologies that may have a similar average annual capacity factor; therefore, they are shown separately as non-dispatchable technologies. Similarly, hydroelectric resources, including facilities where storage reservoirs allow for more flexible day-to-day operation, generally have high seasonal variation in output. They are also shown as non-dispatchable to discourage comparison with technologies that have more consistent seasonal availability. The capacity factors for solar, wind, and hydroelectric resources are averages of the capacity factor (weighted or unweighted) for the marginal site in each region, which can vary significantly by region, and will not necessarily

[8]The AEO2018 was prepared prior to passage of the Tax Cuts and Jobs Act of 2017. The new tax rate and depreciation schedules are expected to affect all technologies and will be incorporated into future EIA analyses of energy markets.

correspond to projected capacity factors for these resources in the AEO2018 or in other EIA analyses that represent capacity factors of cumulative capacity additions and existing units.

The LCOE values shown in Table 1a are a weighted average of region-specific LCOE values using weights reflecting the projected regional capacity builds in AEO2018 for new plants coming online in 2022.

Table 1a. Estimated levelized cost of electricity (capacity-weighted average[1]) for new generation resouces entering service in 2022 (2017 $/MWh)

Plant type	Capacity factor (%)	Levelized capital cost	Levelized fixed O&M	Levelized variable O&M	Levelized transmission cost	Total system LCOE	Levelized tax credit[2]	Total LCOE including tax credit
Dispatchable technologies								
Coal with 30% CCS[3]	NB	NB	NB	NB	NB	NB	NA	NB
Coal with 90% CCS[3]	NB	NB	NB	NB	NB	NB	NA	NB
Conventional CC	87	13.0	1.5	32.8	1.0	48.3	NA	48.3
Advanced CC	87	15.5	1.3	30.3	1.1	48.1	NA	48.1
Advanced CC with CCS	NB	NB	NB	NB	NB	NB	NA	NB
Conventional CT	NB	NB	NB	NB	NB	NB	NA	NB
Advanced CT	30	22.7	2.6	51.3	2.9	79.5	NA	79.5
Advanced nuclear	90	67.0	12.9	9.3	0.9	90.1	NA	90.1
Geothermal	91	28.3	13.5	0.0	1.3	43.1	-2.8	40.3
Biomass	83	40.3	15.4	45.0	1.5	102.2	NA	102.2
Non-dispatchable technologies								
Wind, onshore	43	33.0	12.7	0.0	2.4	48.0	-11.1	37.0
Wind, offshore	45	102.6	20.0	0.0	2.0	124.6	-18.5	106.2
Solar PV[4]	33	48.2	7.5	0.0	3.3	59.1	-12.5	46.5
Solar thermal	NB	NB	NB	NB	NB	NB	NB	NB
Hydroelectric[5]	65	56.7	14.0	1.3	1.8	73.9	NA	73.9

[1]The capacity-weighted average is the average levelized cost per technology, weighted by the new capacity coming online in each region. The capacity additions for each region are based on additions in 2020–2022. Technologies for which capacity additions are not expected do not have a capacity-weighted average and are marked as *NB* or not built.

[2]The tax credit component is based on targeted federal tax credits such as the PTC or ITC available for some technologies. It reflects tax credits available only for plants entering service in 2022 and the substantial phase out of both the PTC and ITC as scheduled under current law. Technologies not eligible for PTC or ITC are indicated as *NA* or not available. The results are based on a regional model, and state or local incentives are not included in LCOE calculations. See text box on page 2 for details on how the tax credits are represented in the model.

[3]Because Section 111(b) of the Clean Air Act requires conventional coal plants to be built with CCS to meet specific CO2 emission standards, two levels of CCS removal are modeled: 30%, which meets the NSPS, and 90%, which exceeds the NSPS but may be seen as a build option in some scenarios. The coal plant with 30% CCS is assumed to incur a 3 percentage-point increase to its cost of capital to represent the risk associated with higher emissions.

[4]Costs are expressed in terms of net AC power available to the grid for the installed capacity.

[5]As modeled, hydroelectric is assumed to have seasonal storage so that it can be dispatched within a season, but overall operation is limited by resources available by site and season.

CCS=carbon capture and sequestration. CC=combined-cycle (natural gas). CT=combustion turbine. PV=photovoltaic.

Source: U.S. Energy Information Administration, *Annual Energy Outlook 2018*.

Table 1b reports an unweighted average across all 22 EMM regions for the same generation resources projected to come online in 2022.

Table 1b. Estimated levelized cost of electricity (unweighted average) for new generation resources entering service in 2022 (2017 $/MWh)

Plant type	Capacity factor (%)	Levelized capital cost	Levelized fixed O&M	Levelized variable O&M	Levelized transmission cost	Total system LCOE	Levelized tax credit[1]	Total LCOE including tax credit
Dispatchable technologies								
Coal with 30% CCS[2]	85	84.0	9.5	35.6	1.1	130.1	NA	130.1
Coal with 90% CCS[2]	85	68.5	11.0	38.5	1.1	119.1	NA	119.1
Conventional CC	87	12.6	1.5	34.9	1.1	50.1	NA	50.1
Advanced CC	87	14.4	1.3	32.2	1.1	49.0	NA	49.0
Advanced CC with CCS	87	26.9	4.4	42.5	1.1	74.9	NA	74.9
Conventional CT	30	37.2	6.7	51.6	3.2	98.7	NA	98.7
Advanced CT	30	23.6	2.6	55.7	3.2	85.1	NA	85.1
Advanced nuclear	90	69.4	12.9	9.3	1.0	92.6	NA	92.6
Geothermal	90	30.1	13.2	0.0	1.3	44.6	-3.0	41.6
Biomass	83	39.2	15.4	39.6	1.1	95.3	NA	95.3
Non-dispatchable technologies								
Wind, onshore	41	43.1	13.4	0.0	2.5	59.1	-11.1	48.0
Wind, offshore	45	115.8	19.9	0.0	2.3	138.0	-20.8	117.1
Solar PV[3]	29	51.2	8.7	0.0	3.3	63.2	-13.3	49.9
Solar thermal	25	128.4	32.6	0.0	4.1	165.1	-38.5	126.6
Hydroelectric[4]	64	48.2	9.8	1.8	1.9	61.7	NA	61.7

[1]The tax credit component is based on targeted federal tax credits such as the PTC or ITC available for some technologies. It reflects tax credits available only for plants entering service in 2022 and the substantial phase out of both the PTC and ITC as scheduled under current law. Technologies not eligible for PTC or ITC are indicated as *NA* or not available. The results are based on a regional model, and state or local incentives are not included in LCOE calculations. See text box on page 2 for details on how the tax credits are represented in the model.

[2]Because Section 111(b) of the Clean Air Act requires conventional coal plants to be built with CCS to meet specific CO2 emission standards, two levels of CCS removal are modeled: 30%, which meets the NSPS, and 90%, which exceeds the NSPS but may be seen as a build option in some scenarios. The coal plant with 30% CCS is assumed to incur a 3 percentage-point increase to its cost of capital to represent the risk associated with higher emissions.

[3]Costs are expressed in terms of net AC power available to the grid for the installed capacity.

[4]As modeled, hydroelectric is assumed to have seasonal storage so that it can be dispatched within a season, but overall operation is limited by resources available by site and season.

CCS=carbon capture and sequestration. CC=combined-cycle (natural gas). CT=combustion turbine. PV=photovoltaic.

Source: U.S. Energy Information Administration, *Annual Energy Outlook 2018*.

Table 2. Regional variation in levelized cost of electricity for new generation resources entering service in 2022 (2017 $/MWh)

Plant type	Range for total system levelized costs: Minimum	Simple average	Capacity-weighted average[2]	Maximum	Range for total system levelized costs with tax credits[1]: Minimum	Simple average	Capacity-weighted average[2]	Maximum
Dispatchable technologies								
Coal with 30% CCS[3]	117.2	130.1	NB	191.1	117.2	130.1	NB	191.1
Coal with 90% CCS[3]	110.5	119.1	NB	139.5	110.5	119.1	NB	139.5
Conventional CC	44.5	50.1	48.3	78.5	44.5	50.1	48.3	78.5
Advanced CC	43.5	49.0	48.1	76.8	43.5	49.0	48.1	76.8
Advanced CC with CCS	66.5	74.9	NB	84.8	66.5	74.9	NB	84.7
Conventional CT	87.2	98.7	NB	144.9	87.2	98.7	NB	144.9
Advanced CT	75.0	85.1	79.5	128.5	75.0	85.1	79.5	128.5
Advanced nuclear	89.7	92.6	90.1	97.5	89.7	92.6	90.1	97.5
Geothermal	41.7	44.6	43.1	49.5	39.2	41.6	40.3	45.8
Biomass	74.0	95.3	102.2	111.2	74.0	95.3	102.2	111.2
Non-dispatchable technologies								
Wind, onshore	40.7	59.1	48.0	77.3	29.7	48.0	37.0	66.2
Wind, offshore	122.2	138.0	124.6	168.5	103.8	117.1	106.2	142.3
Solar PV[4]	42.3	63.2	59.1	113.9	34.2	49.9	46.5	88.2
Solar thermal	145.1	165.1	NB	187.9	111.9	126.6	NB	144.3
Hydroelectric[5]	49.6	61.7	73.9	73.9	49.6	61.7	73.9	73.9

[1]Levelized cost with tax credits reflects tax credits available for plants entering service in 2022. See note 1 in Tables 1a and 1b.

[2]The capacity-weighted average is the average levelized cost per technology, weighted by the new capacity coming online in each region. The capacity additions for each region are based on additions in 2020–2022. Technologies for which capacity additions are not expected do not have a capacity-weighted average and are marked as *NB* or not built.

[3]Because Section 111(b) of the Clean Air Act requires conventional coal plants to be built with CCS to meet specific CO2 emission standards, two levels of CCS removal are modeled: 30%, which meets the NSPS, and 90%, which exceeds the NSPS but may be seen as a build option in some scenarios. The coal plant with 30% CCS is assumed to incur a 3 percentage-point increase to its cost of capital to represent the risk associated with higher emissions.

[4]Costs are expressed in terms of net AC power available to the grid for the installed capacity.

[5]As modeled, hydroelectric is assumed to have seasonal storage so that it can be dispatched within a season, but overall operation is limited by resources available by site and season.

CCS=carbon capture and sequestration. CC=combined-cycle (natural gas). CT=combustion turbine. PV=photovoltaic.

Note: The levelized costs for non-dispatchable technologies are calculated based on the capacity factor for the marginal site modeled in each region, which can vary significantly by region. The capacity factor ranges for these technologies are as follows: 37%–46% for onshore wind, 41%–50% for offshore wind, 22%–34% for solar PV, 21%–26% for solar thermal, 30%–79% for hydroelectric. The levelized costs are also affected by regional variations in construction labor rates and capital costs as well as resource availability.

Source: U.S. Energy Information Administration, *Annual Energy Outlook 2018*.

Table 2 shows the significant regional variation in LCOE values based on local labor markets and the cost and availability of fuel or energy resources such as windy sites. For example, without consideration of the PTC, the LCOE for incremental onshore wind capacity ranges from $40.7/MWh in the region with the best available wind resources to $77.3/MWh in the region with the lowest-quality wind resources and/or higher capital costs for the best sites. Because onshore wind plants will most likely be built in regions that offer low costs and high value, the weighted average cost across regions is closer to the low end of the range, at $48.0/MWh. Costs for wind generators may include additional expenses associated with transmission upgrades needed to access remote resources, as well as other factors that markets may or may not internalize into the market price for wind power.

As previously indicated, LACE provides an estimate of the cost of generation and capacity resources displaced by a marginal unit of new capacity of a particular type, thus providing an estimate of the value of building that new capacity. This estimate is especially important to consider for intermittent resources, such as wind or solar, that have substantially different duty cycles than the baseload, intermediate, and peaking duty cycles of conventional generators. Table 3 provides the range of LACE estimates for different capacity types. The LACE estimates in this table have been calculated assuming the same maximum capacity factor as in the LCOE. Values are not shown for combustion turbines, because combustion turbines are generally built for their capacity value to meet a reserve margin rather than to meet generation requirements and avoided energy costs.

Table 3. Regional variation in levelized avoided cost of electricity for new generation resources entering service in 2022 (2017 $/MWh)

Plant type	Minimum	Simple average	Capacity-weighted average[1]	Maximum
Dispatchable technologies				
Coal with 30% CCS[2]	38.5	46.8	NB	74.9
Coal with 90% CCS[2]	38.5	46.8	NB	74.9
Conventional CC	38.5	47.2	46.5	74.9
Advanced CC	38.5	47.2	47.5	74.9
Advanced CC with CCS	38.5	47.2	NB	74.9
Advanced nuclear	38.6	45.1	43.3	51.7
Geothermal	45.9	57.3	66.8	74.6
Biomass	38.2	47.1	45.1	74.6
Non-dispatchable technologies				
Wind, onshore	35.9	41.1	42.9	72.1
Wind, offshore	41.6	47.3	47.6	76.6
Solar PV[3]	36.5	55.3	72.4	78.6
Solar thermal	35.8	59.7	NB	83.3
Hydroelectric[4]	40.6	52.6	74.6	74.6

[1]The capacity-weighted average is the average levelized cost per technology, weighted by the new capacity coming online in each region. The capacity additions for each region are based on additions in 2020-2022. Technologies for which capacity additions are not expected do not have a capacity-weighted average and are marked as *NB* or not built.

[2]Because Section 111(b) of the Clean Air Act requires conventional coal plants to be built with CCS to meet specific CO2 emission standards, two levels of CCS removal are modeled: 30%, which meets the NSPS, and 90%, which exceeds the NSPS but may be seen as a build option in some scenarios. The coal plant with 30% CCS is assumed to incur a 3 percentage-point increase to its cost of capital to represent the risk associated with higher emissions.

[3]Costs are expressed in terms of net AC power available to the grid for the installed capacity.

[4]As modeled, hydroelectric is assumed to have seasonal storage so that it can be dispatched within a season, but overall operation is limited by resources available by site and season.

CCS=carbon capture and sequestration. CC=combined-cycle (natural gas). CT=combustion turbine. PV=photovoltaic.

Source: U.S. Energy Information Administration, *Annual Energy Outlook 2018*.

When the LACE of a particular technology exceeds its LCOE at a given time and place, that technology would generally be economically attractive to build. The build decisions in the real world and as modeled in the AEO2018, however, are more complex than a simple LACE to LCOE comparison because they include such factors as policy and non-economic drivers. Nevertheless, the net economic value (difference between LACE and LCOE) provides a reasonable point of comparison of first-order economic competitiveness among a wider variety of technologies than is possible using either LCOE or LACE tables individually. In Tables 4a and 4b, a negative net difference indicates that the cost of the marginal new unit of capacity exceeds its value to the system, and a net positive difference indicates that the marginal new unit brings in value higher than its cost by displacing more expensive generation and capacity options. The *Average Net Difference* represents the average of the *LACE minus LCOE* calculation, where the difference is calculated for each of the 22 regions. This range of differences is not based on the difference between the minimum and maximum values shown in Tables 2 and 3 but represents the lower and upper bound resulting from the LACE minus the LCOE calculations for each of the 22 regions.

Table 4a. Difference between capacity-weighted levelized avoided cost of electricity and capacity-weighted levelized cost of electricity with tax credits for new generation resources entering service in 2022 (2017 $/MWh)

Plant type	Average capacity-weighted[1] LCOE with tax credits	Average capacity-weighted[1] LACE	Average net difference[2]
Dispatchable technologies			
Coal with 30% CCS[3]	NB	NB	NB
Coal with 90% CCS[3]	NB	NB	NB
Conventional CC	48.3	46.5	-1.7
Advanced CC	48.1	47.5	-0.6
Advanced CC with CCS	NB	NB	NB
Advanced nuclear	90.1	43.3	-46.8
Geothermal	40.3	66.8	26.5
Biomass	102.2	45.1	-57.1
Non-dispatchable technologies			
Wind, onshore	37.0	42.9	5.9
Wind, offshore	106.2	47.6	-58.6
Solar PV[4]	46.5	72.4	25.8
Solar thermal	NB	NB	NB
Hydroelectric[5]	73.9	74.6	0.7

[1]The capacity-weighted average is the average levelized cost per technology, weighted by the new capacity coming online in each region. The capacity additions for each region are based on additions in 2020–2022. Technologies for which capacity additions are not expected do not have a capacity-weighted average and are marked as *NB* or not built.
[2]The *Average net difference* represents the net economic value or the average of the LACE minus LCOE calculation, where the difference is calculated for each of the 22 regions based on the cost with tax credits for each technology, as available.
[3]Because Section 111(b) of the Clean Air Act requires conventional coal plants to be built with CCS to meet specific CO2 emission standards, two levels of CCS removal are modeled: 30%, which meets the NSPS, and 90%, which exceeds the NSPS but may be seen as a build option in some scenarios. The coal plant with 30% CCS is assumed to incur a 3 percentage-point increase to its cost of capital to represent the risk associated with higher emissions.
[4]Costs are expressed in terms of net AC power available to the grid for the installed capacity.
[5]As modeled, hydroelectric is assumed to have seasonal storage so that it can be dispatched within a season, but overall operation is limited by resources available by site and season.
CCS=carbon capture and sequestration. CC=combined-cycle (natural gas). CT=combustion turbine. PV=photovoltaic.
Source: U.S. Energy Information Administration, *Annual Energy Outlook 2018*.

As shown in Table 4a, the capacity-weighted average net difference is above zero in 2022 for geothermal, solar PV, and onshore wind, suggesting that these technologies are being built in regions where they are economically viable. Although the capacity-weighted average net difference for advanced CC is negative, it is close to zero, which suggests that the technology has been the most attractive marginal capacity addition and the market has developed the technology to the point where the net economic value is close to breakeven after having met load growth and/or displaced higher cost generation.[9]

Table 4b. Difference between unweighted levelized avoided cost of electricity and unweighted levelized cost of electricity with tax credits for new generation resources entering service in 2022 (2017 $/MWh)

Plant type	Average unweighted LCOE with tax credits	Average unweighted LACE	Average net difference[1]	Minimum[2]	Maximum[2]
Dispatchable technologies					
Coal with 30% CCS[3]	130.1	46.8	-83.3	-116.2	-71.3
Coal with 90% CCS[3]	119.1	46.8	-72.3	-83.8	-63.2
Conventional CC	50.1	47.2	-2.9	-10.2	1.2
Advanced CC	49.0	47.2	-1.8	-9.1	1.3
Advanced CC with CCS	74.9	47.2	-27.7	-35.4	-6.4
Advanced nuclear	92.6	45.1	-47.5	-53.3	-41.0
Geothermal	41.6	57.3	15.7	5.7	34.7
Biomass	95.3	47.1	-48.2	-59.6	-33.3
Non-dispatchable technologies					
Wind, onshore	48.0	41.1	-6.9	-26.5	19.3
Wind, offshore	117.1	47.3	-69.8	-92.1	-31.1
Solar PV[4]	49.9	55.3	5.4	-27.0	30.7
Solar thermal	126.6	59.7	-66.9	-94.5	-48.3
Hydroelectric[5]	61.7	52.6	-9.0	-18.7	0.7

[1]The *Average net difference* represents the net economic value or the average of the LACE minus LCOE calculation, where the difference is calculated for each of the 22 regions based on the cost with tax credits for each technology, as available.
[2]The range of unweighted differences is not based on the difference between the minimum values shown in Tables 2 and 3, but represents the lower and upper bound resulting from the LACE minus LCOE calculations for each of the 22 regions.
[3]Because Section 111(b) of the Clean Air Act requires conventional coal plants to be built with CCS to meet specific CO2 emission standards, two levels of CCS removal are modeled: 30%, which meets the NSPS, and 90%, which exceeds the NSPS but may be seen as a build option in some scenarios. The coal plant with 30% CCS is assumed to incur a 3 percentage-point increase to its cost of capital to represent the risk associated with higher emissions.
[4]Costs are expressed in terms of net AC power available to the grid for the installed capacity.
[5]As modeled, hydroelectric is assumed to have seasonal storage so that it can be dispatched within a season, but overall operation is limited by resources available by site and season.
CCS=carbon capture and sequestration. CC=combined-cycle (natural gas). CT=combustion turbine. PV=photovoltaic.
Source: U.S. Energy Information Administration, *Annual Energy Outlook 2018*.

[9] For a more detailed discussion of the LACE versus LCOE measures, see *Assessing the Economic Value of New Utility-Scale Electricity Generation Projects*, which can be found at http://www.eia.gov/renewable/workshop/gencosts/pdf/lace-lcoe_070213.pdf

LCOE and LACE projections

Table 5 compares LCOE with the applicable tax credit, LACE, and net difference between LACE and LCOE for advanced CC, onshore wind, and solar PV plants entering service in 2022 and 2040 (as shown in Appendix B). Changes in costs between 2022 and 2040 reflect a number of different factors, sometimes working in different directions. Technology improvement tends to reduce LCOE through lower capital costs or improved performance (as measured by heat rate for advanced CC plants or capacity factor for onshore wind or solar PV plants). For advanced CC plants, changing fuel prices also factor into the change in LCOE. For wind and solar resources, the availability of high-quality resources may also be a factor. As the best, least-cost resources are utilized, future development will occur in less favorable areas, potentially resulting in higher project development costs, higher costs to access transmission lines, or access to lower-performing resources. Changes in the value of generation are a function of load growth. Wind and solar may show strong daily or seasonal generation patterns; as a result, the value of such renewable generation may see significant reductions as these time periods become more saturated with generation from similar resources and generation from new facilities must compete with lower-cost options in the dispatch merit order.

Table 5. Levelized cost of electricity, levelized avoided cost of electricity, and net economic value for selected generating technologies entering service in 2022 and 2040 (2017 $/MWh)

	Advanced CC		Onshore wind		Solar PV[1]	
Indicator	**2022**	**2040**	**2022**	**2040**	**2022**	**2040**
Capacity-weighted[2]						
LCOE[3]	48.1	47.6	37.0	56.4	46.5	40.8
LACE	47.5	48.1	42.9	67.6	72.4	56.7
Average net difference[4]	-0.6	0.5	5.9	11.2	25.8	15.9
Unweighted						
LCOE[3]	49.0	51.7	48.0	49.7	49.9	48.1
LACE	47.2	50.9	41.1	44.7	55.3	58.4
Average net difference[4]	-1.8	-0.8	-6.9	-4.9	5.4	10.3

[1]Costs are expressed in terms of net AC power available to the grid for the installed capacity.

[2]The capacity-weighted average is the average levelized cost per technology, weighted by the new capacity coming online in each region. The capacity additions for each region are based on additions in 2020–2022 for plants coming online in 2022 and in 2038–2040 for plants coming online in 2040.

[3]Levelized-cost with tax credits reflects tax credits available for plants entering service in 2022 and 2040. See note 1 in Tables 1a and 1b.

[4]The *Average net difference* represents the net economic value or the average of the LACE minus LCOE calculation, where the difference is calculated for each of the 22 regions based on the cost with tax credits for each technology, as available.

Source: U.S. Energy Information Administration, *Annual Energy Outlook 2018*.

Appendix A: LCOE tables for new generation resources entering service in 2020

Table A1a. Estimated levelized cost of electricity (capacity-weighted average[1]) for new generation resources entering service in 2020 (2017 $/MWh)

Plant type	Capacity factor (%)	Levelized capital cost	Levelized fixed O&M	Levelized variable O&M	Levelized transmission cost	Total system LCOE	Levelized tax credit[2]	Total LCOE including tax credit
Dispatchable technologies								
Conventional CC	87	11.1	1.5	33.6	1.0	47.1	NA	47.1
Advanced CC	87	13.2	1.3	29.5	1.0	45.1	NA	45.1
Conventional CT	30	30.7	6.7	48.0	2.7	88.1	NA	88.1
Advanced CT	30	19.5	2.6	52.7	2.7	77.5	NA	77.5
Non-dispatchable technologies								
Wind, onshore	42	32.7	13.1	0.0	2.4	48.1	-17.5	30.6
Solar PV[3]	31	46.5	8.1	0.0	3.1	57.7	-13.9	43.8

[1]The capacity-weighted average is the average levelized cost per technology, weighted by the new capacity coming online in each region. The capacity additions for each region are based on additions in 2018-2020.

[2]The tax credit component is based on targeted federal tax credits such as the PTC or ITC available for some technologies. It reflects tax credits available only for plants entering service in 2020 and the substantial phase out of both the PTC and ITC as scheduled under current law. Technologies not eligible for PTC or ITC are indicated as *NA* or not available. The results are based on a regional model, and state or local incentives are not included in LCOE calculations. See text box on page 2 for details on how the tax credits are represented in the model.

[3]Costs are expressed in terms of net AC power available to the grid for the installed capacity.

CC=combined-cycle (natural gas). CT=combustion turbine. PV=photovoltaic.

Source: U.S. Energy Information Administration, *Annual Energy Outlook 2018*.

Table A1b. Estimated levelized avoided cost of electricity (unweighted average) for new generation resources entering service in 2020 (2017 $/MWh)

Plant type	Capacity factor (%)	Levelized capital cost	Levelized fixed O&M	Levelized variable O&M	Levelized transmission cost	Total system LCOE	Levelized tax credit[1]	Total LCOE including tax credit
Dispatchable technologies								
Conventional CC	87	11.5	1.5	34.1	1.1	48.1	NA	48.1
Advanced CC	87	13.1	1.3	31.1	1.1	46.7	NA	46.7
Conventional CT	30	33.9	6.7	49.9	3.1	93.6	NA	93.6
Advanced CT	30	21.7	2.6	55.8	3.1	83.2	NA	83.2
Non-dispatchable technologies								
Wind, onshore	40	40.4	13.7	0.0	2.5	56.6	-17.5	39.1
Solar PV[2]	29	51.3	8.7	0.0	3.2	63.2	-15.4	47.8

[1]The tax credit component is based on targeted federal tax credits such as the PTC or ITC available for some technologies. It reflects tax credits available only for plants entering service in 2020 and the substantial phase out of both the PTC and ITC as scheduled under current law. Technologies not eligible for PTC or ITC are indicated as *NA* or not available. The results are based on a regional model, and state or local incentives are not included in LCOE calculations. See text box on page 2 for details on how the tax credits are represented in the model.

[2]Costs are expressed in terms of net AC power available to the grid for the installed capacity.

CC=combined-cycle (natural gas). CT=combustion turbine. PV=photovoltaic.

Source: U.S. Energy Information Administration, *Annual Energy Outlook 2018*.

Table A2. Regional variation in levelized cost of electricity for new generation resources entering service in 2020 (2017 $/MWh)

Plant type	Range for total system levelized costs				Range for total system levelized costs with tax credits[1]			
	Minimum	Simple average	Capacity-weighted average[2]	Maximum	Minimum	Simple average	Capacity-weighted average[2]	Maximum
Dispatchable technologies								
Conventional CC	43.3	48.1	47.1	58.1	43.3	48.1	47.1	58.1
Advanced CC	42.0	46.7	45.1	56.5	42.0	46.7	45.1	56.5
Conventional CT	85.8	93.6	88.1	111.8	85.8	93.6	88.1	111.8
Advanced CT	75.8	83.2	77.5	100.9	75.8	83.2	77.5	100.9
Non-dispatchable technologies								
Wind, onshore	40.1	56.6	48.1	70.4	22.6	39.1	30.6	52.9
Solar PV[3]	42.4	63.2	57.7	114.0	32.9	47.8	43.8	84.3

[1]Levelized cost with tax credits reflects tax credits available for plants entering service in 2020. See note 1 in Tables A1a and A1b.

[2]The capacity-weighted average is the average levelized cost per technology, weighted by the new capacity coming online in each region. The capacity additions for each region are based on additions in 2018–2020.

[3]Costs are expressed in terms of net AC power available to the grid for the installed capacity.

CC=combined-cycle (natural gas). CT=combustion turbine. PV=photovoltaic.

Note: The levelized costs for non-dispatchable technologies are calculated based on the capacity factor for the marginal site modeled in each region that can vary significantly by region. The capacity factor ranges for these technologies are as follows: 36%–45% for onshore wind and 22%–34% for solar PV. The levelized costs are also affected by regional variations in construction labor rates and capital costs as well as resource availability.

Source: U.S. Energy Information Administration, *Annual Energy Outlook 2018*.

Table A3. Regional variation in levelized avoided cost of electricity for new generation resources entering service in 2020 (2017 $/MWh)

Plant type	Minimum	Simple average	Capacity-weighted average[1]	Maximum
Dispatchable technologies				
Conventional CC	38.6	45.5	45.0	58.4
Advanced CC	38.6	45.5	46.2	58.4
Conventional CT	42.2	58.7	60.6	77.8
Advanced CT	42.2	58.7	61.7	77.8
Non-dispatchable technologies				
Wind, onshore	34.0	40.2	38.0	50.8
Solar PV[2]	32.5	52.1	53.4	71.6

[1]The capacity-weighted average is the average levelized cost per technology, weighted by the new capacity coming online in each region. The capacity additions for each region are based on additions in 2018–2020.

[2]Costs are expressed in terms of net AC power available to the grid for the installed capacity.

CC=combined-cycle (natural gas). CT=combustion turbine. PV=photovoltaic.

Source: U.S. Energy Information Administration, Annual Energy Outlook 2018.

Table A4a. Difference between capacity-weighted levelized avoided cost of electricity and capacity-weighted levelized cost of electricity with tax credits for new generation resources entering service in 2020 (2017 $/MWh)

Plant type	Average capacity-weighted[1] LCOE with tax credits	Average capacity-weighted[1] LACE	Average net difference[2]
Dispatchable technologies			
Conventional CC	47.1	45.0	-2.1
Advanced CC	45.1	46.2	1.2
Conventional CT	88.1	60.6	-27.5
Advanced CT	77.5	61.7	-15.8
Non-dispatchable technologies			
Wind, onshore	30.6	38.0	7.3
Solar PV[3]	43.8	53.4	9.6

[1]The capacity-weighted average is the average levelized cost per technology, weighted by the new capacity coming online in each region. The capacity additions for each region are based on additions in 2018–2020.
[2]The *Average net difference* represents the net economic value or the average of the LACE minus LCOE calculation, where the difference is calculated for each of the 22 regions based on the cost with tax credits for each technology, as available.
[3]Costs are expressed in terms of net AC power available to the grid for the installed capacity.
CC=combined-cycle (natural gas). CT=combustion turbine. PV=photovoltaic.
Source: U.S. Energy Information Administration, *Annual Energy Outlook 2018*.

Table A4b. Difference between unweighted levelized avoided cost of electricity and unweighted levelized cost of electricity with tax credits for new generation resources entering service in 2020 (2017 $/MWh)

Plant type	Average unweighted LCOE with tax credits	Average unweighted LACE	Average net difference[1]	Minimum[2]	Maximum[2]
Dispatchable technologies					
Conventional CC	48.1	45.5	-2.6	-9.3	4.2
Advanced CC	46.7	45.5	-1.1	-7.6	6.1
Conventional CT	93.6	58.7	-34.9	-53.7	-22.2
Advanced CT	83.2	58.7	-24.4	-42.9	-12.6
Non-dispatchable technologies					
Wind, onshore	39.1	40.2	1.1	-13.0	20.5
Solar PV[3]	47.8	52.1	4.3	-27.6	14.2

[1]The *Average net difference* represents the net economic value or the average of the LACE minus LCOE calculation, where the difference is calculated for each of the 22 regions based on the cost with tax credits for each technology, as available.
[2]The range of unweighted differences is not based on the difference between the minimum values shown in Tables A2 and A3, but represents the lower and upper bound resulting from the LACE minus LCOE calculations for each of the 22 regions.
[3]Costs are expressed in terms of net AC power available to the grid for the installed capacity.
CC=combined-cycle (natural gas). CT=combustion turbine. PV=photovoltaic.
Source: U.S. Energy Information Administration, *Annual Energy Outlook 2018*.

Appendix B: LCOE and LACE tables for new generation resources entering service in 2040

Table B1a. Estimated levelized cost of electricity (capacity-weighted average[1]) for new generation resources entering service in 2040 (2017 $/MWh)

Plant type	Capacity factor (%)	Levelized capital cost	Levelized fixed O&M	Levelized variable O&M	Levelized transmission cost	Total system LCOE	Levelized tax credit[2]	Total LCOE including tax credit
Dispatchable technologies								
Coal with 30% CCS[3]	NB	NB	NB	NB	NB	NB	NB	NB
Coal with 90% CCS[3]	NB	NB	NB	NB	NB	NB	NB	NB
Conventional CC	87	9.4	1.5	38.3	0.9	50.1	NA	50.1
Advanced CC	87	10.4	1.3	35.0	1.0	47.6	NA	47.6
Advanced CC with CCS	NB	NB	NB	NB	NB	NB	NB	NB
Conventional CT	NB	NB	NB	NB	NB	NB	NB	NB
Advanced CT	30	17.3	2.6	58.7	2.9	81.5	NA	81.5
Advanced nuclear	NB	NB	NB	NB	NB	NB	NB	NB
Geothermal	93	18.6	15.5	0.0	1.3	35.4	-1.9	33.5
Biomass	NB	NB	NB	NB	NB	NB	NB	NB
Non-dispatchable technologies								
Wind, onshore	38	38.9	14.2	0.0	3.3	56.4	NA	56.4
Wind, offshore	NB	NB	NB	NB	NB	NB	NB	NB
Solar PV[4]	32	33.2	8.0	0.0	2.9	44.1	-3.3	40.8
Solar thermal	NB	NB	NB	NB	NB	NB	NB	NB
Hydroelectric[5]	NB	NB	NB	NB	NB	NB	NB	NB

[1]The capacity-weighted average is the average levelized cost per technology, weighted by the new capacity coming online in each region. The capacity additions for each region are based on additions in 2038–2040. Technologies for which capacity additions are not expected do not have a capacity-weighted average and are marked as *NB* or not built.

[2]The tax credit component is based on targeted federal tax credits such as the PTC or ITC available for some technologies. It reflects tax credits available only for plants entering service in 2040 and the substantial phase out of both the PTC and ITC as scheduled under current law. Technologies not eligible for PTC or ITC are indicated as *NA* or not available. The results are based on a regional model, and state or local incentives are not included in LCOE calculations. See text box on page 2 for details on how the tax credits are represented in the model.

[3]Because Section 111(b) of the Clean Air Act requires conventional coal plants to be built with CCS to meet specific CO2 emission standards, two levels of CCS removal are modeled: 30%, which meets the NSPS, and 90%, which exceeds the NSPS but may be seen as a build option in some scenarios. The coal plant with 30% CCS is assumed to incur a 3 percentage-point increase to its cost of capital to represent the risk associated with higher emissions.

[4]Costs are expressed in terms of net AC power available to the grid for the installed capacity.

[5]As modeled, hydroelectric is assumed to have seasonal storage so that it can be dispatched within a season, but overall operation is limited by resources available by site and season.

CCS=carbon capture and sequestration. CC=combined-cycle (natural gas). CT=combustion turbine. PV=photovoltaic.

Source: U.S. Energy Information Administration, *Annual Energy Outlook 2018*.

Table B1b. Estimated levelized cost of electricity (unweighted average) for new generation resources entering service in 2040 (2017 $/MWh)

Plant type	Capacity factor (%)	Levelized capital cost	Levelized fixed O&M	Levelized variable O&M	Levelized transmission cost	Total system LCOE	Levelized tax credit[1]	Total LCOE including tax credit
Dispatchable technologies								
Coal with 30% CCS[2]	85	66.8	9.5	36.2	1.1	113.6	NA	113.6
Coal with 90% CCS[2]	85	54.5	11.0	35.8	1.1	102.4	NA	102.4
Conventional CC	87	10.4	1.5	40.6	1.1	53.6	NA	53.6
Advanced CC	87	11.3	1.3	38.0	1.1	51.7	NA	51.7
Advanced CC with CCS	87	20.0	4.4	50.4	1.1	75.9	NA	75.9
Conventional CT	30	30.6	6.7	60.3	3.1	100.8	NA	100.8
Advanced CT	30	17.7	2.6	61.2	3.1	84.7	NA	84.7
Advanced nuclear	90	54.4	12.9	9.8	1.0	78.1	NA	78.1
Geothermal	92	27.4	19.2	0.0	1.3	47.9	-2.7	45.2
Biomass	83	31.5	15.4	36.8	1.1	84.8	NA	84.8
Non-dispatchable technologies								
Wind, onshore	40	33.7	13.5	0.0	2.5	49.7	NA	49.7
Wind, offshore	45	88.2	19.9	0.0	2.3	110.4	NA	110.4
Solar PV[3]	29	40.1	8.7	0.0	3.3	52.1	-4.0	48.1
Solar thermal	24	103.6	33.7	0.0	4.2	141.4	-10.4	131.1
Hydroelectric[4]	61	42.9	9.4	4.1	2.0	58.4	NA	58.4

[1]The tax credit component is based on targeted federal tax credits such as the PTC or ITC available for some technologies. It reflects tax credits available only for plants entering service in 2040 and the substantial phase out of both the PTC and ITC as scheduled under current law. Technologies not eligible for PTC or ITC are indicated as *NA* or not available. The results are based on a regional model, and state or local incentives are not included in LCOE calculations. See text box on page 2 for details on how the tax credits are represented in the model.

[2]Because Section 111(b) of the Clean Air Act requires conventional coal plants to be built with CCS to meet specific CO2 emission standards, two levels of CCS removal are modeled: 30%, which meets the NSPS, and 90%, which exceeds the NSPS but may be seen as a build option in some scenarios. The coal plant with 30% CCS is assumed to incur a 3 percentage-point increase to its cost of capital to represent the risk associated with higher emissions.

[3]Costs are expressed in terms of net AC power available to the grid for the installed capacity.

[4]As modeled, hydroelectric is assumed to have seasonal storage so that it can be dispatched within a season, but overall operation is limited by resources available by site and season.

CCS=carbon capture and sequestration. CC=combined-cycle (natural gas). CT=combustion turbine. PV=photovoltaic.

Source: U.S. Energy Information Administration, *Annual Energy Outlook 2018*.

Table B2. Regional variation in levelized cost of electricity for new generation resources entering service in 2040 (2017 $/MWh)

	Range for total system levelized costs				Range for total system levelized costs with tax credits[1]			
Plant type	Minimum	Simple average	Capacity-weighted average[2]	Maximum	Minimum	Simple average	Capacity-weighted average[2]	Maximum
Dispatchable technologies								
Coal with 30% CCS[3]	101.3	113.6	NB	171.6	101.3	113.6	NB	171.6
Coal with 90% CCS[3]	94.2	102.4	NB	121.6	94.2	102.4	NB	121.6
Conventional CC	47.7	53.6	50.1	81.6	47.7	53.6	50.1	81.6
Advanced CC	45.6	51.7	47.6	78.8	45.6	51.7	47.6	78.8
Advanced CC with CCS	70.6	75.9	NB	83.0	70.6	75.9	NB	83.0
Conventional CT	92.1	100.8	NB	134.7	92.1	100.8	NB	134.7
Advanced CT	77.0	84.7	81.5	114.5	77.0	84.7	81.5	114.5
Advanced nuclear	75.7	78.1	NB	81.9	75.7	78.1	NB	81.9
Geothermal	35.4	47.9	35.4	69.6	33.5	45.2	33.5	65.3
Biomass	67.6	84.8	NB	104.1	67.6	84.8	NB	104.1
Non-dispatchable technologies								
Wind, onshore	34.5	49.7	56.4	63.6	34.5	49.7	56.4	63.6
Wind, offshore	97.8	110.4	NB	133.8	97.8	110.4	NB	133.8
Solar PV[4]	35.4	52.1	44.1	92.2	33.0	48.1	40.8	84.5
Solar thermal	121.0	141.4	NB	160.0	112.3	131.1	NB	148.5
Hydroelectric[5]	42.5	58.4	NB	70.1	42.5	58.4	NB	70.1

[1]Levelized cost with tax credits reflects tax credits available for plants entering service in 2040. See note 1 in Tables B1a and B1b.

[2]The capacity-weighted average is the average levelized cost per technology, weighted by the new capacity coming online in each region. The capacity additions for each region are based on additions in 2038–2040. Technologies for which capacity additions are not expected do not have a capacity-weighted average and are marked as *NB* or not built.

[3]Because Section 111(b) of the Clean Air Act requires conventional coal plants to be built with CCS to meet specific CO2 emission standards, two levels of CCS removal are modeled: 30%, which meets the NSPS, and 90%, which exceeds the NSPS but may be seen as a build option in some scenarios. The coal plant with 30% CCS is assumed to incur a 3 percentage-point increase to its cost of capital to represent the risk associated with higher emissions.

[4]Costs are expressed in terms of net AC power available to the grid for the installed capacity.

[5]As modeled, hydroelectric is assumed to have seasonal storage so that it can be dispatched within a season, but overall operation is limited by resources available by site and season.

CCS=carbon capture and sequestration. CC=combined-cycle (natural gas). CT=combustion turbine. PV=photovoltaic.

Note: The levelized costs for non-dispatchable technologies are calculated based on the capacity factor for the marginal site modeled in each region that can vary significantly by region. The capacity factor ranges for these technologies are as follows: 37%–46% for onshore wind, 41%–50% for offshore wind, 22%–34% for solar PV, 21%–26% for solar thermal, 35%–79% for hydroelectric. The levelized costs are also affected by regional variations in construction labor rates and capital costs as well as resource availability.

Source: U.S. Energy Information Administration, *Annual Energy Outlook 2018*.

Table B3. Regional variation in levelized avoided cost of electricity for new generation resources entering service in 2040 (2017 $/MWh)

Plant type	Minimum	Simple average	Capacity-weighted average[1]	Maximum
Dispatchable technologies				
Coal with 30% CCS[2]	36.1	50.3	NB	80.0
Coal with 90% CCS[2]	36.1	50.3	NB	80.0
Conventional CC	36.0	50.9	48.5	79.9
Advanced CC	36.0	50.9	48.1	79.9
Advanced CC with CCS	36.0	50.9	NB	79.9
Advanced nuclear	36.4	48.5	NB	59.3
Geothermal	35.5	56.0	79.2	79.2
Biomass	35.5	50.4	NB	79.2
Non-dispatchable technologies				
Wind, onshore	31.6	44.7	67.6	74.0
Wind, offshore	34.2	50.9	NB	83.2
Solar PV[3]	43.4	58.4	56.7	87.8
Solar thermal	50.7	65.3	NB	98.5
Hydroelectric[4]	35.5	53.3	NB	79.2

[1]The capacity-weighted average is the average levelized cost per technology, weighted by the new capacity coming online in each region. The capacity additions for each region are based on additions in 2038–2040. Technologies for which capacity additions are not expected do not have a capacity-weighted average and are marked as *NB* or not built.

[2]Because Section 111(b) of the Clean Air Act requires conventional coal plants to be built with CCS to meet specific CO2 emission standards, two levels of CCS removal are modeled: 30%, which meets the NSPS, and 90%, which exceeds the NSPS but may be seen as a build option in some scenarios. The coal plant with 30% CCS is assumed to incur a 3 percentage-point increase to its cost of capital to represent the risk associated with higher emissions.

[3]Costs are expressed in terms of net AC power available to the grid for the installed capacity.

[4]As modeled, hydroelectric is assumed to have seasonal storage so that it can be dispatched within a season, but overall operation is limited by resources available by site and season.

CCS=carbon capture and sequestration. CC=combined-cycle (natural gas). CT=combustion turbine. PV=photovoltaic.

Source: U.S. Energy Information Administration, *Annual Energy Outlook 2018*.

Table B4a. Difference between capacity-weighted levelized avoided cost of electricity and capacity-weighted levelized cost of electricity with tax credits for new generation resources entering service in 2040 (2017 $/MWh)

Plant type	Average capacity-weighted[1] LCOE with tax credits	Average capacity-weighted[1] LACE	Average net difference[2]
Dispatchable technologies			
Coal with 30% CCS[3]	NB	NB	NB
Coal with 90% CCS[3]	NB	NB	NB
Conventional CC	50.1	48.5	-1.5
Advanced CC	47.6	48.1	0.5
Advanced CC with CCS	NB	NB	NB
Advanced nuclear	NB	NB	NB
Geothermal	33.5	79.2	45.7
Biomass	NB	NB	NB
Non-dispatchable technologies			
Wind, onshore	56.4	67.6	11.2
Wind, offshore	NB	NB	NB
Solar PV[4]	40.8	56.7	15.9
Solar thermal	NB	NB	NB
Hydroelectric[5]	NB	NB	NB

[1]The capacity-weighted average is the average levelized cost per technology, weighted by the new capacity coming online in each region. The capacity additions for each region are based on additions in 2038–2040. Technologies for which capacity additions are not expected do not have a capacity-weighted average and are marked as *NB* or not built.

[2]The *Average net difference* represents the net economic value or the average of the LACE minus LCOE calculation, where the difference is calculated for each of the 22 regions based on the cost with tax credits for each technology, as available.

[3]Because Section 111(b) of the Clean Air Act requires conventional coal plants to be built with CCS to meet specific CO2 emission standards, two levels of CCS removal are modeled: 30%, which meets the NSPS, and 90%, which exceeds the NSPS but may be seen as a build option in some scenarios. The coal plant with 30% CCS is assumed to incur a 3 percentage-point increase to its cost of capital to represent the risk associated with higher emissions.

[4]Costs are expressed in terms of net AC power available to the grid for the installed capacity.

[5]As modeled, hydroelectric is assumed to have seasonal storage so that it can be dispatched within a season, but overall operation is limited by resources available by site and season.

CCS=carbon capture and sequestration. CC=combined-cycle (natural gas). CT=combustion turbine. PV=photovoltaic.

Source: U.S. Energy Information Administration, *Annual Energy Outlook 2018*.

Table B4b. Difference between unweighted levelized avoided cost of electricity and unweighted levelized cost of electricity with tax credits for new generation resources entering service in 2040 (2017 $/MWh)

Plant type	Average unweighted LCOE with tax credits	Average unweighted LACE	Average net difference[1]	Minimum[2]	Maximum[2]
Dispatchable technologies					
Coal with 30% CCS[3]	113.6	50.3	-63.3	-91.5	-49.7
Coal with 90% CCS[3]	102.4	50.3	-52.1	-62.0	-38.5
Conventional CC	53.6	50.9	-2.7	-12.5	0.9
Advanced CC	51.7	50.9	-0.8	-11.2	2.2
Advanced CC with CCS	75.9	50.9	-25.1	-35.7	-0.3
Advanced nuclear	78.1	48.5	-29.5	-42.4	-21.6
Geothermal	45.2	56.0	10.8	-12.1	45.7
Biomass	84.8	50.4	-34.4	-58.5	-20.0
Non-dispatchable technologies					
Wind, onshore	49.7	44.7	-4.9	-20.6	18.1
Wind, offshore	110.4	50.9	-59.5	-77.5	-18.3
Solar PV[4]	48.1	58.4	10.3	-24.3	41.8
Solar thermal	131.1	65.3	-65.7	-90.5	-40.3
Hydroelectric[5]	58.4	53.3	-5.1	-14.0	9.1

[1]The *Average net difference* represents the net economic value or the average of the LACE minus LCOE calculation, where the difference is calculated for each of the 22 regions based on the cost with tax credits for each technology, as available.
[2]The range of unweighted differences is not based on the difference between the minimum values shown in Tables B2 and B3, but represents the lower and upper bound resulting from the LACE minus LCOE calculations for each of the 22 regions.
[3]Because Section 111(b) of the Clean Air Act requires conventional coal plants to be built with CCS to meet specific CO2 emission standards, two levels of CCS removal are modeled: 30%, which meets the NSPS, and 90%, which exceeds the NSPS but may be seen as a build option in some scenarios. The coal plant with 30% CCS is assumed to incur a 3 percentage-point increase to its cost of capital to represent the risk associated with higher emissions.
[4]Costs are expressed in terms of net AC power available to the grid for the installed capacity.
[5]As modeled, hydroelectric is assumed to have seasonal storage so that it can be dispatched within a season, but overall operation is limited by resources available by site and season.
CCS=carbon capture and sequestration. CC=combined-cycle (natural gas). CT=combustion turbine. PV=photovoltaic.
Source: U.S. Energy Information Administration, *Annual Energy Outlook 2018*.

2017

ECOFIN WHITE PAPER

In association with CARBONANALYTICS

THE ROLE OF UTILITIES IN DECARBONISING PORTFOLIOS

Introduction

One of the key recent successes in fighting climate change has been the Portfolio Decarbonization Coalition which is a multi-stakeholder initiative that aims to drive reductions in GHG emissions by mobilizing a critical mass of institutional investors committed to gradually decarbonizing their portfolios.[i]

"Some of the biggest -and potentially transformational- announcements at my Climate Summit investors came from the private sector. A coalition of institutional investors has committed to decarbonize $100 billion in institutional equity investments"

Ban Ki-Moon, Secretary General of the United Nations

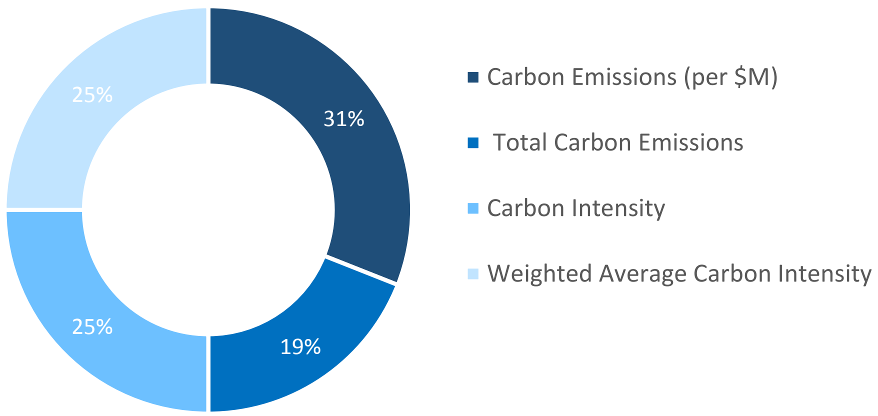
The Coalition believes, and we at Ecofin entirely agree, that portfolio decarbonisation can be achieved by withdrawing capital from especially carbon-intensive companies, projects and technologies in each sector and re-investing that capital into particularly carbon-efficient companies, projects and technologies in the same sector; investors can also achieve portfolio decarbonisation by active and targeted engagement with portfolio companies. We believe that the key words in the above sentence are "in each sector", and we believe that the power generation sector is unique and should be looked at separately.

The aim of this paper is to show how a focus on carbon data – such as carbon emissions and carbon intensity – at a portfolio level alone intrinsically incorporates enormous sector bias and could lead unwittingly to underinvestment in the extremely carbon intensive power generation sector at a time when increased investment in clean generation and electrification of transportation is most necessary, completely at odds with the underlying decarbonisation philosophy. Our proposal is, instead, that when decarbonising a portfolio, investors should look separately at the power generation sector, noting the implicit double counting inherent in calculating both the emissions of the sector and the emissions from the power bought by their customers. We believe the right approach is to compare the carbon footprint of each company or owner of power generating assets to that of the grid in which they sit, allowing investors to allocate capital to the cleanest companies while encouraging their dirtier peers to invest in clean generation.

How is the carbon footprint of a portfolio typically measured?

Assets owners typically look at the following metrics when measuring the carbon footprint of their portfolios[ii] .

Carbon Emissions	*What is my portfolio's normalized carbon footprint per million dollars invested?*
Total Carbon Emissions	*What is my portfolio's total carbon footprint?*
Carbon Intensity	*How efficient is my portfolio in terms of emissions per unit of output?*
Weighted Average Carbon Intensity	*What is my portfolio's exposure to carbon-intensive companies?*



As of May 2015, based on interviews with assets owners and assets managers. n=16.

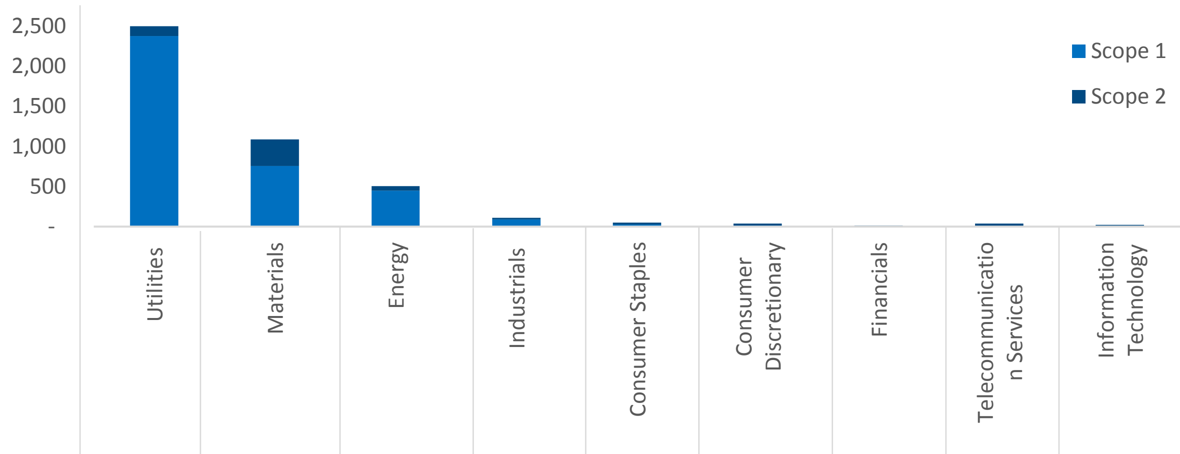
What does this analysis mean for utilities?

There are few activities on the planet which are more carbon intensive that the production of power from fossil fuels. We believe there is a path to zero carbon power, however it is a long-term path. While new build will rapidly move towards 100% clean generation, the intermittency of renewables means that clean energy and even battery storage needs to be backed up with traditional power generation. Electrification is also the key to decarbonising transportation and this will require very significant investment in clean generation and transmission and distribution by the utility sector. Hence, it is vital for asset owners to engage with utilities around the world to ensure they direct capital towards the lowest carbon forms of generation and lay the groundwork for the electrification of transportation.

It is a concern that the application of the metrics outlined above to a portfolio would imply significant divestment from utilities. Utilities are 10 times more carbon intensive than the S&P500 average and they account for more of the Scope 1 emissions in the MSCI World Index than all of the other sectors tallied together (see the appendix for the definition of Scope 1 and Scope 2 emissions).

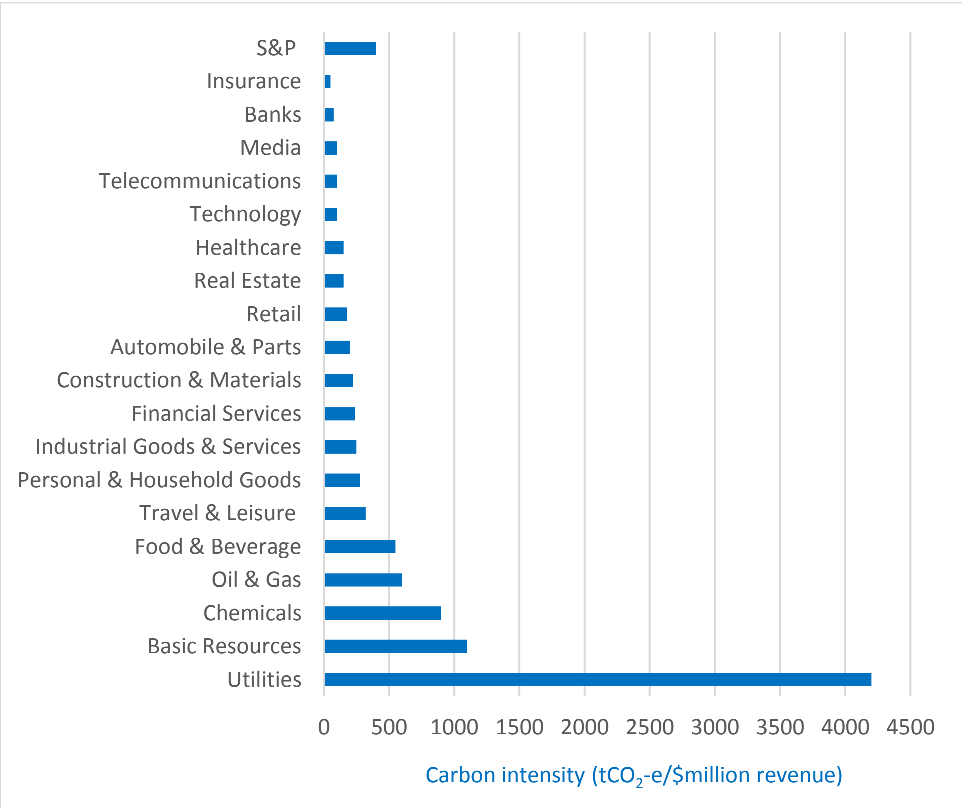
It is also worth noting that the analysis implies some element of double counting, in that the utility sector's Scope 1 emissions are, of course, other sector's Scope 2 emissions, which also suggests that the utility sector should be looked at differently when decarbonising portfolios.

Scope 1 vs. Scope 2 Emissions by Sector (tCO_2-e)[iv]



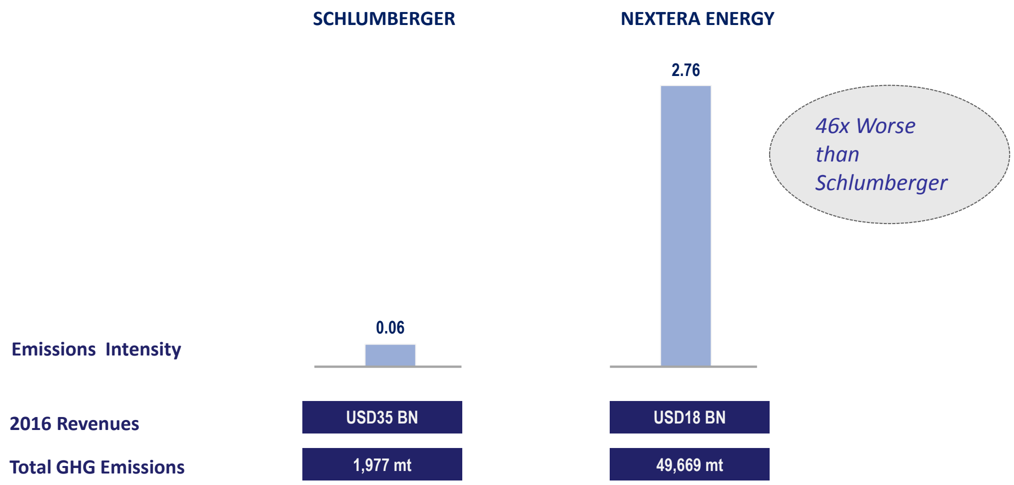
	Utilities	Materials	Energy	Industrials	Consumer Staples	Consumer Discretionary	Financials	Telecommunication Services	Information Technology
Scope 2	124	332	53	20	26	24	9	33	15
Scope 1	2,377	758	451	90	25	15	5	5	5

Carbon Intensity by Sector[v]



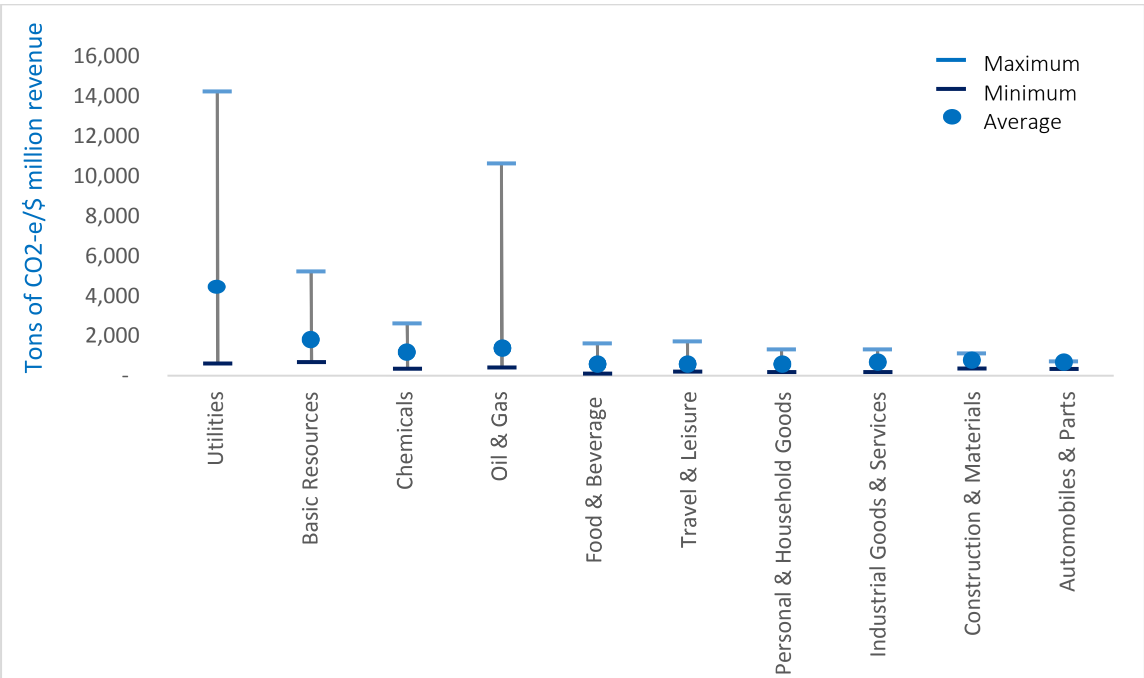
It is instructive, and slightly ironic, that the companies dedicated to the extraction of natural resources and, in particular, the services companies which facilitate that extraction are significantly less carbon intensive than the utilities that combust those resources. From an emissions intensity perspective, for example, owning shares in NextEra Energy, one of the world's largest owners of and investor in clean generation but also an integrated utility which owns fossil fuel generation, is almost 50 times worse than owning Schlumberger, one of the world's largest oil services companies.

Optimising for impact, we believe that asset owners should be overweight in 'clean' utilities tasked with investing in zero carbon generation, not underweight.



The carbon intensity within the utility sector also varies dramatically by company depending on how much fossil fuel generation each utility owns – see chart below.

Range in Carbon Intensity in 10 Carbon-intensive Sectors[vi]



Within the utility sector, transmission and distribution, as well as water and gas utilities, are not carbon intensive activities, whereas power generation of any kind is extremely carbon intensive, but of course without power generation there is no transmission and distribution. Hence, it is superficial to invest simply in the least carbon-intensive utilities; asset owners need to look specifically at power generation and favour those companies which are contributing the most to 'greening' the grid, even if those companies own some fossil fuel generation, and encourage companies which are underperforming to invest more in clean generation.

A POTENITAL SOLUTION

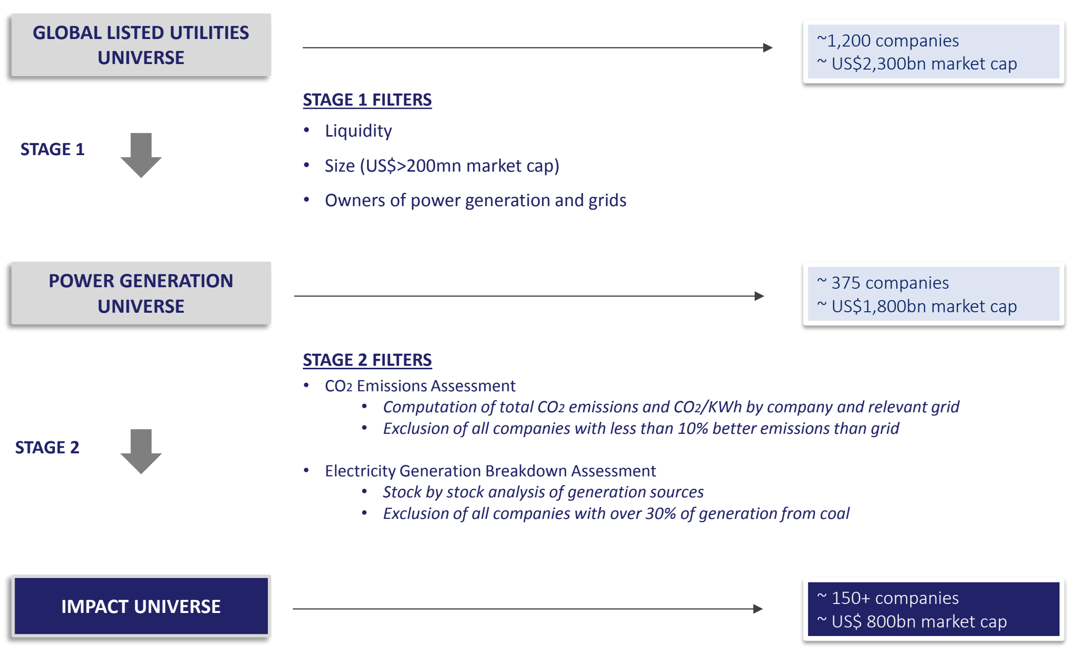
In association with CARBONANALYTICS we have conducted a proprietary study of all listed utilities globally which own power generation assets. This has allowed us to populate a database with the generation mix for each company by country and by generation type. We have applied standard factors to each generation type and calculated a carbon footprint for each generation mix. We use the same standard factors and World Bank data for generation mix to calculate the carbon footprint of the generation mix for each country. We are now able to compare the carbon footprint of each utility to that of the grid in which it sits, and to highlight utilities whose assets are effectively "greening their grid" and those whose assets are dirtier than average. We can also calculate the annual tonnes of carbon avoided for each utility and, ultimately, for the ownership stake of each investor.

We believe it is important to compare the generation mix and carbon footprint of each utility to that of the grid in which it sits, rather than to a global average, because the impact of various types of generation is quite different depending on the type of power it displaces: For example, a new gas-fired power station in predominantly renewables fuelled New Zealand would have quite a negative impact on the carbon footprint of the grid, whereas the same asset in predominantly coal fuelled China could have a positive impact.

It is worth noting that this is the same methodology as used by the EU Emissions Trading System in calculating the value of carbon offset credits, and that 'carbon avoided' is the most common impact measure for private equity owners of clean infrastructure assets.

We then apply the below filtering process. We eliminate all of the companies in the global universe whose emissions are less than 10% better than the grid in which they sit and also those companies whose generation mix includes more than 30% coal.

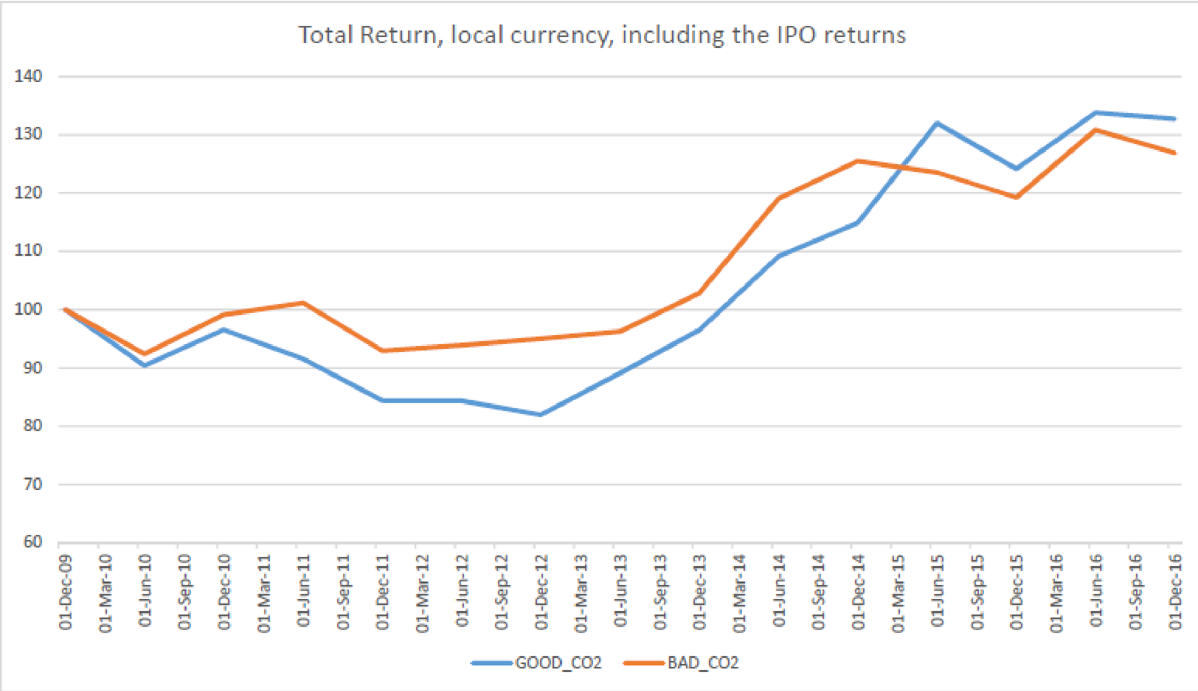
Applying the filtering process



How has the impact universe performed?

The resulting 'impact' universe of companies has performed very slightly better than the dirtier companies (which were excluded) since 2009. Looking ahead and over the longer-term, we would expect the impact universe to perform better than the peer average given the stranded asset risk inherent for owners of higher carbon-intensive generation.

Share Price Performance of the Impact Universe since 2009



The power of engagement

This methodology has maximum impact when applied as a tool for engagement. Rather than divesting from or simply underweighting the more carbon intensive utilities, asset owners can instead actively engage with these companies to encourage investment in cleaner generation, providing a 'live' measure of the carbon intensity of the local grid as the target to beat. As their peers become cleaner generators, companies will have to move more quickly to meet the required standards, resulting in a long-term virtuous circle which should encourage investment in 'greening the grid' for the future and enabling much needed electrification.

APPENDIX: THE DEFINITION OF SCOPE 1, SCOPE 2 AND SCOPE 3 CARBON EMISSIONS[vii]

- Scope 1: All direct GHG emissions from sources owned or controlled by the company. Some examples include emissions from fossil fuels burned on site, and emissions from entity-owned or leased vehicles.
- Scope 2: Indirect GHG emissions from consumption of purchased electricity, heat, or steam, and the transmission and distribution (T&D) losses associated with some purchased utilities.
- Scope 3: Other indirect emissions that occur from sources not owned or controlled by the company. Some examples of Scope 3 activities are extraction and production of purchased materials; transportation of purchased fuels; and use of sold products and services.

  Since Scope 3 emissions occur from sources not owned or controlled by the company, and the boundaries to measure Scope 3 emissions are not well-defined, it is not consistently calculated or disclosed by companies.

  The inconsistency of Scope 3 emissions data makes it difficult to perform any meaningful comparative analysis across companies or industries. Further, due to lack of control of the emission sources and boundaries, it is difficult to estimate such emissions comprehensively.

Notes and Sources:

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[i] Source: Portfolio Decarbonization Coalition. http://unepfi.org/pdc/

[ii] Source: MSCI – Carbon Footprinting 101, September 2015

[iii] Source: MSCI – Carbon Footprinting 101, September 2015

[iv] Source: MSCI – Carbon Footprinting 101, September 2015

[v] Source: IRRC Institute – Carbon Risks And Opportunities In The S&P 500

[vi] Source: IRRC Institute – Carbon Risks And Opportunities In The S&P 500

[vii] Source of definitions: GHG Protocol