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# Resource Efficiency: A Case Study in Carbon and Water Use

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Natural resources are strained and it may be helpful to examine how we use them to generate economic growth.

In recent years, there has been increasing awareness around the issues related to climate change, and substantial amounts of money have been committed to tackle it. This includes undertakings to decarbonize institutional equity investments. Increasing the efficiency of the fossil fuels we already consume is undoubtedly an important focus. However, can we extend this approach to take into account how well we consume other resources (such as water) so that we can look at resource efficiency at large?

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## EXECUTIVE FINDINGS

- Scarcity of natural resources means that there may be merit in considering the efficiency of a number of resources at the same time, especially given that the demand for them is correlated.
- Despite limited data history, our preliminary findings show that more carbon- and resource-efficient companies may outperform the less-efficient ones.
- Focusing on efficiency could help businesses mitigate risks such as regulation, resource depletion, and reputational risks.

## INTRODUCTION

In recent years, there has been increasing awareness of the threats and opportunities arising from climate change. The asset management industry is well aware of these changes and has acted by forming associations, such as the Portfolio Decarbonization Coalition and the Montreal Carbon Pledge, a commitment to reduce the carbon footprint of at least USD 100 billion<sup>1</sup> of institutional equity investments between 2014 and 2015. Interest in this area was further heightened subsequent to the United Nations-sponsored COP21 Climate Change Conference, where politicians and business leaders worked together in order to stem the ever-increasing global temperature and reverse some of the devastating effects associated with global warming.

<sup>1</sup> *Mobilizing financial markets to catalyze economic decarbonization*, The Portfolio Decarbonization Coalition, <http://unepfi.org/pdc/>.

With unprecedented demand for resources, improving efficiency may be part of the answer.

The commitment to keep the global temperature increase to well below 2°C, or ideally 1.5°C, above pre-industrial levels is a direct result of that collaboration. There is widespread recognition that the failure to keep the temperature increase under control could cause substantial loss of lives and property. According to research conducted by Climate Central, an increase of 4°C would see the homes of 760 million people eventually submerged (Euractiv, 2015) and large parts of Belgium and the Netherlands vanish. For this reason, climate change has featured prominently on the agenda of policymakers and investors. While the focus on carbon emissions is necessary, the underlying causes that have given rise to extreme weather conditions and altered weather patterns have also strained other depletable resources in the environment—namely, water and land—upon which human life and economic activity rely. Given this, it seems reasonable to examine the way in which we are using our natural resources as a whole to generate economic activity and its concomitant impact on the environment.

Until now, consumption has underpinned global economic development, and it was the unprecedented drop in the price of key resources—by almost one-half in real terms (Dobbs et al, 2013)—that sustained much of the growth in the 20<sup>th</sup> century. However, we are entering an era of unparalleled resource pressure, driven chiefly by population growth and the emergence of a sizeable middle class<sup>2</sup> in developing countries. The consequence is that the prices of resources are expected to become much more volatile and less predictable. Moreover, in many cases, resources were not even priced in a manner that reflected the entire cost of production (for example, unpriced water or energy subsidies) and the negative externalities (side effects), such as carbon emissions, in relation to their use. This implies that the resource-dependent growth model to which we are so accustomed may no longer be sustainable. The issue is therefore about decoupling the relationship between economic growth and resource consumption, and improving resource efficiency<sup>3</sup> may be part of the answer.

At its simplest, decoupling is separating environmental deterioration and economic growth, hence reducing the amount of resources used to produce economic output. Our analysis shows that only 153 out of 922 of the reporting companies in the S&P Global LargeMidCap managed to increase revenues while increasing carbon and water efficiency between 2009 and 2014, and this process is far from being complete. A further issue relates to how efficiency efforts are pursued. Even where there is widespread acceptance of “do more with less,” programs designed to promote efficiency tend to be disparate and carried out in a piecemeal fashion. For

<sup>2</sup> There are 1.8 billion people in the middle class and this is predicted to grow to 3.2 billion by the end of the decade (Kharas et al, 2010), and the increase in wealthier populations will lead to higher demand for all foods and services.

<sup>3</sup> Public policies and measures for decoupling should be based on the “triangle” of efficiency (“more with less”), sufficiency (“less can be more”), and consistency (“better than more”) (Niazi, et al., 2014).

instance, energy efficiency and water efficiency efforts are generally pursued separately, without any coordination (UNEP, 2014). In view of this, there may be merit in adopting a multi-faceted approach apropos of resource efficiency.

The first section of this research paper explores the interconnectedness between the demand for different resources and the rationale for considering how efficiently we use a number of scarce resources as a whole. As a case study, we have opted to look at carbon emissions and water in the context of resource efficiency, but resource efficiency is clearly not confined to these areas. The second section assesses the financial and business reasons for investors to select carbon- and resource-efficient companies. Finally, the third section reviews a number of investment strategies that provide exposure to more carbon- and resource-efficient companies.

### Data Methodology

The data on which the analyses conducted in this research paper were based came from Trucost,<sup>4</sup> an environmental data consultancy firm specializing in examining the economic consequences of natural resource dependency. We made use of Trucost's carbon emissions and water efficiency data. Carbon emissions efficiency is defined as the sum of direct greenhouse gas emissions and first tier of indirect emissions,<sup>5</sup> normalized by the amount of revenue in U.S. dollars. It should be noted that carbon emissions will mostly derive from fossil fuel consumption. Water efficiency is defined as the sum of direct cooling water, direct process water, and purchased water,<sup>6</sup> normalized by the amount of revenue in U.S. dollars.

The demand for resources is correlated and managing their efficiency in a concerted way may have merit.

### SECTION 1: RESOURCE EFFICIENCY—A “JOINED-UP” APPROACH

For a long time, efficiency has been concerned with how well a single natural resource is managed, without due regard to how the demand for one resource affects another. Managing the threat posed by high carbon emissions is global in scope and necessitates global policies, while water management tends to be local and varies from region to region. Even though the challenges may be different for managing different resources, improving efficiency has to be a priority as the growth of the world economy and increasing population pose unprecedented challenges for the environment. In reality, the Earth's natural resources—such as water, soil, clean air, and fossil fuels—are being exhausted rapidly, and growing competition for them will lead to scarcities and increasing prices. For this

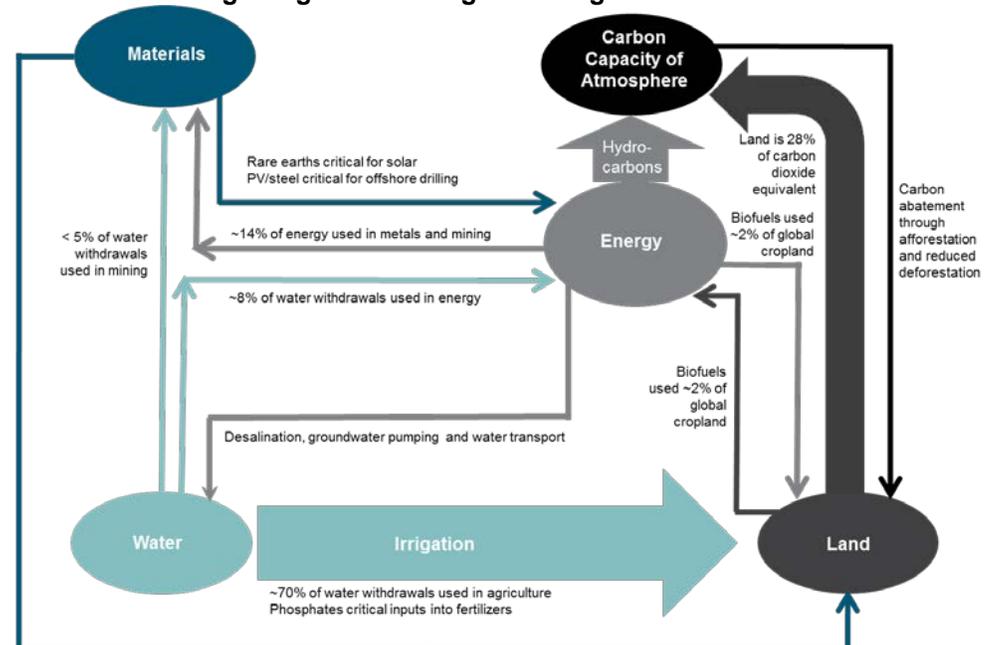
<sup>4</sup> See Appendix 1 for a full description of how Trucost collects and models its data.

<sup>5</sup> See Appendix 1.

<sup>6</sup> Direct cooling water is the volume of water that is directly abstracted by the company and used for cooling purposes, direct process water is the volume of water that is directly abstracted by the company and used for processing, and purchased water is the volume of water that is purchased by the company from utility companies.

reason, resources need to be utilized well throughout their lifecycle: from extraction, transportation, transformation, and consumption to waste disposal. Besides optimizing how resources are used, it is equally important to understand the interdependence of different resources and manage them in a concerted, rather than a disjointed, manner. This is particularly true because demand is often correlated across a number of different resources (see Exhibit 1).

### Exhibit 1: The High Degree of Linkages Among Resources



Source: *Meeting the World's Energy, Materials, Food, and Water Needs*, McKinsey, 2011. Chart is provided for illustrative purposes.

Using new techniques to reduce carbon emissions may sometimes lead to an increase in water usage.

For instance, the world's water and energy systems are closely linked in many ways. Huge quantities of water and energy are required in agricultural production; it accounts for two-thirds of total fresh water withdrawals (Berggren, 2014). However, demand from other industries, such as manufacturing and electricity generation, is fast overtaking the agricultural sector in terms of water consumption. Over 70% of the total water abstractions in France were intended for cooling power plants (Eurostat, 2014). In reality, the operation of many industries hinges on the supply of fresh water. Taking the energy sector as an example, fresh water is essential for each step of the delivery process—from energy extraction and production, to transportation and storage. In fact, vast quantities of water are often needed at each stage. This is applicable not only for power generation from “dirty” conventional fossil fuels but also from clean renewable energy sources (notably biomass and hydropower).

In fact, many of these cleaner energy sources (such as biomass) often require substantially more water than dirty fossil fuels to produce (Meldrum et al., 2013), and this ignores the fact that biofuels derived from irrigated

crops use around 100 times more water per kilometer than petroleum products (Breggren, 2014). In addition, carbon mitigation technologies are highly water intensive. For example, carbon capture systems, the only viable option for decarbonizing fossil fuels on a large scale, demand more than double the amount of water per kWh than power generation with fossil fuels without carbon mitigation (Merschmann et al, 2013).

In the same vein, both energy and water are indispensable inputs into the food production process. Agriculture accounts for 70% of total global freshwater withdrawals, making it by far the largest user, and it consumes 30% of all the energy globally (FAO, 2011). This already neglects the growing trend of cultivating crops for energy, which helps reduce carbon emissions but may also result in increased competition for land and water resources (FAO, 2014). Even everyday products, such as cars, take vast amounts of water and energy to manufacture. Given this interconnectedness, it is reasonable to posit a potential relationship between how much carbon a company emits in the course of conducting business (carbon emissions efficiency) and how much water it uses (water efficiency).

Exhibit 2 shows the pairwise correlation<sup>7</sup> between the carbon emissions efficiency and water efficiency of over 2,500 companies within the S&P Global LargeMidCap universe between 2009 and 2014. We can observe that, regardless of how the overall correlation is measured—whether within sectors or sub-industries—it has been consistently strong. However, breaking down the overall correlation numbers by sectors tells a rather different story. For instance, both water management and carbon emissions are identified as key issues to consider in many of the energy sub-industries,<sup>8</sup> based on the standards set out by the Sustainability Accounting Standards Board<sup>9</sup> and given the interdependence of the consumption of water and energy. It would therefore be justifiable to assume that the correlation between carbon emissions efficiency and water efficiency should be high; however, it was only 0.49. The materials sector is yet another example. Although water management and carbon emissions are highlighted as critically important issues for companies operating in the sector, the correlation between carbon emission efficiency and water efficiency stood at a low 0.20. These statistics may suggest that, in sectors where it is necessary to monitor both the amount of carbon emissions generated and water use, this is either not done at all, or it is done in an uncoordinated fashion, perhaps owing to technology-related differences.

Correlation between carbon efficiency and water efficiency is high, but not in all sectors.

<sup>7</sup> Spearman's rank correlation is computed for the analysis.

<sup>8</sup> Oil & Gas—Exploration & Production, Oil & Gas—Midstream, Oil & Gas—Refining and Marketing, and Oil & Gas—Services all face the need to reduce carbon emissions and to manage water better.

<sup>9</sup> Non-Renewables Sector Industry Brief, The Sustainability Accounting Standards Board, [www.sasb.org](http://www.sasb.org).

This lack of coordination in the management of different resources is likely to stretch far beyond just water and energy, and it is undoubtedly pertinent for the management of other resources. Effective resource management calls for a multi-pronged, concerted approach that evaluates trade-offs between resources and encourages cross-sector planning. Such an approach is crucial for the sustainable management and development of all natural resources (World Bank, 2013).

Exhibit 2: Pairwise Correlation Between Carbon Emissions and Water Efficiency					
Overall Pairwise Correlation Between Carbon Emissions and Water Efficiency				Pairwise Correlation Between Carbon Emissions Efficiency and Water Efficiency Within Sectors in 2014	
Years	Ranking Across All Sectors	Ranking Within Sector	Ranking Within Sub-Industry	Sector	Correlation Within Each Sector in 2014
2009	0.78	0.75	0.64	Energy	0.49
2010	0.77	0.74	0.63	Materials	0.20
2011	0.75	0.74	0.63	Industrials	0.23
2012	0.76	0.75	0.61	Consumer Discretionary	0.60
2013	0.75	0.75	0.59	Consumer Staples	0.66
2014	0.75	0.75	0.59	Healthcare	0.50
All Years	0.76	0.75	0.62	Financials	0.80
				Information Technology	0.78
				Telecommunication Services	-0.03
				Utilities	0.61

Source: S&P Dow Jones Indices LLC and Trucost. Data as of December 2015. Data based on annual carbon intensity generated per million U.S. dollars of total revenue and water intensity generated per million U.S. dollars of total revenue and are supplied by Trucost. Table is provided for illustrative purposes.

Investing in carbon- or resource-efficient companies is as much about generating a return over the long run as it is about managing other business risks, and discussion without the latter would make the analysis incomplete.

## SECTION 2: FINANCIAL AND BUSINESS REASONS FOR INVESTING IN CARBON- AND RESOURCE-EFFICIENT COMPANIES

The discussion about the close relationship between the use of one natural resource and that of another is definitely interesting, and a key question is how is it relevant to the average investor who values companies that pursue active policies in managing resources efficiently? As discussed previously, one approach is to take into consideration how well a number of resources are used. It is precisely for this reason that we have defined resource efficiency here as the average of the carbon emissions efficiency and water efficiency scores over the previous one-year period, as reported by Trucost. As part of the analysis, we have examined and compared the financial performance of both carbon- and resource-efficient companies.<sup>10</sup> However, investing in carbon- or resource-efficient companies is as much

<sup>10</sup> Resource efficiency is defined as carbon emissions efficiency and water efficiency. Data for other resources is also difficult to compute and obtain.

about generating a return over the long run as it is about managing other business risks, and discussion without the latter would make the analysis incomplete.

Before we look at the performance of carbon- and resource-efficient companies, it would be useful to study whether there was persistence in the carbon- and resource-efficiency scores. In other words, would a carbon- or resource-efficient company be likely to remain efficient a few years later? This is necessary to explore, because if the numbers were to remain largely static, then the aim would simply be to identify these “star” companies. On the other hand, if there are changes in the numbers, then a case can be made to adopt a dynamic strategy that is designed to select the most efficient companies.

## 2.1 The Persistence of Efficiency Scores

There is high persistence in efficiency scores overall.

In this analysis, we have elected to look at carbon and water efficiency scores on a sector level. The reasons for this are twofold. First, the aim is to identify companies that are the most efficient in a given sector, so that an apples-to-apples comparison can be made as much as possible. Second, there has to be a sufficient number of companies within the category to ensure that this sort of investigation is worthwhile. Exhibit 3 shows that the percentage of companies that remained in the same quintile (quintile one and quintile five) one year and five years after being sorted by carbon and resource efficiency scores.

As expected, there was a strong level of persistence (75%-85%) after one year, which means that companies that were carbon or resource efficient one year prior were likely to be efficient one year later. Even after five years, there was still a good level of persistence in the efficiency scores. The implications of this are that there are companies in a given sector that continuously outperformed their peers in regard to efficiency. However, the level of persistence varied across sectors; in the case of service-based sectors such as telecommunication services, in which neither water nor energy are major inputs into the production process, the efficiency scores were much less dispersed. That being said, although the energy consumption of the telecommunication services sector is currently fairly limited vis-à-vis other industries, its energy use is becoming more material, as additional demand drives the need for new network facilities and data capacity.<sup>11</sup> The utilities sector is where there has been more innovation, and this may explain why there is a relatively lower persistence of carbon scores in the sector. An example of this innovation includes gasification, which entails turning coal into a gas and removing impurities from the gas before it is combusted.<sup>12</sup>

<sup>11</sup> Telecoms Industry Brief: Sustainability Accounting Standards Board.

<sup>12</sup> <http://www.engineerlive.com/content/22603>

Exhibit 3: Persistence of Carbon-Efficiency and Resource-Efficiency Scores Over Time					
Time Period	Sector	Persistence of Carbon Efficiency Scores		Persistence of Resource Efficiency Scores	
		Quintile 1 (Most Efficient) (%)	Quintile 5 (Least Efficient) (%)	Quintile 1 (Most Efficient) (%)	Quintile 5 (Least Efficient) (%)
After 1 Year	Energy	77.8	80.6	83.3	88.6
	Materials	85.5	90.9	78.6	82.5
	Industrials	86.1	87.3	85.3	84.9
	Consumer Discretionary	83.9	83.9	92.3	83.3
	Consumer Staples	91.7	91.7	93.2	76.5
	Health Care	87.0	91.3	81.5	56.5
	Financials	74.5	92.7	77.0	95.7
	Information Technology	87.0	81.8	86.7	78.7
	Telecommunication Services	60.0	65.0	46.2	57.1
	Utilities	76.9	81.5	74.2	86.2
	Overall	81.6	87.2	82.7	84.7
After 5 Years	Energy	50.0	55.6	41.7	57.1
	Materials	43.6	45.5	52.4	37.5
	Industrials	59.5	68.4	61.8	53.4
	Consumer Discretionary	71.4	64.3	75.4	62.1
	Consumer Staples	61.1	72.2	65.9	58.8
	Health Care	69.6	65.2	66.7	47.8
	Financials	57.8	63.3	64.0	67.2
	Information Technology	47.8	63.6	48.3	70.2
	Telecommunication Services	15.0	30.0	15.4	28.6
	Utilities	42.3	59.3	38.7	65.5
	Overall	55.1	61.4	58.2	59.8

Source: S&P Dow Jones Indices LLC and Trucost. Data as of December 2015. Data based on annual carbon intensity generated per million U.S. dollars of total revenue and water intensity generated per million of U.S. dollars of total revenue and are supplied by Trucost. Table is provided for illustrative purposes.

## 2.2 Financial Performance of Efficient Companies

Initial findings show that the more efficient companies generated a higher return.

In the foregoing discussion, we have provided reasons for looking at resource efficiency in a wider context by considering the efficiency of a number of resources at the same time. We now turn to evaluate whether there is any rationale for targeting carbon- or resource-efficient companies as part of an investment strategy. To achieve this, we parsed the S&P Global LargeMidCap universe into five quintiles on the basis of their carbon- and resource-efficient scores within each of the Global Industry Classification Standard (GICS®) sectors. We then reviewed the average performance of the companies in each of the quintiles on a one-year rolling basis, as well as the annualized performance differential of the first and fifth quintile companies one, two, and four years forward.

Results in Exhibit 3 indicate that carbon- and resource-efficient (Quintile 1) companies generated higher average returns than those that were less efficient (Quintile 5) between 2009 and 2014. In fact, efficient companies continued to register a significantly higher annualized performance in subsequent time periods. Of course, it would be necessary to exercise caution in interpreting the significance of these conclusions, which were drawn on the merits of only six years of data. Nonetheless, it is instructive to observe that efficient companies may provide outperformance.

Efficiency scores might have had merit in predicting forward performance.

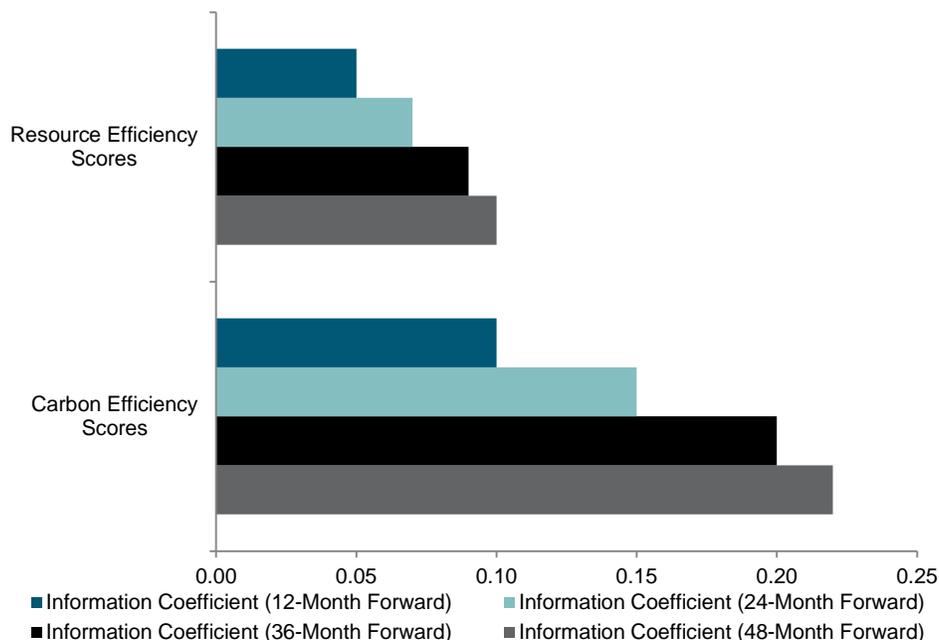
In addition to examining average return in each of the efficiency quintiles, we have also analyzed whether efficiency scores had any potential merit in predicting forward performance, and we have calculated the information coefficient for this. The information coefficient is the correlation coefficient between the factor rank and the return rank for all the eligible companies, and it is a measure of how well a factor is correlated with subsequent returns. The findings in Exhibit 4 suggest that the information coefficient for efficiency scores, sorted by GICS sectors, rose progressively over time. A similar conclusion could be drawn even if the companies were sorted by GICS sub-industries, which are more narrowly defined than GICS sectors.<sup>13</sup> Put differently, efficiency scores seemed to demonstrate merit in forecasting returns in the “longer run,” and this is in line with the expectation that more efficient and sustainable companies should reap benefits over the longer term. Undoubtedly, the same analysis should be carried out again as and when more data becomes available.

Exhibit 4: Rolling Performance of Companies Sorted by Carbon-Efficiency and Resource Efficiency Quintiles (Within Sectors)								
Score	Annualized Return on a Rolling 1-Year Basis					Annualized Spread on a Rolling Forward Basis		
	Q1 (Most Efficient) (%)	Q2 (%)	Q3 (%)	Q4 (%)	Q5 (Least Efficient) (%)	Q1 Versus Q5 (12 Months Forward) (%)	Q1 Versus Q5 (24 Months Forward) (%)	Q1 Versus Q5 (48 Months Forward) (%)
Carbon Efficiency	8.6	7.1	6.3	6.0	4.7	3.2	3.4	4.6
Resource Efficiency	9.3	6.3	6.7	5.8	5.0	3.6	4.5	5.3

Source: S&P Dow Jones Indices LLC and Trucost. Figures based on annual USD returns. Data from December 2009 to December 2014. Table is provided for illustrative purposes.

<sup>13</sup> Please see Appendix 2 for additional analyses.

**Exhibit 5: Information Coefficients of Efficiency Scores on a Forward Basis (Within Sectors)**



Source: S&P Dow Jones Indices LLC and Trucost. Figures based on annual USD returns. Data from December 2009 to December 2014. Table is provided for illustrative purposes. All information coefficients are statistically significant at the 5% level.

Inefficient companies may face significant business risks.

### 2.3 Other Considerations Associated With Efficiency

The results in the foregoing analysis certainly appear promising for carbon- and resource-efficient companies, but as yet they are inconclusive, as the data history on which the analysis is based is not sufficiently long. However, what is certain is that besides performance in financial markets, companies may face other important business considerations if they do not promote efficiency in their business activities, and this may adversely affect their future profitability.<sup>14</sup> Some of the risks include the following.

- Increased Regulation Risk:** More regulations can lead to higher compliance and litigation costs. For instance, France has approved a domestic consumption tax that is levied on the basis of the amount of carbon emissions on energy products that are not covered in the European Emissions Trading Scheme (World Bank, 2014); and freshwater withdrawals in Pennsylvania and New York were temporarily suspended in April 2012 as a consequence of low river levels (PRI, 2014).

<sup>14</sup> In its report *Investing in a Time of Climate Change*, Mercer, a leading pension consultancy, identified four climate change risk factors, which can serve as “lenses” through which the future investment implications of climate change can be considered.

- **Resource Depletion Risk:** As resources are being used up, their supply will become more unpredictable and the amount of money that has to be spent to secure reliable supplies is also expected to escalate. For example, MahaGenco's Parli thermal power plant in India had to be temporarily closed in 2015 because of water shortages.<sup>15</sup>
- **Reputational and Financing Risk:** Companies can face reputational risks and may find it difficult to raise money to finance their business activities if they do not implement more sustainable business policies. An example of this is the recent divestment movement focused on institutional investors. Some investors—namely, Norway's sovereign wealth fund and the Rockefeller Brothers Fund—have chosen to divest all or some of their fossil fuel holdings, while others are developing targeted shareholder engagement and sustainable and responsible investment strategies as a way of managing this risk (WRI, 2015).

These risks can translate into higher costs, reduced sales, and subsequently a loss in profit (WEF, 2016), and they provide a basis for natural resource efficiency—in other words, “doing more with less” (EEA, 2015).

### SECTION 3: CASE STUDY—CARBON- AND RESOURCE-EFFICIENT STRATEGIES

Both the carbon- and resource-efficient strategies had a slightly higher return than their respective benchmarks, and their volatilities were also comparable to those of the benchmarks.

Following the analysis in the previous sections, we proceed to review a number of strategies that could potentially allow investors to augment the carbon and resource efficiency of their portfolios. To illustrate, we examine four portfolios in detail. The first two portfolios involve improving the carbon and resource efficiency of portfolios invested in a European stock universe. For this, we have elected to use the [S&P Europe 350<sup>®</sup> Carbon Efficient Select Index](#), which aims to ameliorate the carbon efficiency of the investment portfolio by removing the dirtiest (or least carbon efficient) issues, while minimizing the tracking error of the final portfolio with the benchmark. We have also created a simulation that aims to improve the resource efficiency of the European investment portfolio. The same analysis was repeated on a U.S. stock universe and we have chosen to use the [S&P 500<sup>®</sup> Carbon Efficient Select Index](#) as our carbon-efficient portfolio, and have put together a simulation that seeks to improve the resource efficiency of the U.S. investment portfolio.

<sup>15</sup> <http://www.dnaindia.com/mumbai/report-lack-of-rain-in-marathwada-to-affect-power-plants-2131595>.

In addition to targeting more efficient companies, there are other ways to improve efficiency by looking at resource productivity through the supply chain in an integrated way.

Both the carbon- and resource-efficient strategies had a slightly higher return (approximately 0.7%-0.9% per year) than their respective benchmarks, and their volatilities were also comparable to those of the benchmarks (see Exhibits 6, 7, and 8). In respect to the carbon and water savings of the four strategies, the two carbon-efficient strategies had a much higher level of carbon reduction than the resource-efficient strategies. On the other hand, the resource-efficient portfolios reduced their water footprints by 72%-87% compared with those of the benchmarks, which was much higher than their carbon footprint reduction. In addition to targeting more resource efficient companies, there are other ways to improve efficiency by looking at resource productivity through the supply chain in an integrated way. Greenlick, an environmental efficiency and sustainability consultancy firm, proposes minimizing waste by addressing energy, water, and materials productivity. The company uses savings search engines and decision support systems to benchmark materials and product waste combined with energy and water productivity at their production sites and can be used across multiple supply chains (Benoy and Owen, 2016).

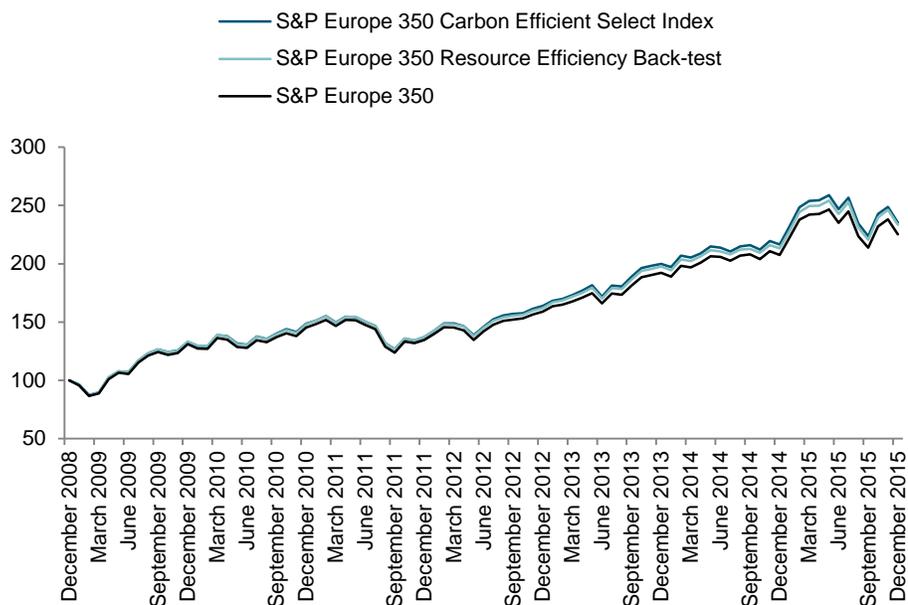
Exhibit 6: Performance of Carbon-Efficient and Resource-Efficient Strategies Versus Their Respective Benchmarks							
Categories	Parameters	S&P Europe 350 Related Strategies			S&P 500 Related Strategies		
		Carbon-Efficient Portfolio	Resource-Efficient Portfolio	Benchmark	Carbon-Efficient Portfolio	Resource-Efficient Portfolio	Benchmark
Financial	Annualized Return (%)	13.0	12.9	12.3	15.1	15.0	14.5
	Annualized Risk (%)	14.3	14.3	14.4	14.3	14.1	14.3
	Risk-Adjusted Return	0.91	0.90	0.85	1.06	1.06	1.01
	Tracking Error (%)	0.78	0.67	-	0.89	0.80	-
	Information Ratio	0.90	0.86	-	0.61	0.58	-
	Maximum Drawdown (%)	-18.3	-18.5	-18.7	-15.6	-16.1	-17.0
Non-Financial	Carbon Savings <sup>16</sup> (Relative to the Benchmark) (%)	68.6	19.0	-	46.1	40.5	-
	Water Savings <sup>17</sup> (Relative to the Benchmark) (%)	31.3	87.0	-	21.7	72.8	-

Source: S&P Dow Jones Indices LLC and Trucost. Figures for the S&P Europe 350 and its related strategies are based on annual returns in EUR and figures based on the S&P 500 and its related strategies are based on annual returns in USD. Data from December 2009 to December 2014. Past performance is no guarantee of future results. Chart is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosures at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

<sup>16</sup> As of December 2015.

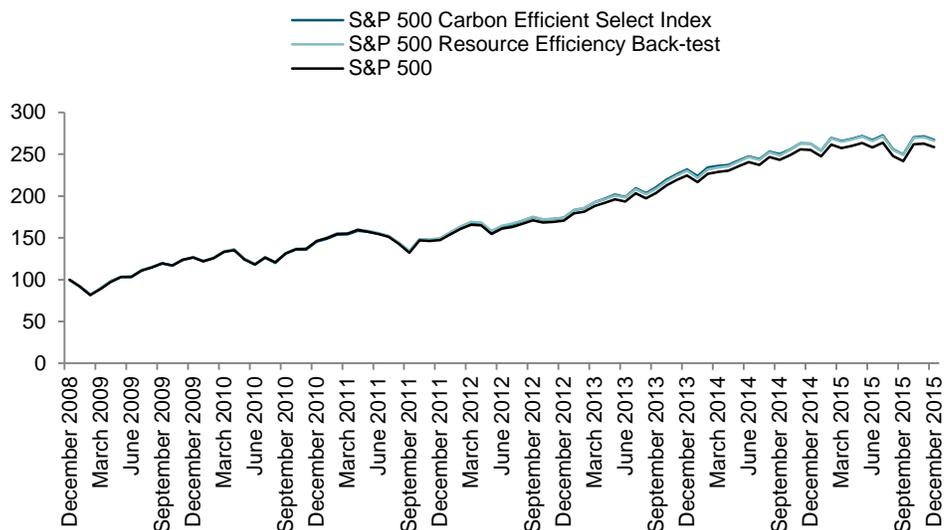
<sup>17</sup> As of December 2015.

### Exhibit 7: Performance of Carbon-Efficient and Resource-Efficient Strategies Versus Their Respective Benchmarks



Source: S&P Dow Jones Indices LLC and Trucost. Figures for the S&P Europe 350 and its related strategies are based on annual returns in EUR and figures based on the S&P 500 and its related strategies are based on annual returns in USD. The S&P Europe 350 Carbon Efficient Select Index was launched on August 18, 2015. All information prior to that date is back-tested. Data from December 2009 to December 2014. Past performance is no guarantee of future results. Chart is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosures at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

### Exhibit 8: Performance of Carbon-Efficient and Resource-Efficient Strategies Versus Their Respective Benchmarks



Source: S&P Dow Jones Indices LLC and Trucost. Figures for the S&P 500 and its related strategies are based on annual returns in USD and figures based on the S&P 500 and its related strategies are based on annual returns in USD. Data from December 2009 to December 2014. The S&P 500 Carbon Efficient Select Index was launched on March 9, 2009. All information prior to that date is back-tested. Past performance is no guarantee of future results. Chart is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosures at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

## CONCLUSION

The COP21 Climate Change Conference in Paris has firmly shifted the focus to climate change and carbon-abatement strategies. While this is an encouraging development, lowering carbon emissions is not the only environmental challenge facing the world's economies. Other scarce resources (such as water and land) are under severe stress too, partly because of our inability to achieve economic growth without overconsumption of natural resources. One of the ways to overcome this challenge is to increase resource efficiency. Because of the correlated demand between different resources, it may be sensible to look at resource efficiency in a coordinated, rather than disjointed, fashion, and we have studied carbon and resource efficiency (carbon and water efficiency) in this research paper.

Preliminary results show that more efficient companies outperformed less efficient ones.

Despite the availability of limited data, our preliminary results show that more resource efficient companies outperformed less resource efficient ones. Unquestionably, it is also important to look at other aspects when targeting efficient companies. Not only may it help to reduce business risks (regulation risk, resource depletion risk, and reputational and financing risk), but it may also help to minimize the overall carbon and water footprint in investment portfolios.

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## APPENDIX 1

### Who Is Trucost?

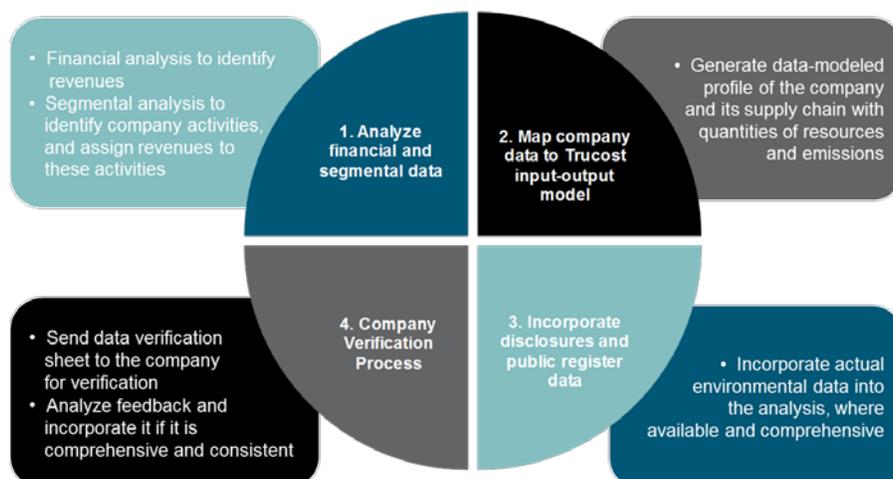
Trucost is an environmental data consultancy firm that has specialized in examining economic consequences of natural resource dependency for over 12 years. It covers over 6,000 companies, which represents approximately 80% of global market capitalization.

Trucost has a comprehensive approach to calculating environmental impact across operations, supply chains, and investment portfolios by making use of an environmental profiling model that looks at 464 industries worldwide and tracks over 100 environmental impacts. The model also examines the interactions and cash flows between sectors in order to map each sector's supply chain.

In order to assess an organization's environmental impacts, Trucost carries out the following four steps.

- **Analyzing company data:** Financial information is assessed to establish the primary business activities of an organization and then revenues to those activities are apportioned accordingly.
- **Mapping company data:** Using the information in Step 1, the environmental profiling model can calculate an organization's direct and supply chain environmental impacts.
- **Incorporating disclosures and public data:** Incorporate reported environmental data obtained from public sources (such as annual reports and websites). Where environmental reporting is not available, Trucost draws on sources of proxy information (namely, fuel use or expenditure data), which can be converted into emissions data. Reported figures are standardized for consistency.
- **Engaging with target companies (company verification process):** Each analyzed company is then invited to verify or refine the environmental profile Trucost has created. This further augments the reliability of their data.

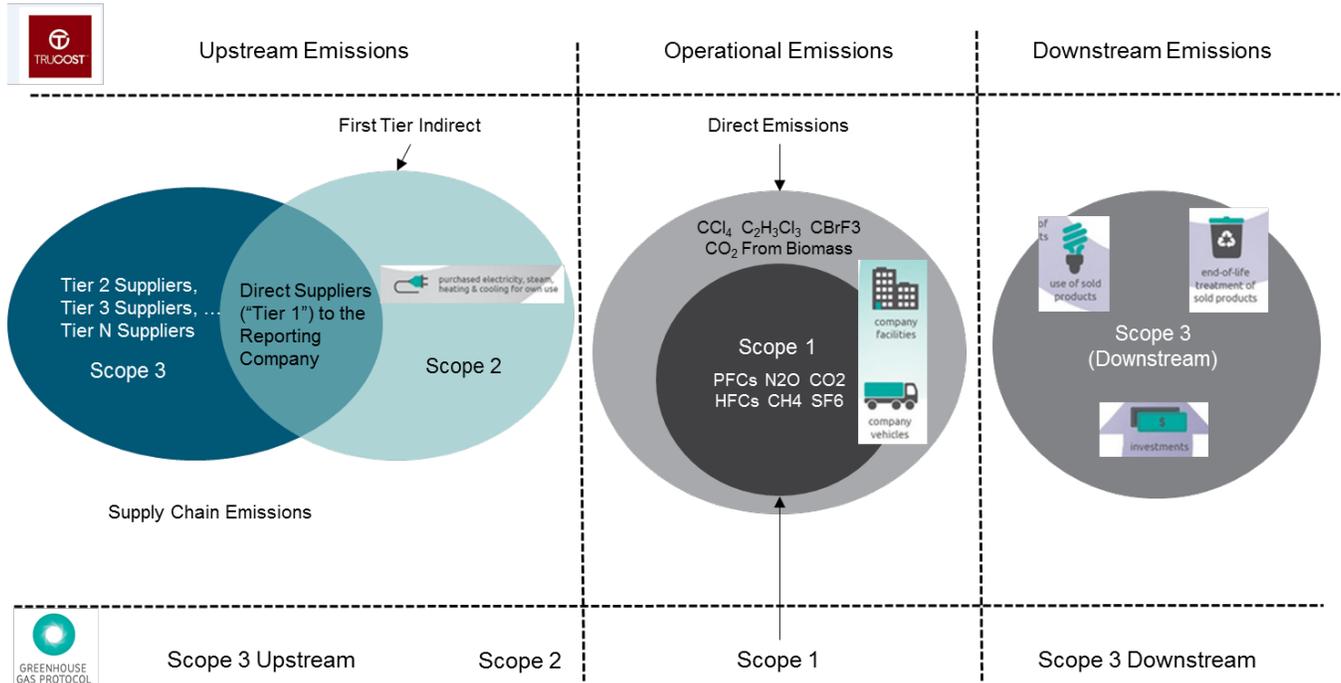
### Trucost's Steps



Source: Trucost. Chart is provided for illustrative purposes.

### What Is Included in Trucost's Calculation of Direct and Indirect Emissions?

Direct and First Tier Indirect Emissions Versus Scope 1 and Scope 2



Source: Trucost. Chart is provided for illustrative purposes.

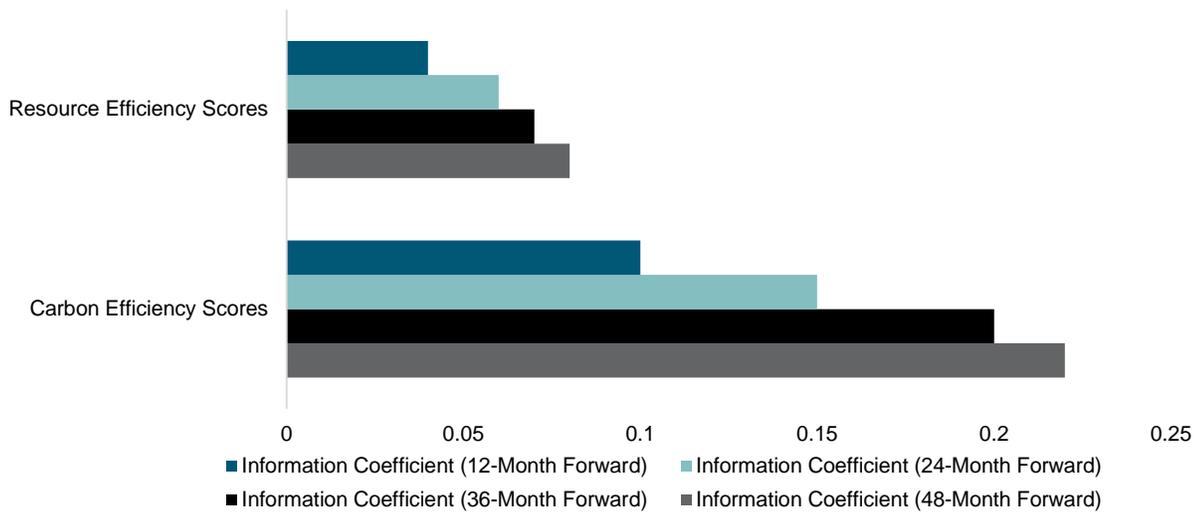
APPENDIX 2

**Exhibit A2.1: Rolling Performance of Companies Sorted by Carbon-Efficiency and Resource-Efficiency Quintiles (Within Sub-Industries)**

Scores	Annualized Return on a Rolling 1-Year Basis					Annualized Spread on a Rolling Forward Basis		
	Q1 (Most Efficient)	Q2	Q3	Q4	Q5 (Least Efficient)	Q1 Versus Q5 (12 Months Forward)	Q1 Versus Q5 (24 Months Forward)	Q1 Versus Q5 (48 Months Forward)
Carbon Efficiency	7.83	7.22	7.07	6.48	4.13	3.30	2.62	3.30
Resource Efficiency	8.27	7.27	6.67	6.23	4.12	3.64	3.66	3.88

Source: S&P Dow Jones Indices LLC and Trucost. Figures based on annual returns in USD. Data from December 2009 to December 2014. Past performance is no guarantee of future results. Table is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosures at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

**Exhibit A2.2: Information Coefficients of Efficiency Scores on a Forward Basis (Within Sub-Industries)**



Source: S&P Dow Jones Indices LLC and Trucost. Figures based on annual USD returns. Data from, December 2009 to December 2014. Table is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosures at the end of this document for more information regarding the inherent limitations associated with back-tested performance. All information coefficients are statistically significant at the 5% level.

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