W.K. Associates, Inc.
77 Broadway, Suite 2 Amityville, NY. 11701
[redacted]

November 3, 2022

Ms. Vanessa A. Countryman
Secretary
Securities and Exchange Commission
100 F. Street, NE
Washington, D.C. 20549-1090

RE: Proposed Rule "The Enhancement and Standardization of Climate-Related Disclosures for Investors" ("Proposed Rule"), Attention: 87 FR 21334; Docket ID: SEC-2022-06342; File No. S7-10-22

Dear Ms. Countryman,

We are writing to provide clarification regarding the order and intention of the letters and research W.K. Associates submitted in response to the request for comment on the Enhancement and the Standardization of Climate-Related Disclosures for Investors.

On May 23, 2022, W.K. Associates submitted a cover letter (https://www.sec.gov/comments/s7-10-22/s71022-20133888-303807.pdf) and a study titled "A Demanding Change: Oil and Gas in 2050" (https://www.sec.gov/comments/s7-10-22/s71022-20129438-295567.pdf) to your office. These documents refer to each other and were intended to be treated as one submission.

However, they are separated in the Commission's record of submitted comments, as the cover letter is included among the comments dated May 23, 2022 and the study is included among the comments dated March 22, 2022. So, we are writing to clarify that these two comments are intended to be read together and that they both build upon the comment W.K. Associates submitted to the Commission on June 24, 2021 (https://www.sec.gov/comments/climate-disclosure/cll12-8916955-245033.pdf). Each of these documents is attached for your reference.

We appreciate the opportunity to provide these clarifications and welcome the chance to engage further on these important issues.

Sincerely,

Paul Bugala
Senior Advisor, Climate Risk
W.K. Associates

W.K. Associates, Inc.
77 Broadway, Suite 2 Amityville, NY. 11701
[redacted]

May 23, 2022

The Honorable Gary Gensler, Chair
Commissioner Allison Harron Lee
Commissioner Hester M. Peirce
Commissioner Caroline A. Crenshaw
U.S. Securities and Exchange Commission
100 F Street, NE
Washington, DC 20549

Re: File Number S7-10-22 - Enhancement and the Standardization of Climate-Related Disclosures for Investors

Dear Chair Gensler and Commissioners:

We are writing to share research that responds to the request for comment on the Enhancement and the Standardization of Climate-Related Disclosures for Investors[1] The attached study by W.K. Associates, Inc. titled, "A Demanding Change: Oil & Gas in 2050" is a further elaboration on our June 14, 2021, comment[2]. Both submissions demonstrate the use of Scope 3 oil and gas emissions data, as well as the Emissions Embedded in Reserves metric, for conventional securities analysis.

The comment responds to the following questions included in the proposed rule filing:

52. Should we require a registrant to provide contextual information, including a description of significant inputs and assumptions used, and if applicable, policy decisions made by the registrant to calculate the specified metrics, as proposed? Should we revise the proposed requirement to provide contextual information to require specific information instead? We provide some examples of contextual information disclosure in Sections II.F.2 and II.F.3 below. Would providing additional examples or guidance assist registrants in preparing this disclosure?

79. The proposed rule does not specifically address expensed or capitalized costs that are partially incurred towards the climate-related events and transition activities (e.g., the expenditure relates to research and development expenses that are meant to address both the risks associated with the climate-related events and other risks). Should we prescribe a particular approach to disclosure in such situations? Should we require a registrant to provide a reasonable estimate of the amount of expense or capitalized costs incurred toward the climate-related events and transition activities and to provide disclosure about the assumptions and information that resulted in the estimate?

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[1] https://www.sec.gov/rules/proposed/2022/33-11042.pdf
[2] https://www.sec.gov/comments/climate-disclosure/cll12-8916955-245033.pdf

81. Should we require disclosure of financial estimates and assumptions impacted by the climate-related events and transition activities (including disclosed targets), as proposed? How would investors use this information?

93. How would investors use GHG emissions disclosures to inform their investment and voting decisions? How would such disclosures provide insight into a registrant's financial condition, changes in financial condition, and results of operations? How would such disclosures help investors evaluate an issuer's climate risk-related exposure? Would such disclosures enable investors to better assess physical risks associated with climate-related events, transition risks, or both types of risks?

106. Should we require a registrant that is required to disclose its Scope 3 emissions to describe the data sources used to calculate the Scope 3 emissions, as proposed? Are there other sources of data for Scope 3 emissions the use of which we should specifically require to be disclosed?

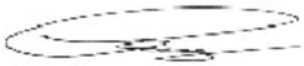
115. Should we base our climate disclosure rules on certain concepts developed by the GHG Protocol without requiring a registrant to follow the GHG Protocol in all respects, as proposed? Would this provide flexibility for registrants to choose certain methods and approaches in connection with GHG emissions determination that meet the particular circumstances of their industry or business or that emerge along with developments in GHG emissions methodology as long as they are transparent about the methods and underlying assumptions used? Are there adjustments that should be made to the proposed methodology disclosure requirements that would provide flexibility for registrants while providing sufficient comparability for investors?

The study submitted to the SEC by WK Associates in June 2021, and this report evaluate amendment of the SEC's oil and gas reserves disclosure regulations (Specifically Regulation S-X §210.4-10[3] and Regulation S-K §229.1202[4]) to reflect effective CO_2 emissions. The proposed method is scientifically valid, straightforward for registrants to prepare and uncomplicated for investors to apply in securities analysis. The resulting data could be included in a balance sheet or income statement (by reference) to explain assumptions about the impact of climate transition risk on consolidated financial statement line items (as required by § 210.14-02 page 455 of the proposed rule). For example, this type of clarification may be useful when a registrant's public greenhouse gas (GHG) emissions reduction targets, or other expenses or capitalized costs, have a more than one percent absolute impact on the net present value of oil and gas reserves and related capitalized costs.

We are grateful for the opportunity to contribute to this very important effort and welcome the chance to discuss our comment further at your convenience.

[3] https://www.govinfo.gov/content/pkg/CFR-2010-title17-vol2/pdf/CFR-2010-title17-vol2-sec210-4-10.pdf
[4] https://www.ecfr.gov/current/title-17/chapter-II/part-229/subpart-229.1200/section-229.1202

Sincerely,



Alexander Schay
Managing Director
W.K. Associates, Inc.

Paul Bugala
Senior Advisor, Climate Risk
W.K. Associates, Inc.

CC:
Ms. Vanessa A. Countryman, Secretary, Securities and Exchange Commission
Ms. Renee Jones, Director, Division of Corporation Finance
Ms. Luna Bloom, Chief, Office of Rulemaking, Division of Corporation Finance
Ms. Kristina Wyatt, Senior Special Counsel
Ms. Mika Morse, Climate Counsel
Ms. Jessica Wachter, Director, Division of Economic and Risk Analysis
Mr. Paul Munter, Acting Chief Accountant

W.K. Associates, Inc.

Version 2.0 March 22, 2022

A Demanding Change: Oil & Gas in 2050

Alexander Schay
Managing Director
W K Associates, Inc

Paul Bugala
Senior Adviser
W K Associates, Inc

Image courtesy: "Offshore Drilling for Oil at Sunset" by Dennis Thompson

Summary:

- A consensus has emerged among the largest and most prominent industry forecasters that 2050 oil and gas demand will fall below current levels -- for the first time in the history of the segment -- despite an expected doubling of global GDP over the period.

- Since the pandemic low, oil and gas E&P stocks have soared, with current price-implied-expectations at historical extremes – starkly at odds with the energy transition consensus.

- This report highlights a useful metric for evaluating the emissions potential of proved undeveloped reserves, the reserves most sensitive to rapidly rising project IRRs due to "green decoupling". This metric can aid investors in framing the current risks to E&Ps, against a volatile backdrop of tremendous future demand uncertainty.

Executive Summary

The year 2021 proved a landmark in the history of the oil and gas industry. Obscured by both the pandemic and an understandable fixation on the expected upward trajectory of oil and gas demand in the current decade, a consensus emerged among the largest and most prominent industry forecasters that 2050 demand will fall below current levels. This despite an expected doubling of global GDP to 2050, severing the virtual lockstep growth in hydrocarbon demand and economic growth witnessed over the last century.

A key feature of investor appeal for oil and gas, despite frequent bouts of uneconomic returns, has always been rock solid demand growth, an oligopolistic market structure, and sufficient sustained advantage to return capital to shareholders in the form of high dividends and buybacks. With the potential removal of one leg of this stool, perhaps two, the industry is at the dawn of a new era of uncertainty and volatility. While there are certainly valid non-consensus forecasts, as is always the case in markets, when the bulk of analysis forecasts a strong energy transition over the next 25 years, investors should take note.

Taking the average analyst estimates across the six providers below yields a forecast of 95 mb/d, 64 mb/d and 40 mb/d (million barrels per day) for the high, middle and low demand scenarios respectively. With 2021 demand estimated at 96.4 mb/d, it's striking that the consensus among the three best known independent forecasters, an equal number of integrated oil companies, as well as Bloomberg and IHS Markit, shows average demand in 2050 below current demand for the first time.

Exec Summary Figure 1
IEA, WoodMac, Rystad, British Petroleum, Lukoil & Shell Oil & Liquids Demand 2050 Scenario Analysis

Forecast	2050 High C	2050 Mid C	2050 Low C	Measure	Oil/Liquids
IEA	104	77	24	mb/d	Oil
WoodMac	110	35	30	mb/d	Oil
Rystad	76	51	38	mb/d	Oil
BP	95	55	30	mb/d	Liquids
Lukoil	99	74	45	mb/d	Liquids
Shell	86	94	72	mb/d	Oil

Range	*110-76*	*94-35*	*72-24*
Mean	*95*	*64*	*40*
Mean ex outlier	*98*	*64*	*36*
Bloomberg	*96*		
IHS Markit	*86*		

Source: WKA Analysis

The prospect of significant energy transition challenges over the next three decades has not cooled a blazing hot runup for oil and gas securities today. Exploration and production companies, given that their valuation is almost solely based on reserves, without midstream and downstream operations, highlight this point well. Since the pandemic low the SPDR S&P Oil & Gas Exploration & Production ETF (NYSE: XOP), with holdings of 61 U.S. E&P companies has gained 267% as Brent has climbed 175%, and the overall S&P has gained 101%. The reasons for this extraordinary runup, against the backdrop of a potential fundamental shift in the long-term dynamics of the industry, are numerous, including: a significant drawdown in oil inventories after a hard pandemic stop, historically low global spare capacity threatening to be overwhelmed by 2022 demand, and a sustained period of underinvestment leading to supply mismatches as demand conditions have shifted.

However, with any appreciable price gain comes a commensurate rise in implied performance expectations. Historically, the E&P industry has struggled to generate returns on capital above the cost of capital for extended periods of time, as exemplified by its performance over the last decade

Exec Summary Figure 2
(ARCX: XOP) E&P Company Price Implied Expectations Analysis (2/20/2022)

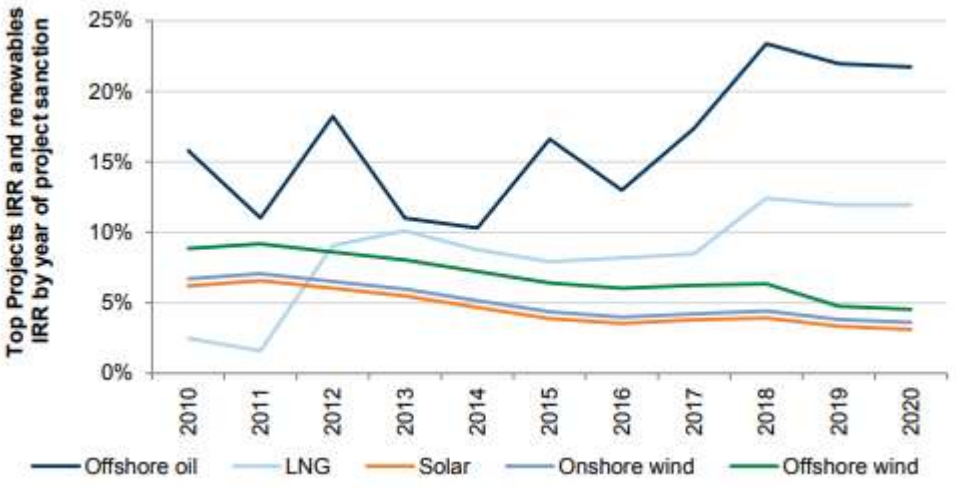
Ticker	Name	Value (000,000)	ROIC	ROCE	WACC	ROCE Spread	ROIC Spread	FCF Yield	GAP	Implied Rev CAGR	3 Yr Rev CAGR (A)	5 Yr Rev CAGR (A)	Avg. Implied ROIC spread	3 Yr ROIC Spread (A)	5 Yr ROIC Spread (A)
CPE	Callon Petroleum	$ 2,901	11.1%	11.3%	8.2%	3.2%	3.0%	22.6%	1<	_	32.6%	50.6%	_	0.0%	-1.6%
LPI	Laredo Petroleum Inc	$ 1,175	7.7%	29.2%	8.0%	21.2%	-0.3%	3.6%	1<	_	-21.7%	3.2%	_	-1.7%	-2.4%
TALO	Talos Energy Inc.	$ 996	7.2%	18.0%	7.0%	11.0%	0.2%	27.3%	50>	3.7%	-18.8%	_	5.7%	-0.4%	-0.4%
CDEV	Centennial Resource	$ 2,179	5.0%	7.0%	6.1%	0.9%	-1.0%	12.9%	50>	3.9%	-2.0%	55.7%	-0.1%	-2.0%	-1.7%
MRO	Marathon Oil Corp	$ 15,982	4.6%	12.6%	6.3%	6.3%	-1.7%	11.0%	50>	3.0%	5.2%	6.4%	3.4%	-4.2%	-4.8%
MTDR	Matador Resources Co	$ 5,244	10.1%	19.3%	8.7%	10.6%	1.4%	6.2%	50>	3.7%	-3.6%	26.5%	34.4%	-0.3%	-1.7%
EOG	EOG Resources, Inc.	$ 65,308	8.4%	19.4%	6.3%	13.1%	2.1%	4.5%	52	3.9%	-19.5%	10.4%	9.7%	0.3%	-0.9%
CTRA	Coterra Energy Inc.	$ 18,379	7.0%	13.2%	5.0%	8.2%	2.0%	1.6%	1<	_	-18.1%	6.1%	_	4.1%	2.8%
FANG	Diamondback Energy Inc.	$ 23,819	9.6%	13.4%	7.0%	6.4%	2.6%	-3.1%	67	4.1%	13.7%	52.0%	7.1%	-0.4%	-0.3%
CLR	Continental Resources	$ 19,224	12.4%	19.7%	6.4%	13.3%	6.0%	-4.8%	92	3.2%	11.1%	16.4%	27.3%	-0.9%	-1.6%
SWN	Southwestern Energy	$ 4,730	9.4%	16.7%	4.4%	12.3%	5.0%	-13.2%	1<	_	-22.7%	-1.3%	_	0.6%	0.4%
OVV	Ovintiv Inc.	$ 10,574	0.6%	16.4%	7.5%	8.9%	-6.9%	13.9%	50>	3.2%	1.2%	19.8%	8.7%	-3.3%	-4.2%
MUR	Murphy Oil Corp	$ 5,062	0.4%	9.1%	7.2%	1.9%	-6.8%	12.3%	50>	3.2%	-12.4%	1.9%	0.4%	-4.1%	-4.6%
AR	Antero Resources Corp	$ 6,823	1.7%	11.7%	7.7%	4.1%	-6.0%	8.7%	50>	3.3%	2.4%	6.0%	4.9%	-3.6%	-2.7%
XOM	Exxon Mobil Corp	$327,509	-0.1%	15.3%	5.7%	9.6%	-5.8%	8.5%	50>	3.3%	-19.8%	-4.8%	-0.4%	-2.9%	-2.5%
OXY	Occidental Petroleum	$ 36,948	2.4%	7.6%	6.5%	1.1%	-4.1%	8.1%	50>	3.2%	0.0%	15.3%	5.0%	-3.4%	-4.0%
HES	Hess Corporation	$ 29,074	3.3%	14.0%	6.9%	7.1%	-3.5%	7.5%	50>	3.4%	-14.1%	-0.5%	3.7%	-4.5%	-6.0%
APA	Apache Corporation	$ 11,683	2.8%	22.7%	8.0%	14.7%	-5.3%	6.8%	50>	3.4%	-22.1%	-4.2%	0.2%	-4.2%	-5.0%
RRC	Range Resources Corp	$ 5,308	-0.9%	17.4%	5.2%	12.2%	-6.1%	5.3%	50>	3.4%	-22.6%	15.7%	3.5%	-3.4%	-3.4%
CNX	CNX Resources Corp	$ 3,209	-3.9%	8.9%	3.8%	5.1%	-7.7%	2.7%	1<	_	24.3%	17.6%	_	-3.0%	-2.3%
CVX	Chevron Corporation	$257,192	4.3%	14.2%	6.1%	8.1%	-1.8%	-0.2%	50>	3.3%	-22.9%	-3.8%	6.6%	-4.5%	-4.0%
KOS	Kosmos Energy Ltd	$ 1,934	2.8%	7.7%	9.8%	-2.1%	-7.1%	-2.5%	50>	3.6%	-4.8%	26.9%	11.5%	-4.2%	-6.3%
COP	ConocoPhillips	$118,217	4.6%	21.9%	5.9%	16.1%	-1.3%	-6.7%	50>	3.9%	-28.2%	-5.6%	12.3%	-2.7%	-3.2%
NOG	Northern Oil & Gas, Inc.	$ 1,585	-4.5%	30.2%	6.4%	23.8%	-10.9%	-7.7%	1<	_	-9.8%	39.7%	_	0.4%	-0.6%
EQT	EQT Corporation	$ 8,393	-3.4%	6.6%	3.9%	2.6%	-7.3%	-13.5%	50>	3.1%	-16.7%	-2.4%	0.4%	-4.6%	-3.2%
DVN	Devon Energy Corp	$ 36,385	4.8%	26.2%	6.7%	19.5%	-1.9%	-15.3%	50>	3.2%	40.1%	-3.3%	7.2%	-4.9%	-5.2%
PXD	Pioneer Natural Resources	$ 56,976	10.4%	20.7%	5.9%	14.9%	4.5%	-20.2%	50>	4.0%	-13.5%	15.5%	40.4%	-1.1%	-2.2%
TELL	Tellurian Inc	$ 1,164	-14.7%	-14.1%	8.1%	-22.2%	-22.8%	-21.2%	50>	6.6%	90.8%	_	5.7%	-31.7%	-34.8%
PDCE	PDC Energy	$ 5,408	1.5%	24.8%	7.8%	17.0%	-6.3%	8.9%	50>	3.6%	-7.0%	36.8%	21.2%	-2.9%	-5.1%
SM	SM Energy Company	$ 4,160	-4.5%	8.4%	8.4%	0.0%	-12.9%	6.7%	50>	6.9%	-17.1%	-1.2%	23.8%	-5.5%	-6.6%

Source: New Constructs, FactSet, WKA Analysis

As can be seen from the Figure above, current market prices for the constituents of the XOP are impounding many years of returns above the cost of capital (see column "GAP"). In fact, 80% of the

index is implying greater than 50 years of value creating returns (ROIC above WACC)! These frothy valuations are not only at odds with individual company return history (as seen in the rightmost column labeled "5 Year ROIC spread Actual") as well as aggregate historical industry returns, but the current valuations also defy the consensus that an energy transition could ultimately bring oil and gas demand below current levels by 2050. While public market equity investors may be proceeding in a business-as-usual fashion, E&P companies are experiencing clear financing stress related to the energy transition. Goldman Sachs estimates that the spread in the cost of capital of hydrocarbon versus renewable developments has widened by greater than ten percentage points over the last five years (Figure below).

Exec Summary Figure 3
Project IRR for oil and gas and renewable projects by year of project sanction



Source: Goldman Sachs

When project IRRs, required returns on long duration, high-cost projects, increase significantly due to uncertainty around demand and the regulatory environment, fewer projects get funded, exploration budgets get cut and write-offs increase. This is validated by the expected 40% decline in the reinvestment ratio for all Oil & Gas in 2022 (based on current trends versus a 10-year average) and highlights an industry beset with poor regulatory clarity and lack of global coordination, in contrast with the electric

utility industry, which has seen positive reinvestment ratios due to price support and more clear regulation. A truism in the industry is that high oil prices are the best cure for high oil prices, as additional capacity ramps and the pendulum swings to oversupply. Over the last decade however, the number of climate-related shareholder resolutions has almost doubled and the percentage of investors voting in favor has almost tripled, to roughly 40%, with a targeted focus on energy producers rather than on final energy consumption. The prospect of continued shareholder pressure and sustained high financing costs may significantly delay what was in years past an almost certain setup for a price crash (now exacerbated by renewed energy security concerns due to Russia's invasion of Ukraine). This volatile backdrop shows no sign of abating, as few doubt the fact that a meaningful energy transition is on the horizon. This issue is particularly challenging for E&P companies, as undeveloped properties are major drivers of firm value. On a NAV basis, E&P companies typically trade well above the discounted value of their proved developed reserves, with the balance of the market value representing implied optionality on proved undeveloped properties (PUD), and possibly more distant P2, P3. Since PUDs require future capital investments, they're keenly sensitive to economic conditions. The National Bureau of Economic Research (NBER) examined the relationship between firm value and proved reserves for 600 oil and gas firms in North America from 1999-2018 and found that proved undeveloped reserves growth and firm value were significantly negatively correlated.

WK Associates built a model portfolio to test the carbon risk sensitivity embedded in proved undeveloped reserves. For the 30 E&P firms in this report, undeveloped proved reserves averaged 40% of total reserves on an annual basis over the last decade. While the growth of aggregate undeveloped reserves is important to valuation, the emissions potential and financing implications of the change in reserves mix needs to be disaggregated (as highlighted by LNG's lower project IRR). The figure below shows the relationship between the change in emissions potential of undeveloped proved reserves and

Enterprise Value for the thirty E&P companies in Exec Summary Figure 2 over the last five years (we removed all firms in XOP that were not "pure play" upstream E&P companies). We plotted the change in undeveloped proved reserves over a given year, calculated the emissions potential of that change in reserves according to the hydrocarbon mix, and then performed a regression against Enterprise Value (firm value as dependent variable).

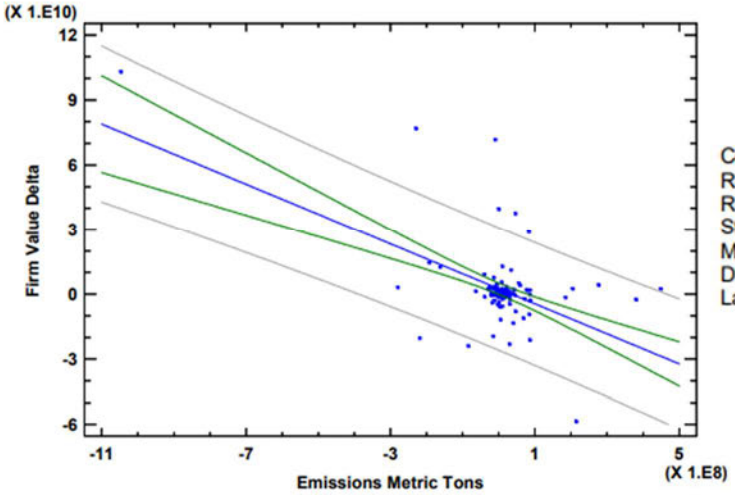
Exec Summary 4
Growth in Emissions Potential of Undeveloped Reserves & Firm Value

Coefficients

Parameter	Least Squares Estimate	Standard Error	T Statistic	P-Value
Intercept	2.47354E9	1.33408E9	1.85412	0.0663
Slope	-69.4842	10.1094	-6.8732	0.0000

Analysis of Variance

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
Model	9.63326E21	1	9.63326E21	47.24	0.0000
Residual	2.30427E22	113	2.03918E20		
Total (Corr.)	3.2676E22	114			



Correlation Coefficient = -0.542965
R-squared = 29.4811 percent
R-squared (adjusted for d.f.) = 28.8571 percent
Standard Error of Est. = 1.428E10
Mean absolute error = 7.56303E9
Durbin-Watson statistic = 2.41602 (P=0.9875)
Lag 1 residual autocorrelation = -0.208819

Source: WK Analysis, FactSet, Statgraphics

As can be seen, an even greater negative correlation exists (-0.54 coefficient, versus -0.23) between CO_2 emissions and firm value. It's important to note that the growth in undeveloped proved reserves alone is impactful, but that growth does not *necessarily* give rise to a linear increase in emissions. The exact quantity of rise or fall in metric tons of CO_2 depends on the mix of proved undeveloped hydrocarbons that rise or fall (i.e., oil, natural gas and NGL).

We utilized emissions factors formulated by the Intergovernmental Panel on Climate Change for each type of hydrocarbon, a standard adopted around the world by governments and companies alike (including the U.S. Department of Energy and Exxon Mobil, outlined in Appendix II of this report). In order to understand the impact of potential emissions from PUDs on equity performance we compared an equal-weighted portfolio of E&P company returns, utilizing the 30 companies outlined in this report, from 2017-2021. In the first scenario, we simply held all 30 companies for the entire period. As can be seen in the Figure below this generated a 158% return. We then rebalanced the portfolio each year and removed the top quintile emitters (i.e., largest increase in potential emissions from undeveloped proved reserves), replacing them with the bottom quintile performers, which mostly consisted of firms that reduced emissions.

Exec Summary 5
Emissions-Based Portfolio Rebalancing

		Year 5	Year 4	Year 3	Year 2	Year 1	Return
30 Hold		**66.4%**	**5.4%**	**-16.2%**	**9.1%**	**61.0%**	
Portfolio Return	*Equal Weight*	166.37	175.41	146.99	160.34	258.21	**158%**
Rebalance Undeveloped		**66.4%**	**17.1%**	**-14.9%**	**-2.3%**	**84.0%**	
Portfolio Return	*Equal Weight*	166.37	194.80	165.70	161.97	298.03	**198%**
Rebalance Emissions		**66.4%**	**17.1%**	**-14.9%**	**-0.1%**	**85.9%**	
Portfolio Return	*Equal Weight*	166.37	194.80	165.70	165.61	307.86	**208%**

Source: WK Analysis

As can be seen, the portfolio return jumped dramatically to 208%, a move of 5000 basis points, or 32% improvement over the hold portfolio! An important observation from these data is that the growth or decline in PUDs and emissions, though highly correlated, sometimes diverged due to the relative mix of hydrocarbons. In addition to the potential portfolio implications outlined, there are individual security analysis benefits to utilizing a metric that tracks the potential emissions associated with undeveloped proved reserves, including the following:

- **Carbon Scoring** – As discussed earlier in this report, many hydrocarbon demand scenarios are now linked to emissions levels, where maximum allowable amounts are established in order to meet global warming targets. Increasingly, investment services and portfolio software providers are scoring an individual company's alignment with temperature benchmarks, sometimes referred to as "carbon scoring" where the analysis contrasts the company's stated targets against a benchmark. Calculating the emissions potential of undeveloped proved reserves would allow analysts to quantify a PUD threshold, or a level of undeveloped reserves that might affect the firm's ability to meet or exceed its stated emissions goals.

- **Precision** -- Increasingly analysts are incorporating higher discount rates as a "blunt force" margin of safety when valuing some oil and gas investments. A few investors we spoke with are utilizing an additional 200-500 basis points on top of the calculated rate for more extreme physical and transition risks. Understanding the trajectory of the emissions potential of PUDs for an individual security can allow analysts to accept their calculated rate without a blunt instrument margin of safety, but with a valuation adjustment to reflect the idiosyncratic risk of either growing or declining emissions potential for the undeveloped proved assets of the valuation target.

- **Corporate Strategy** – Clearly delineating emissions targets and the potential inherent in a firm's undeveloped proved reserves can help a company understand where it fits in a country, regional, or global strategy. Having quantifiable metrics allows companies to manage what they measure, helping to explore the way in which carbon offsets or operational emissions reductions can balance against future expected emissions. If these potential emissions can be aggregated at a market level, it will improve market efficiency with respect to the overall trajectory of emissions in coming years, as well as give context to an individual company's efforts within that overall path.

Numerous institutional investor surveys over the last year have indicated that investors understand the potential materiality of climate change in the valuation of companies. In the Robeco 2021 Global Climate Survey of the 300 largest institutional investors, with a total of $23.4 trillion in assets under management, 71% of respondents asserted that climate change was either a "significant factor" or "at the center" of investment policy (47% and 26% respectively). In addition, in the Greenwich 2021 survey of 101

investors with greater than $3B in assets, it was reported that 58% of respondents actively incorporated climate change considerations into their investment process, with approximately 75% doing so because the practice "improves risk-adjusted returns". Despite majorities in both surveys acknowledging the importance of climate risk, a significant number cited the need for more reliable data, models and disclosures to effectively evaluate the risks. The lack of perceived in-house expertise was a strong limiting factor (40% of investors in the Greenwich survey), as many investors didn't feel they had the requisite expertise to isolate the elements that impacted firm value. Of the respondents in the Greenwich survey roughly 31% utilized carbon emissions data as a factor in their internal analysis, leaving considerable room for more efficient pricing of this factor as adoption increases. As demonstrated in this report, under the right circumstances, investors can use these data to inform their analysis and generate potentially superior returns.

A Demanding Change

Introduction:

The year 2021 witnessed a rapid increase in corporate climate commitments, as well as renewed vigor in globally synchronized efforts to reduce GHG emissions[1]. Over the course of last year an august group of independent forecasters, including the IEA, WoodMac and Rystad, all issued reports on the future of oil and gas demand. With most country-level NetZero commitments centered on the year 2050[2], virtually all the named forecasters estimated *significantly* lower oil demand by that date (even under scenarios with only moderate rates of structural change in the energy industry). Against this uncertain long-long-term backdrop, oil and gas securities soared in 2021, largely indicating business as usual in public markets (and highlighting a disconnect with the distant consensus). While historical oil and gas returns have been persistently uneconomic over multi-year periods[3], the industry's insatiable demand profile has always provided a modicum of sustained advantage, along with its oligopolistic market structure. With that demand picture now blurry at best, the next thirty years pose a profound threat to what has historically been lockstep growth with global GDP over the last century[4].

This report attempts to assess the performance expectations impounded in current prices for a representative group of upstream E&P companies. It will also introduce a metric that can help investors assess the climate risk embedded in a company's reserves. The report consists of three parts: (1). Analysis of the "new" 2050 oil and gas demand consensus that has emerged over the last year, (2). A systematic

[1] COP26, U.S.-China joint statement for the first time

[2] Energy & Climate Intelligence Unit

[3] https://www.mckinsey.com/industries/oil-and-gas/our-insights/the-big-choices-for-oil-and-gas-in-navigating-the-energy-transition

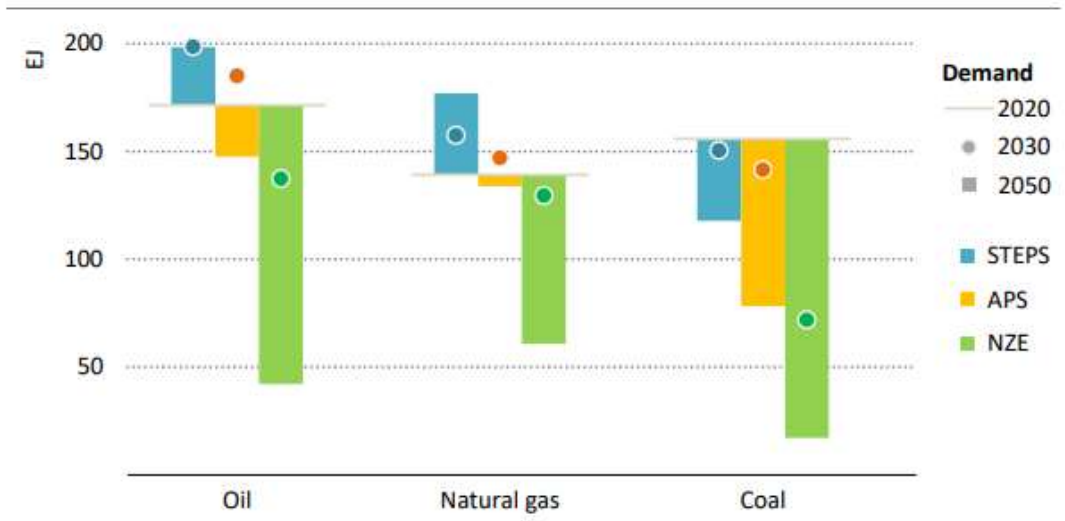
[4] There was a 92% coefficient of determination between global GDP (in current US$) and daily oil demand (mb/d) from 1965-2020, according to World Bank and BP Statistical Review data.

evaluation of current price-implied-expectations for the largest U.S. E&P companies, using a reverse discounted cash flow model, and (3). An assessment of the valuation insights that can be gleaned from calculating the emissions potential of undeveloped proved reserves for individual companies, as well as the metric's potential risk management benefits in the current environment.

Part 1: The Forecasters:

In stark contrast with the ongoing debate over the timing of peak oil demand, the current consensus on expected long-long term O&G demand (typically 2050) shifted markedly over the course of 2020-2021, settling into a remarkably uniform consensus. The International Energy Agency published its annual World Energy Outlook (WEO) in October of 2021, and for the first time in its history oil demand to 2050 was forecast to decline under all examined scenarios (see Figure 1).[5]

Figure 1
International Energy Agency "World Energy Outlook 2021"



Source: IEA, Note: One Exajoule (EJ) is around 0 5 mb/d of oil

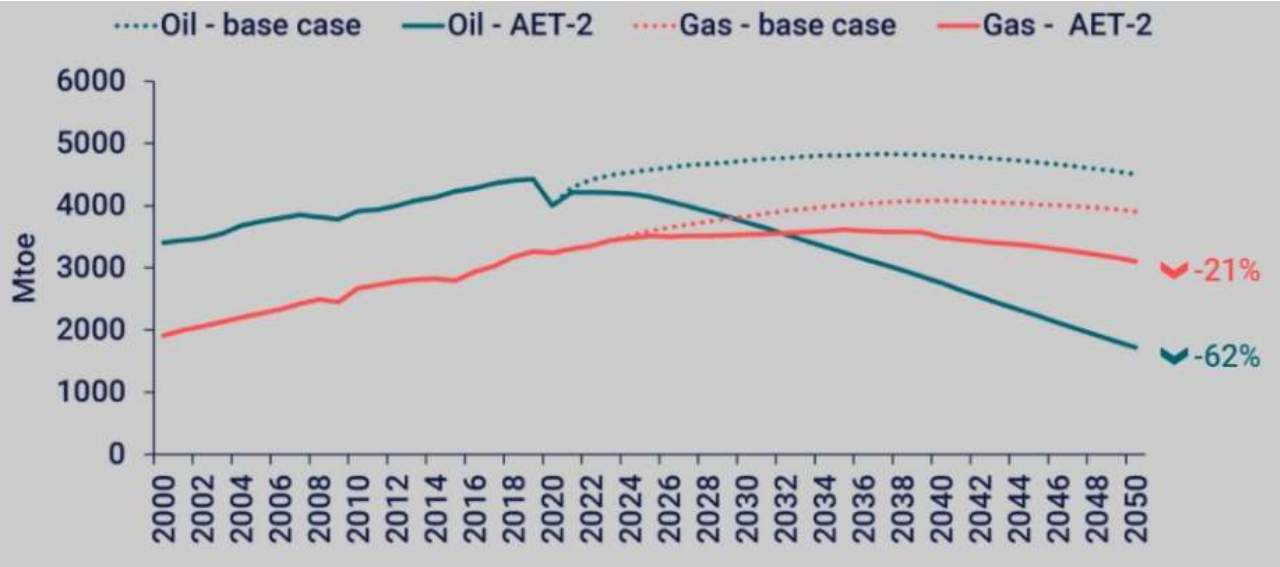
[5] It's important to note that the vast majority of the current industry debate centers on whether "peak" demand occurs by 2030 or is forestalled until after that date. Debate about 2050 demand is less strenuous given the fundamental uncertainty around the next decade's direction.

The IEA's 3 scenarios are labeled STEPS, APS and NZE. Under the Stated Policies Scenario (STEPS), a situation where global average temperatures hit 2.6 °C above pre-industrial levels by 2100, oil demand levels off at 104 mb/d in the mid-2030s and then declines very slightly to 2050. Under the APS, or Announced Pledges Scenario, where global average temperature is held to 2.1 °C (but not achieving net zero, so the temperature trend does not stabilize) global oil demand peaks soon after 2025 at 97 mb/d and declines to 77 mb/d in 2050. In the Net Zero Emissions path (NZE), a narrow roadmap to 1.5 °C, oil demand falls to 72 mb/d in 2030 and to 24 mb/d by 2050. According to the IEA, under the NZE scenario, "By 2030, 60% of all passenger cars sold globally are electric, and no new ICE [Internal Combustion Engine] passenger cars are sold anywhere after 2035. Oil use as a petrochemical feedstock is the only area to see an increase in demand; in 2050, 55% of all oil consumed globally is for petrochemicals."[6]

Wood Mackenzie (WoodMac), a global energy consultancy, recently provided updates to its base case scenario for oil and gas demand (ETO) as well as its two more aggressive energy transition scenarios (AET-2 and AET-1.5). See Figure 2.

[6]https://iea.blob.core.windows.net/assets/0716bb9a-6138-4918-8023-cb24caa47794/NetZeroby2050-ARoadmapfortheGlobalEnergySector.pdf

Figure 2
WoodMac Oil & Gas Demand 2050, AET-2 Versus Base Case



Source: WoodMac

The ETO translates into a 2.5 °C to 2.7 °C pathway and represents WoodMac's assessment of the "most likely outcome", although the firm does not assign probabilities to its analysis[7]. It sees the current global economic recovery leading to energy-related CO_2 emissions rising over the next five years to a new high of 34 Bt in 2026, as well as the world's continued reliance on fossil fuels. By 2050 hydrocarbons share of the global energy mix only falls to 70%, from 80% today. Oil demand plateaus and begins a slow decline in the mid-2030s while gas demand continues to increase into the 2040s, fueled primarily by Asian economic growth. Under the ETO oil demand sits around 110 mb/d by 2050.

Given the experience of capital markets in 2021 and an "ever widening stakeholder community demanding clarity and action on decarbonization" WoodMac's team generated forecasts for both 2 °C and 1.5 °C pathways. The results of the analysis show striking variance with the base case. In its AET-2

[7] https://www.woodmac.com/news/editorial/energy-transition-scenarios/

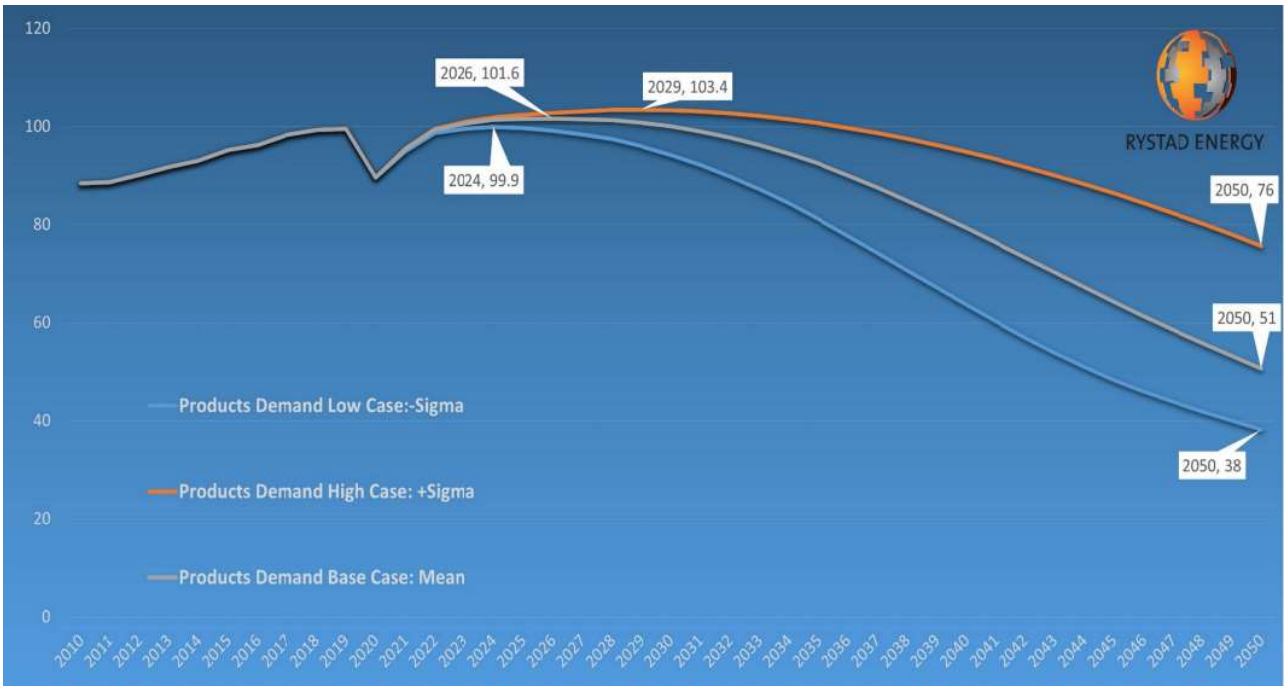
scenario, oil demand falls by 70% to 35 mb/d by 2050 as electric vehicles and hydrogen disrupt road transportation, while recycling limits the feedstock demand for plastics. AET-1.5 is even more aggressive with the demand decline starting almost immediately, ultimately falling below 30 mb/d by 2050. WoodMac warns that "No oil company is preparing for the scale of decline envisioned in any of these scenarios [AET-2 or AET-1.5]".[8] The dramatic difference between the IEA's APS and WoodMac's AET-2, with respect to 2050 oil demand, is primarily a feature of differing outcomes for petrochemical feedstock. The IEA sees a continued role for oil, while WoodMac forecasts oil's displacement by hydrogen.

Norwegian energy intelligence firm Rystad Energy presented its own forecast in 2021 with oil demand at 94 million bpd by 2030 and 38 million bpd by 2050 in its low case, and 51 million bpd in its "mean" case. Rystad expects faster growth of EVs than the IEA but disagrees that "behavioral change and biofuels will be able to remove 23 million bpd of demand by 2030."[9] However, the Rystad forecast is consonant with the IEA in that it sees lower oil demand by 2050 across all three of its scenarios (see Figure 3).

[8] https://www.woodmac.com/news/the-edge/what-different-scenarios-tell-us-about-the-future-of-oil-and-gas/

[9] "Oil Demand Set to Peak at 101.6 million bpd in 2026" April 21, 2021, Rystad, Sofia Guidi di Sante

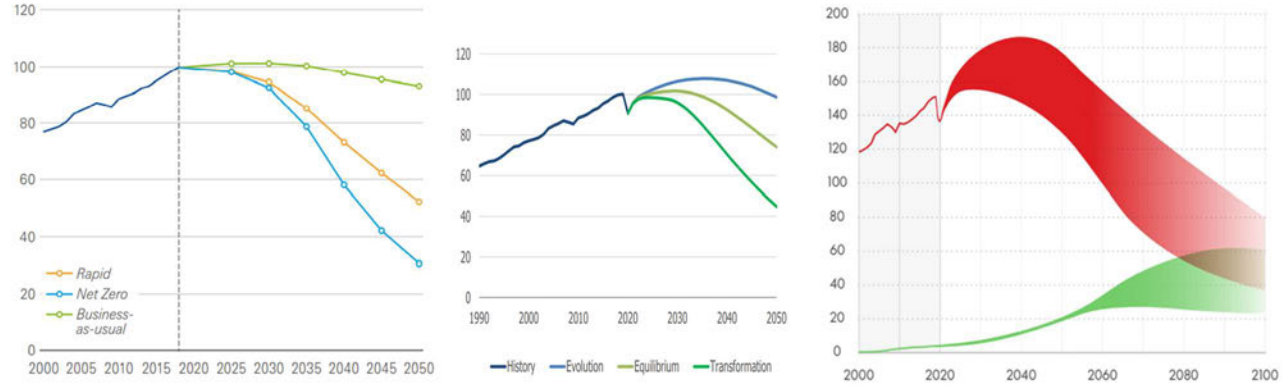
Figure 3
Rystad Energy's Long-Term Global Oil Demand Scenarios (Base, Low, High mb/d)



Source: Rystad

While many of the oil industry players themselves spend considerable effort on demand forecasting, only the largest public companies, with a global presence, tend to publish their world demand estimates. For instance, BP has been continuously publishing its "Statistical Review of World Energy" since 1952 and it has become a trusted source of data for the industry. Figure 4 shows the scenario analysis conducted by three large players: British Petroleum (NYSE: BP), Shell (NYSE: RDS.A) and Lukoil (LSE: LKOD).

Figure 4
British Petroleum, Lukoil & Shell Scenario Analysis



Source: BP, Lukoil, Shell & WKA Analysis

Each company has different names for their scenarios, as well as slightly different metrics for demand, summarized below:

- **British Petroleum** – BP has named its three scenarios Rapid, Net Zero and Business-as-Usual (BAU)[10]. Net Zero corresponds to 95% reduction in global carbon emissions by 2050, in line with limiting temperature rise to 1.5 °C. The Rapid scenario assumes more targeted sector specific measures, reducing emissions by 70%, roughly in line with a 2 °C outcome. The consumption of liquid fuels falls under both scenarios, declining to 30 mb/d by 2050 under Net Zero and less than 55 mb/d under Rapid. The BAU scenario assumes little progress is made and 2050 emissions stand at only 10% below 2018 levels. However, the consumption of liquid fuels in BAU is broadly flat at around 100 Mb/d for 20 years, before edging lower to around 95 Mb/d by 2050. It's important to note that BP aggregates liquid fuels (oil, biofuels and other) so its numbers are slightly higher than oil-only comps.

[10] https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/energy-outlook/bp-energy-outlook-2020.pdf

- **Lukoil** – The second largest Russian oil producer, Lukoil, released its own demand forecasts under three scenarios called, Evolution, Equilibrium and Transformation, roughly corresponding to limiting temperature rise to 2.6 °C, 2 °C and to 1.5 °C respectively[11]. Like BP, Lukoil aggregates liquid fuels and sees year 2050 demand at 99 mb/d, 74 mb/d and 45 mb/d under Evolution, Equilibrium and Transformation.
- **Shell** – Transnational oil major Shell reports demand in terms of Exajoules (roughly 0.5 mb/d) and separates oil from other liquids in its forecast. Its three long horizon scenarios are called Islands, Waves and Sky 1.5, roughly corresponding to 2.5 °C, 2.3 °C and to 1.5 °C respectively[12]. The Islands path is characterized as "late and slow" progress, while Waves is dubbed "late but fast" and both envision a world that does not focus on a specific degree scenario outcome. Only Sky is explicitly aspirational. Under these scenarios Shell sees year 2050 oil demand at 192 ej/year, 209 ej/year and 160 ej/year under Islands, Waves and Sky respectively[13]. This translates to roughly 86 mb/d, 94 mb/d and 72 mb/d. In this case, the 2.3 °C "Waves" scenario corresponds to higher 2050 oil demand than the Islands path because of a focus by countries coming out of the pandemic on wealth accumulation, over autonomy and self-sufficiency (an assumption possibly upended by recent geopolitical events). This initial orientation subsequently puts demand on a higher for longer pathway that notches up the end state condition.

Taking the average of analyst estimates across the 6 providers above yields 95 mb/d, 64 mb/d and 40 mb/d for the high, middle and low scenarios outlined by each forecaster respectively (see Figure 5). With 2021 demand estimated to have been 96.4 mb/d, it's striking that the consensus among the three best

[11] https://www.lukoil.com/FileSystem/9/570593.pdf

[12] https://www.shell.com/energy-and-innovation/the-energy-future/scenarios/the-energy-transformation-scenarios.html#iframe=L3dlYmFwcHMvU2NlbmFyaW9zX2xvbmdfaG9yaXpvbnMv

[13] 192 ej/year = 31,383 mmboe = 86 mb/d; 209 ej/y = 34,162 mmboe = 94 mb/d; 160 ej/year = 26,152 mmboe = 72 mb/d

known independent forecasters and an equal number of integrated oil companies shows average demand in 2050 below current demand, when global GDP will more than double over the same period.[14] One caveat is that multiple forecasters' "High" scenario is also their base case, and the various 1.5 °C projections are largely to indicate the degree of travel necessary to achieve more aspirational change. Finally, two prominent financial market data providers, Bloomberg and IHS Markit have estimates of 96 mb/d and 86 mb/d respectively for their base case 2050 targets. It's important to note that there are some forecasters that dispute the demand drop entirely, such as data intelligence firm Rapidan and supermajor Exxon (NYSE: XOM). Exxon sees 12% growth in liquids to 2050, rising to roughly 110 mb/d, joining WoodMac on the high side of the current consensus[15]. Contrarian forecasters like Robert McNally at Rapidan are the first to admit that peak oil 2030 and a drop below 2021 demand have become "the new normal" forecast, dubbing the scenario "green decoupling" and highlighting the billions in capital currently allocated to support the shift. Rapidan's contrary call is predicated on the fact that peak oil 2030 is almost entirely contingent on strong fuel efficiency standards being enforced in China and the U.S. with no backsliding (as fleet replacement to electric is a multi-decade process). A proposition he views with extreme skepticism.[16] In addition, the U.S. Energy Information Agency has put forth its own estimates for 2050 oil and gas demand, which it takes pains to note are "not designed to be a prediction of what is most likely to happen", but rather an extrapolation of current trends, whereby the reference scenario and all additional modeled scenarios show aggregate demand higher than today's levels.[17]

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[14] PwC forecast 2.6% per annum global GDP growth to 2050.

[15] This study only included integrated oil forecasts with three forecast scenarios. Exxon has provided a high forecast of 110 mb/d by 2050 and a low forecast of 70 mb/d by 2040: https://www.reuters.com/article/us-exxon-mobil-climate-report-idUSKBN1FM2PP. Total Energy forecasts 45 mb/d by 2050 under its "Rupture" scenario and approximately 85 mb/d under its "Momentum" scenario. Factoring both "high" forecasts into the consensus results in a mean of 95 mb/d:

https://totalenergies.com/sites/g/files/nytnzq121/files/documents/2020-09/total-energy-outlook-presentation-29-september-2020.pdf

[16] https://www.bain.com/insights/the-future-of-oil-webinar/

[17] Indeed, consumption in the IEA's "Reference case" reaches approximately 125 million barrels per day (b/d) by 2050, and consumption is highest in the "High Economic Growth case", where it reaches approximately 151 million b/d of total liquid fuels in 2050

https://www.eia.gov/outlooks/ieo/pdf/IEO2021_Climate.pdf and https://www.eia.gov/outlooks/ieo/pdf/IEO2021_Narrative.pdf

The important point to highlight, regardless of whether investors support the consensus[18] or the minority contrarian scenario, is that the industry needs to prepare to be robust to the consensus outcome. Currently, the vast majority are wholly unprepared for a lower demand outcome. According to this current consensus, oil demand 30 years from now will be lower than current demand.[19]

Figure 5
IEA, WoodMac, Rystad, British Petroleum, Lukoil & Shell Oil & Liquids Demand 2050 Scenario Analysis

Forecast	2050 High C	2050 Mid C	2050 Low C	Measure	Oil/Liquids
IEA	104	77	24	mb/d	Oil
WoodMac	110	35	30	mb/d	Oil
Rystad	76	51	38	mb/d	Oil
BP	95	55	30	mb/d	Liquids
Lukoil	99	74	45	mb/d	Liquids
Shell	86	94	72	mb/d	Oil

Range	*110-76*	*94-35*	*72-24*
Mean	*95*	*64*	*40*
Mean ex outlier	*98*	*64*	*36*
Bloomberg	*96*		
IHS Markit	*86*		

Source: WKA Analysis

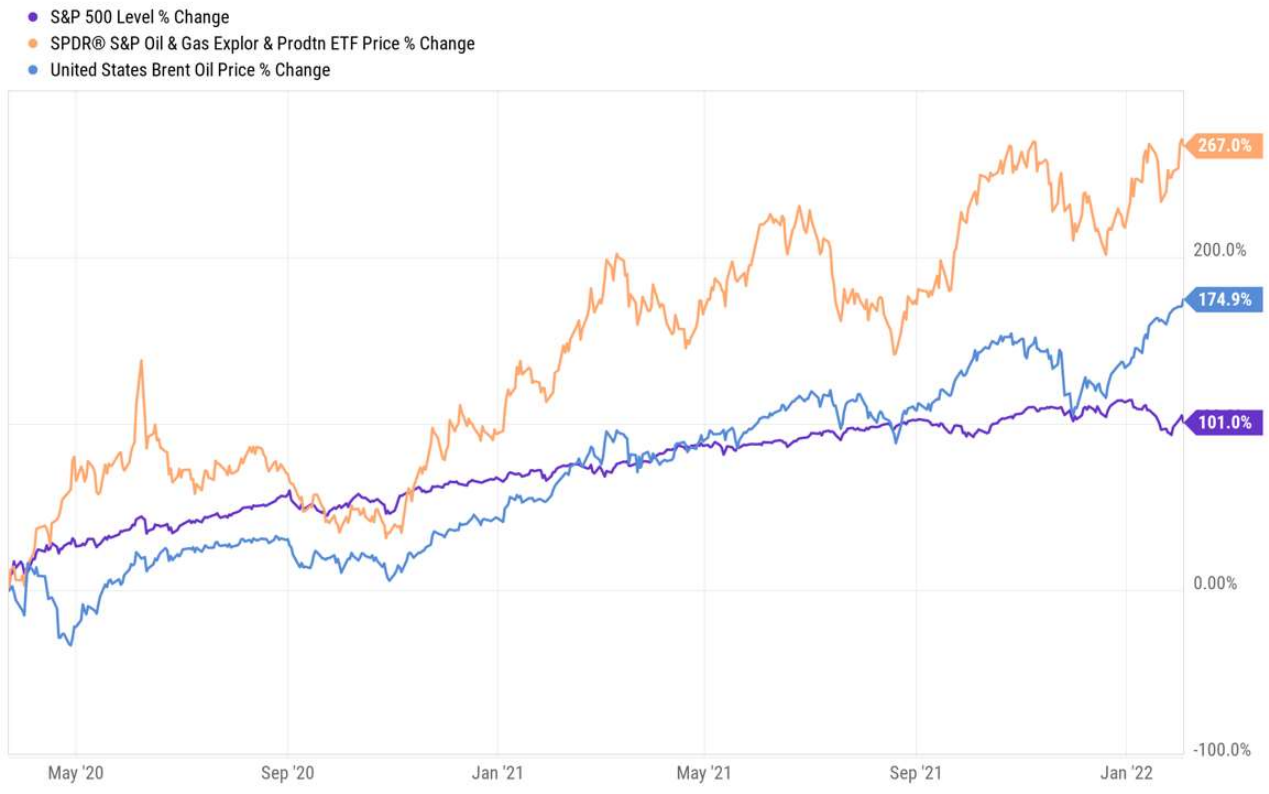
However, expectations for a strong energy transition over the next three decades has not cooled a blazing hot runup for oil and gas securities since the pandemic low. Exploration and production companies, given that their valuation is almost solely based on reserves, without mid and downstream operations,

[18] Many industry insiders see no Paris-aligned pathway poss ble without industrial level carbon capture and storage, hydrogen replacement for petrochemical feedstock and rigorous CAFÉ standards.

[19] This forecast is quite divorced from oil prices, for which there can be both bullish and bearish cases under the aggregate demand scenario.

highlight this point well. Figure 6 shows the performance of the SPDR S&P Oil & Gas Exploration & Production ETF (NYSE: XOP), with holdings of 61 U.S. E&P companies, against the performance of Brent crude and the S&P 500. As can be seen, XOP has gained 267% as Brent has climbed 175% and the overall S&P has gained 101%.[20]

Figure 6
S&P, XOP & Brent Gains Since the March 23rd Pandemic Bottom



Source: YCharts

The reasons for this extraordinary runup, against the backdrop of a potential fundamental shift in the long-long-term dynamics of the industry, are numerous:

[20] XOP also contains several integrated oil companies, refiners and biofuel firms. Please also see footnote 28.

- During the pandemic, economic activity hit a wall worldwide. This resulted in a massive oil demand drop and considerable oversupply, with some of the industry trading at multi-decade lows. Both the demand and supply factors have clearly reversed as economies have reopened. It's estimated that the demand resurgence led to a significant drawdown in oil inventories and an estimated 2 mb/d undersupply over the course of 2021.[21] In addition, potential demand destruction from higher prices has been less than comparable periods in history, implying higher current demand inelasticity and a greater probability of sustained high prices.[22]

- The price of oil is expected to continue to climb in the near term as spare capacity, defined by the IEA as production that can be launched within 90 days and sustained over an extended period, continues to get squeezed. As most spare capacity is in the Gulf, with Saudi Arabia and the UAE accounting for the majority of the estimated 2.5 mb/d, this is very little cushion given geopolitical tensions and an estimated increase in demand of 4.2 mb/d expected in 2022.

- The industry has experienced a long period of underinvestment (since 2015). It takes many years to get most projects onstream and any sustained period of underinvestment leads to supply mismatches over a multi-year horizon should demand conditions shift (as they have). JPM has observed for the last two years that despite developed world downshifts[23], large developing economies like China and India should power a 1-2% annual increase in oil demand to 2030 (despite oil intensity declining faster in non-OECD). Underinvestment over the last five years as

[21] Martijn Rats, Global Commodity Strategist, Morgan Stanley, "Triple Deficit"

[22] Amrita Sen, Energy Aspects, Bloomberg Surveillance, Tuesday February 22, 2022

[23] Roughly 2/3rd of global demand has already peaked and declined, with the 1/3rd remaining driving growth.

companies shifted capital allocation strategies has redounded to the current moment and will likely persist in the short to medium term.[24]

The history of the industry is rife with boom-bust periods and the ebbing power of OPEC+ to stabilize the business will likely lead to continued volatility.[25] This coupled with profound shifts in future energy infrastructure equals tremendous uncertainty for the segment. With a 175% rise in the price of oil from the recent low the rising tide of oil demand has lifted many boats. However, with any appreciable price gain comes a commensurate rise in implied performance expectations. In the next section we try to unpack the expectations embedded in current E&P company prices.

Part 2: Great Expectations:

In theory, valuing an oil and gas Exploration & Production (E&P) company is a straightforward affair, but often devilishly difficult in practice. Since an E&P's raison d'être is to bring crude oil and natural gas out of the ground, a mainstay of valuation is ascribing some value to the hydrocarbon reserves that it accumulates. In contrast with net asset value assessments (NAV), a traditional discounted cash flow valuation (DCF) makes less sense. In a traditional DCF, a firm earns discrete cash flows for a designated period, hopefully in excess of the cost of capital, and then is ascribed some enduring value through a perpetuity. The possibility of enduring value only exists if reserves can be replaced economically for the entirety of an E&P's future as a going concern. It's difficult to say with confidence that any E&P company can grow in perpetuity between 1-3% and certainly not in consideration of the "green decoupling" consensus described in the opening section of this report.

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[24] JPM March 2020 initial Oil Supercycle thesis to current November 29, 2021, Global Energy: Supercycle IV OPEC+ 'Show me the Barrels'; $150/bbl on the horizon as capacity shocks; LT Brent raised to $80/bb, Christyan F Malek et al

[25] McNally, Robert*, Crude Volatility*, Columbia University Press 2017

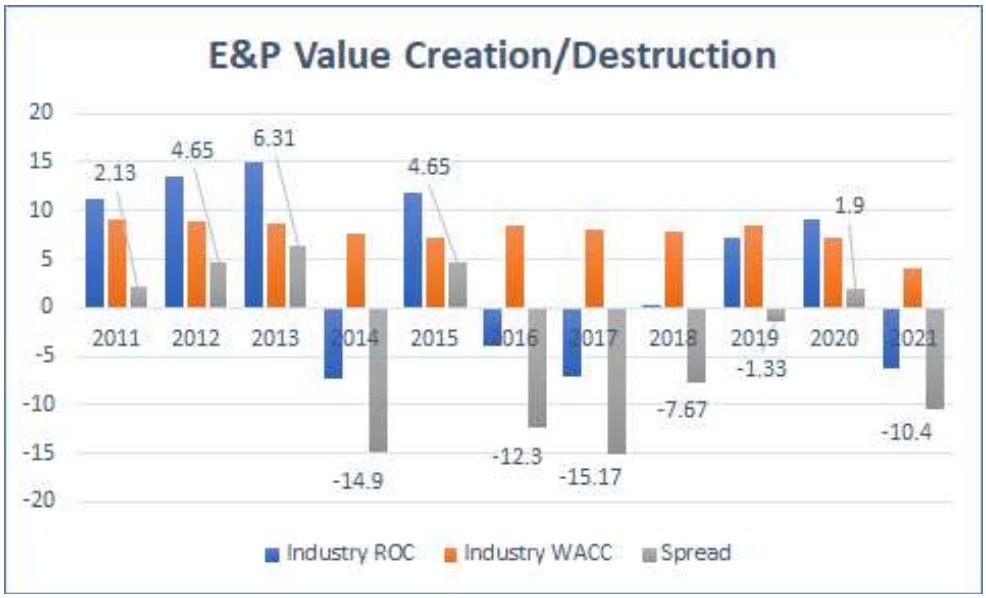
Historically, the E&P industry has struggled to generate returns on capital above the cost of capital for extended periods of time, as exemplified by performance over the last decade, shown in Figure 7 below. As can be seen, roughly half the time, investors were not adequately compensated for the risk of holding E&P companies (negative spread but positive ROC), or simply experienced pure value destruction (negative ROC).

Important to note however, these returns came after an extraordinary decade of both positive returns and spreads for the overall industry. The fundamental nature of the business model, massive capital investments and long horizons for the realization of cash flows pose operating challenges that necessitate extreme capital discipline. A comprehensive study of the cash economics of the E&P business, utilizing cash flow return on investment (CFROI), a metric that approximates the cumulative IRR of all a company's projects, concluded that the average E&P company returned 3% per annum since 1955[26], which reflects the challenging economics of the industry.

Largely for this reason, the industry's preferred metric for evaluating performance is return on capital employed (ROCE). A measure that does not consider taxes, thus boosting the numerator in the equation (EBIT versus NOPAT), and utilizes "capital employed" in the denominator, where the calculation is total assets minus all current liabilities, versus total assets minus "excess" cash minus non-interest-bearing current liabilities for the "invested capital" calculation. In general, more capital-intensive businesses favor the ROCE metric because it boosts reported returns (as can be seen in Figure 8).

[26] Kevin Holt, CIO, Invesco, "The Math on E&P Stocks Doesn't Add Up" 2017

Figure 7
Oil Production Value Creation/Destruction



Source: Damodaran[27], WKA Analysis

Due to the factors described earlier in this report, 2022 is shaping up to be a banner year for E&P equity securities. The rise from the pandemic low has already been significant and the short to medium term outlook is promising, as oil prices continue to rise (amplified by geopolitical tensions).

Despite the limitations of a DCF in valuing E&P companies, utilizing a reverse discounted cash flow model with no effective perpetuity value (ultralong time horizon) can be instructive in evaluating the expectations impounded in current prices[28].

[27] Data courtesy of Damodaran at http://people.stern.nyu.edu/adamodar/New_Home_Page/dataarchived.html#returns

[28] See for details on GAP https://www.newconstructs.com/how-new-constructs-discounted-cash-flow-model-works/
See also for algo substantiation: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3467814

Figure 8
(ARCX: XOP) E&P Company Price Implied Expectations Analysis (2/20/2022)

Ticker	Name	Value (000,000)	ROIC	ROCE	WACC	ROCE Spread	ROIC Spread	FCF Yield	GAP	Implied Rev CAGR	3 Yr Rev CAGR (A)	5 Yr Rev CAGR (A)	Avg. Implied ROIC spread	3 Yr ROIC Spread (A)	5 Yr ROIC Spread (A)
CPE	Callon Petroleum	$ 2,901	11.1%	11.3%	8.2%	3.2%	3.0%	22.6%	1 <	_	32.6%	50.6%	_	0.0%	-1.6%
LPI	Laredo Petroleum Inc	$ 1,175	7.7%	29.2%	8.0%	21.2%	-0.3%	3.6%	1 <	_	-21.7%	3.2%	_	-1.7%	-2.4%
TALO	Talos Energy Inc.	$ 996	7.2%	18.0%	7.0%	11.0%	0.2%	27.3%	50 >	3.7%	-18.8%	_	5.7%	-0.4%	-0.4%
CDEV	Centennial Resource	$ 2,179	5.0%	7.0%	6.1%	0.9%	-1.0%	12.9%	50 >	3.9%	-2.0%	55.7%	-0.1%	-2.0%	-1.7%
MRO	Marathon Oil Corp	$ 15,982	4.6%	12.6%	6.3%	6.3%	-1.7%	11.0%	50 >	3.0%	5.2%	6.4%	3.4%	-4.2%	-4.8%
MTDR	Matador Resources Co	$ 5,244	10.1%	19.3%	8.7%	10.6%	1.4%	6.2%	50 >	3.7%	-3.6%	26.5%	34.4%	-0.3%	-1.7%
EOG	EOG Resources, Inc.	$ 65,308	8.4%	19.4%	6.3%	13.1%	2.1%	4.5%	52	3.9%	-19.5%	10.4%	9.7%	0.3%	-0.9%
CTRA	Coterra Energy Inc.	$ 18,379	7.0%	13.2%	5.0%	8.2%	2.0%	1.6%	1 <	_	-18.1%	6.1%	_	4.1%	2.8%
FANG	Diamondback Energy Inc.	$ 23,819	9.6%	13.4%	7.0%	6.4%	2.6%	-3.1%	67	4.1%	13.7%	52.0%	7.1%	-0.4%	-0.3%
CLR	Continental Resources	$ 19,224	12.4%	19.7%	6.4%	13.3%	6.0%	-4.8%	92	3.2%	11.1%	16.4%	27.3%	-0.9%	-1.6%
SWN	Southwestern Energy	$ 4,730	9.4%	16.7%	4.4%	12.3%	5.0%	-13.2%	1 <	_	-22.7%	-1.3%	_	0.6%	0.4%
OVV	Ovintiv Inc.	$ 10,574	0.6%	16.4%	7.5%	8.9%	-6.9%	13.9%	50 >	3.2%	1.2%	19.8%	8.7%	-3.3%	-4.2%
MUR	Murphy Oil Corp	$ 5,062	0.4%	9.1%	7.2%	1.9%	-6.8%	12.3%	50 >	3.2%	-12.4%	1.9%	0.4%	-4.1%	-4.6%
AR	Antero Resources Corp	$ 6,823	1.7%	11.7%	7.7%	4.1%	-6.0%	8.7%	50 >	3.3%	2.4%	6.0%	4.9%	-3.6%	-2.7%
XOM	Exxon Mobil Corp	$327,509	-0.1%	15.3%	5.7%	9.6%	-5.8%	8.5%	50 >	3.3%	-19.8%	-4.8%	-0.4%	-2.9%	-2.5%
OXY	Occidental Petroleum	$ 36,948	2.4%	7.6%	6.5%	1.1%	-4.1%	8.1%	50 >	3.2%	0.0%	15.3%	5.0%	-3.4%	-4.0%
HES	Hess Corporation	$ 29,074	3.3%	14.0%	6.9%	7.1%	-3.5%	7.5%	50 >	3.4%	-14.1%	-0.5%	3.7%	-4.5%	-6.0%
APA	Apache Corporation	$ 11,683	2.8%	22.7%	8.0%	14.7%	-5.3%	6.8%	50 >	3.4%	-22.1%	-4.2%	0.2%	-4.2%	-5.0%
RRC	Range Resources Corp	$ 5,308	-0.9%	17.4%	5.2%	12.2%	-6.1%	5.3%	50 >	3.4%	-22.6%	15.7%	3.5%	-3.4%	-3.4%
CNX	CNX Resources Corp	$ 3,209	-3.9%	8.9%	3.8%	5.1%	-7.7%	2.7%	1 <	_	24.3%	17.6%	_	-3.0%	-2.3%
CVX	Chevron Corporation	$257,192	4.3%	14.2%	6.1%	8.1%	-1.8%	-0.2%	50 >	3.3%	-22.9%	-3.8%	6.6%	-4.5%	-4.0%
KOS	Kosmos Energy Ltd	$ 1,934	2.8%	7.7%	9.8%	-2.1%	-7.1%	-2.5%	50 >	3.6%	-4.8%	26.9%	11.5%	-4.2%	-6.3%
COP	ConocoPhillips	$118,217	4.6%	21.9%	5.9%	16.1%	-1.3%	-6.7%	50 >	3.9%	-28.2%	-5.6%	12.3%	-2.7%	-3.2%
NOG	Northern Oil & Gas, Inc.	$ 1,585	-4.5%	30.2%	6.4%	23.8%	-10.9%	-7.7%	1 <	_	-9.8%	39.7%	_	0.4%	-0.6%
EQT	EQT Corporation	$ 8,393	-3.4%	6.6%	3.9%	2.6%	-7.3%	-13.5%	50 >	3.1%	-16.7%	-2.4%	0.4%	-4.6%	-3.2%
DVN	Devon Energy Corp	$ 36,385	4.8%	26.2%	6.7%	19.5%	-1.9%	-15.3%	50 >	3.2%	40.1%	-3.3%	7.2%	-4.9%	-5.2%
PXD	Pioneer Natural Resources	$ 56,976	10.4%	20.7%	5.9%	14.9%	4.5%	-20.2%	50 >	4.0%	-13.5%	15.5%	40.4%	-1.1%	-2.2%
TELL	Tellurian Inc	$ 1,164	-14.7%	-14.1%	8.1%	-22.2%	-22.8%	-21.2%	50 >	6.6%	90.8%	_	5.7%	-31.7%	-34.8%
PDCE	PDC Energy	$ 5,408	1.5%	24.8%	7.8%	17.0%	-6.3%	8.9%	50 >	3.6%	-7.0%	36.8%	21.2%	-2.9%	-5.1%
SM	SM Energy Company	$ 4,160	-4.5%	8.4%	8.4%	0.0%	-12.9%	6.7%	50 >	6.9%	-17.1%	-1.2%	23.8%	-5.5%	-6.6%

Source: New Constructs, FactSet, WKA Analysis

As can be seen from Figure 8, current market prices for the constituents[29] of the XOP (S&P Oil & Gas Exploration & Production) are impounding many years of returns above the cost of capital. In fact, 80% of the index is implying greater than 50 years of value creating returns (ROIC above WACC)! To say the

[29] We deleted numerous names from XOP to get a pure play index of upstream oil and gas E&P companies. Eliminated business models included refining, biofuel, fracking, enhanced oil recovery, ethanol, marketing and transportation, LNG import facility construction, landowners, mineral rights acquirers and clean energy fuels, resulting in the exclusions of the following: REGI, MNRL, ALTO, REX, PBF, VLO, CVR, CLNE, INT, TPL, MPC, DK, PSX, HFC, GEVO, GPRE, NFE, OAS, DEN, PARR, MCF, WLL, MGY. In addition, we removed 3 firms where we had no "GAP" data.

least, the current expectations of more than 50 years of never-before-seen returns does not exactly square with the situation the industry currently faces. In sum, these frothy valuations are not only at odds with individual company return history (as seen in the rightmost column labeled "5 Year ROIC spread Actual") as well as the historical industry returns outlined earlier, but the current valuations also defy the consensus that an energy transition could ultimately bring oil and gas demand below current levels by 2050. See Appendix 1 for a complete discussion of GAP and reverse cash flow modelling.

Despite this, for more senior observers of multiple oil and gas industry cycles, these arguably euphoric valuations are consistent with the historical boom-bust nature of the segment (where valuation extremes are not uncommon). Perhaps more importantly, current valuations imply a business-as-usual outlook amongst investors currently bidding up the names, without regard for the expected energy transition (i.e., nothing has really changed in how investors value these companies). For the reasons outlined previously (inventories, spare capacity and capital expenditures), this approach has been vindicated as a rational investment decision, at least in the short term.

Some studies indicate that investors with longer expected holding periods are uncomfortable with the regulatory uncertainty and volatility around future demand and are simply opting out of investing in E&P companies altogether (over 800 firms representing $6 trillion in AUM have pursued an exclusionary approach to oil, gas and coal), leaving the remaining investors to price securities in line with historical norms[30]. This is a troubling situation for investors that want exposure to hydrocarbon names – especially

[30] See: https://2degrees-investing.org/wp-content/uploads/2019/11/MASTER_Fossil_Fuel_Ownership_Nov_2018.pdf

See: https://www.oxfordenergy.org/wpcms/wp-content/uploads/2019/01/Energy-Transition-Uncertainty-and-the-Implications-of-Change-in-the-Risk-Preferences-of-Fossil-Fuel-Investors-Insight-45.pdf

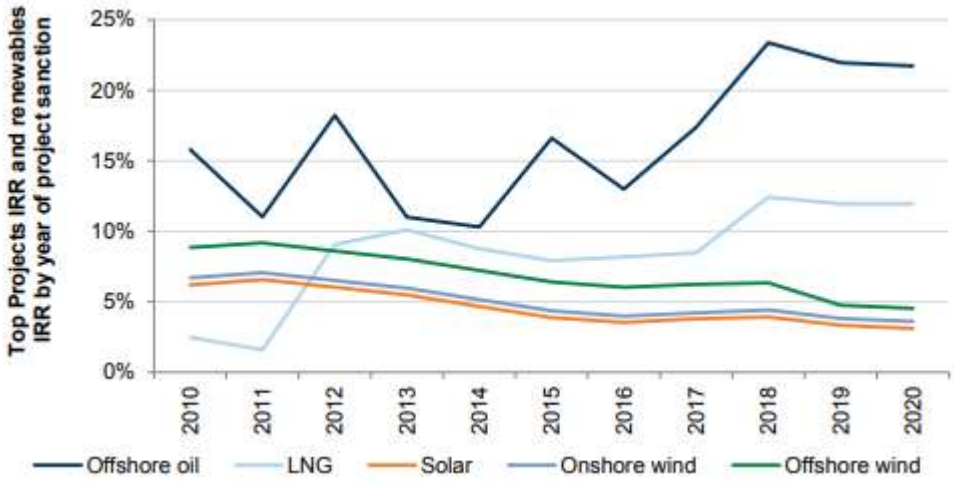
to firms actively navigating the expected transition -- but find an assessment of the associated risks challenging.

At root, absent enormous advances in technology, the industry is facing an emissions problem, as consensus future demand scenarios envision a steep reduction in output due to the climate implications. The final section of this report will introduce a metric to help investors more finely tune the risks associated with the energy transition for the oil and gas E&P segment.

Part 3: Material Risks

While public market equity investors may be proceeding in a business-as-usual fashion, E&P companies are experiencing clear financing stress related to the energy transition. Goldman Sachs estimates that the spread in the cost of capital of hydrocarbon versus renewable developments has widened by greater than ten percentage points over the last five years (Figure 9).

Figure 9
Project IRR for oil and gas and renewable projects by year of project sanction



Source: Goldman Sachs

When project IRRs, required returns on long duration, high-cost projects, increase significantly due to uncertainty around demand and the regulatory environment, fewer projects get funded, exploration budgets get cut and write-offs increase. This is validated by the expected 40% decline in the reinvestment ratio for all Oil & Gas in 2022 (based on current trends versus a 10-year average) and highlights an industry beset with poor regulatory clarity and lack of global coordination, in contrast with the electric utility industry, which has seen positive reinvestment ratios due to price support and more clear regulation[31]. A truism in the industry is that high oil prices are the best cure for high oil prices, as additional capacity ramps and the pendulum swings to oversupply. Over the last decade however, the number of climate-related shareholder resolutions has almost doubled and the percentage of investors voting in favor has almost tripled, to roughly 40%, with a targeted focus on energy producers rather than on final energy consumption. The prospect of continued shareholder pressure and sustained high financing costs may significantly delay what was in years past an almost certain setup for a price crash. This volatile backdrop shows no sign of abating, as few doubt the fact that a meaningful energy transition is on the horizon. Absent a global carbon tax regime or coordinated country-level emissions reductions, investors should gird for continued instability.

This issue is particularly challenging for E&P companies, as undeveloped properties are major drivers of firm value. As can be seen in Figure 10, the probability of development for various categories of oil and gas reserves are not the same. As a firm moves down the chain of various commercial categories, the probability of development decreases. A reserve is only considered proven if it's probable that a minimum of 90% is recoverable and economically profitable, with proved reserves divided into developed and undeveloped.

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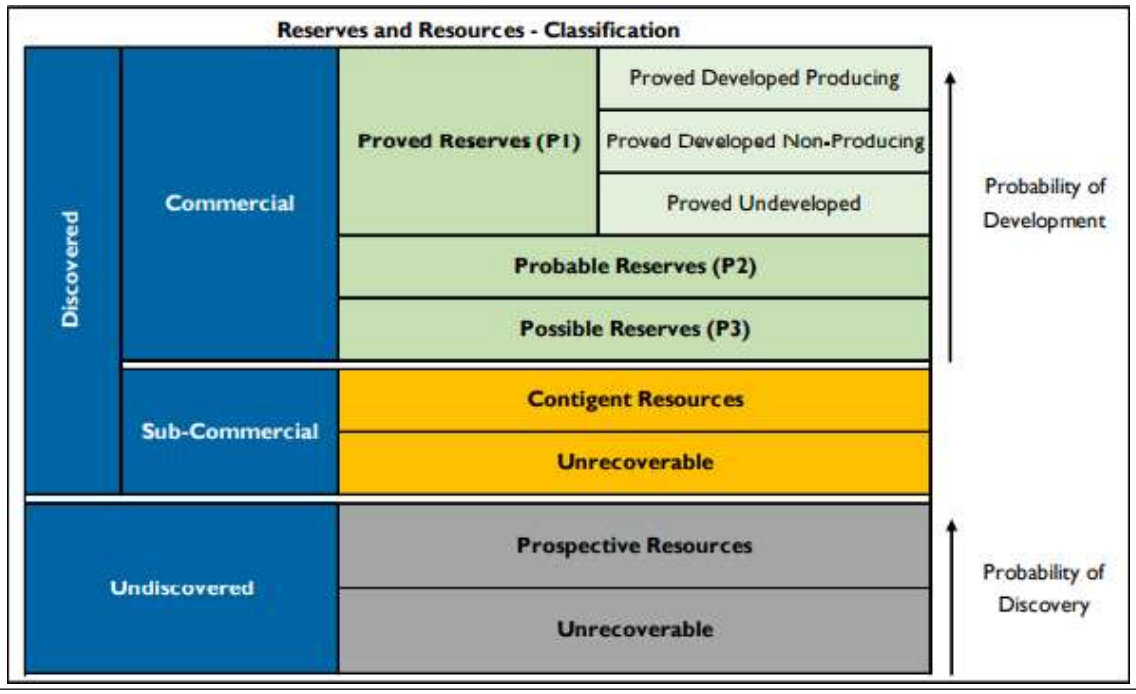
[31] https://www.goldmansachs.com/insights/pages/gs-research/dual-action-of-capital-markets-transforms-net-zero-cost-curve/the-dual-action-of-capital-markets-transforms-the-net-zero-cost-curve.pdf

Figure 10
Reserve Categories Versus Probability of Development



Source: Valuescope

On a NAV basis, E&P companies typically trade well above the discounted value of their proved developed reserves, with the balance of the market value representing implied optionality on proved undeveloped properties (PUD), and possibly more distant P2, P3 according to some studies[32]. Since PUDs require future capital investments, they're keenly sensitive to economic conditions. In a recent paper[33], the National Bureau of Economic Research examined the relationship between firm value and proved reserves for 600 oil and gas firms in North America from 1999-2018 and found that proved undeveloped reserves growth and firm value were significantly negatively correlated (see Figure 10).

[32] https://www.tandfonline.com/doi/pdf/10.1080/23322039.2017.1385443

[33] https://www.nber.org/system/files/working_papers/w26497/revisions/w26497.rev0.pdf

Figure 10
Oil Reserves & Firm Value

	(1)	(2)	(3)	(4)	(5)	(6)
Total reserves	0.0260**		0.0263*			
	(0.024)		(0.073)			
Growth total reserves		-0.0000420**	-0.0000411**			
		(0.021)	(0.024)			
Developed reserves				0.835*		1.595***
				(0.065)		(0.004)
Undeveloped reserves				-0.112		-0.234**
				(0.136)		(0.011)
Growth developed reserves					0.00346	0.00502**
					(0.136)	(0.039)
Growth undeveloped reserves					-0.000850***	-0.000928***
					(0.001)	(0.000)

Source: National Bureau of Economic Research

As can be seen from the data, the highlighted coefficient and p-value for the level of undeveloped reserves *growth* against firm value (Tobin's Q) is significant and economically impactful (column 6 highlighted), as a single standard deviation increase in growth of PUDs decreases firm value by 2.6% of the mean. To the left in Column 4, which represents the relation between firm value and the absolute level of reserves, rather than the growth of reserves, there is a high positive correlation with developed reserves and a negative correlation with undeveloped reserves, but both, arguably, are insignificant as the p-value (in parenthesis 0.136 and 0.065) are above the indicated 1% test level[34].

Given that reserves reporting is typically sub-categorized into oil, natural gas and natural gas liquids segments (NGL), a finer grained analysis of the relation between the emissions potential of these reserves

[34] The p-values in parentheses are based on clustered standard errors across firms. A single asterisk indicates significance at the 10% level, two asterisks the 5% level and three asterisks the 1% level.

and firm value can aid in securities analysis.[35] For the 30 E&P firms in this report, undeveloped proved reserves averaged 40% of total reserves on an annual basis over the last decade. While the growth of aggregate undeveloped reserves is important to valuation, the emissions potential and financing implications of the change in reserves mix needs to be disaggregated (as highlighted by LNG's lower project IRR in Figure 9). Figure 11 below shows the relationship between the change in emissions potential of undeveloped proved reserves and Enterprise Value for the thirty E&P companies in Figure 8 over the last five years. We plotted the change in undeveloped proved reserves over a given year, calculated the emissions potential of that change in reserves according to the hydrocarbon mix, and then performed a regression against Enterprise Value (firm value as dependent variable).

[35] XOM and others provide additional information on "bitumen" and "synthetics" as separate categories of reserves.

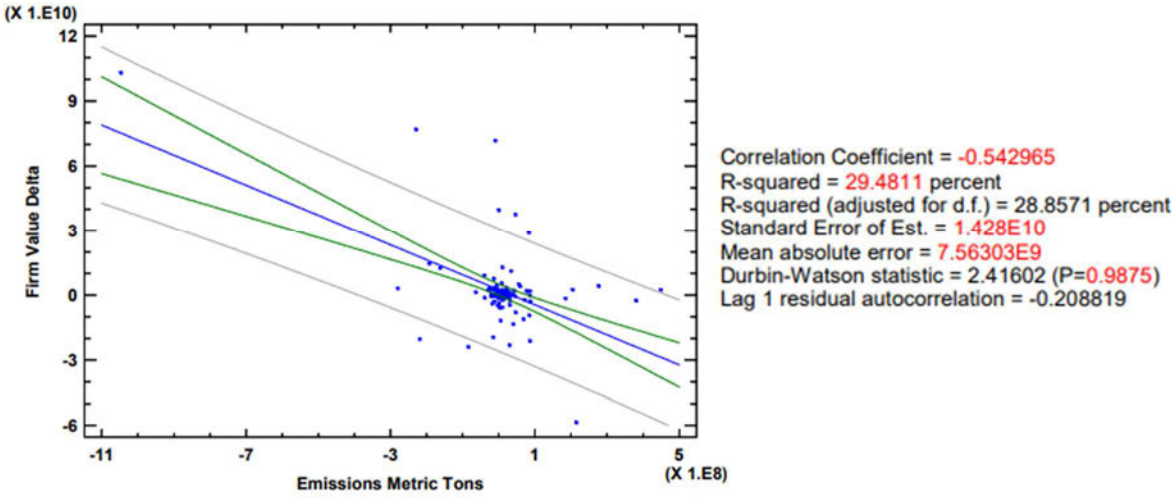
Figure 11
Growth in Emissions Potential of Undeveloped Reserves & Firm Value

Coefficients

Parameter	Least Squares Estimate	Standard Error	T Statistic	P-Value
Intercept	2.47354E9	1.33408E9	1.85412	0.0663
Slope	-69.4842	10.1094	-6.8732	0.0000

Analysis of Variance

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
Model	9.63326E21	1	9.63326E21	47.24	0.0000
Residual	2.30427E22	113	2.03918E20		
Total (Corr.)	3.2676E22	114			



Source: WK Analysis, FactSet, Statgraphics

As can be seen, an even greater negative correlation exists (-0.54 coefficient, versus -0.23) between CO_2 emissions and firm value. Again, it's important to note that the growth in undeveloped proved reserves alone is impactful, but that growth does not *necessarily* give rise to a linear increase in emissions. The exact quantity of rise or fall in metric tons of CO_2 depends on the mix of proved undeveloped hydrocarbons that rise or fall (i.e., oil, natural gas and NGL). We utilized emissions factors formulated by the

Intergovernmental Panel on Climate Change[36] for each type of hydrocarbon, a standard adopted around the world by governments and companies alike (including the U.S. Department of Energy and Exxon Mobil). Please see Appendix 2 for more information regarding the IPCC factors.

In order to understand the impact of potential emissions from PUDs on equity performance we compared an equal-weighted portfolio of E&P company returns, utilizing the 30 companies outlined in this report, from 2017-2021. In the first scenario, we simply held all 30 companies for the entire period. As can be seen in Figure 12, this generated a 158% return. We then rebalanced the portfolio each year and removed the top quintile emitters (i.e., largest increase in potential emissions from undeveloped proved reserves), replacing them with the bottom quintile performers, which mostly consisted of firms that reduced emissions.

Figure 12
Emissions-Based Portfolio Rebalancing

		Year 5	Year 4	Year 3	Year 2	Year 1	Return
30 Hold		**66.4%**	**5.4%**	**-16.2%**	**9.1%**	**61.0%**	
Portfolio Return	*Equal Weight*	166.37	175.41	146.99	160.34	258.21	**158%**
Rebalance Undeveloped		**66.4%**	**17.1%**	**-14.9%**	**-2.3%**	**84.0%**	
Portfolio Return	*Equal Weight*	166.37	194.80	165.70	161.97	298.03	**198%**
Rebalance Emissions		**66.4%**	**17.1%**	**-14.9%**	**-0.1%**	**85.9%**	
Portfolio Return	*Equal Weight*	166.37	194.80	165.70	165.61	307.86	**208%**

Source: WK Analysis

As can be seen, the portfolio return jumped dramatically to 208%, a move of 5000 basis points, or 32% improvement over the hold portfolio! An important observation from these data is that the growth or

[36] https://www.ipcc-nggip.iges.or.jp/EFDB/main.php

decline in PUDs and emissions, though highly correlated, sometimes diverged due to the relative mix of hydrocarbons. Here are some examples:

- **Talos Energy** (NYSE: TALO) a Gulf coast offshore E&P had a significant 334% rise in undeveloped proved reserves in Year 4 and potential emissions jumped an even greater 370% due to the oil content of those reserves, while Centennial Resource Development (Nasdaq: CDEV), a Permian operator, increased its PUDs in Year 2 by 6% while potential emissions only jumped 4% due to the focus on natural gas.

- **Murphy Oil** (NYSE: MUR), a U.S. operator with undeveloped reserves in Australia, Brazil, Brunei, Mexico and Vietnam decreased its PUDs in Year 2 by 14% but witnessed an emission decrease of 21% due to the write off of oil-rich properties. In contrast, in the same year, Marathon Oil (NYSE: MRO) cut undeveloped proved by 8% but only saw a 6% reduction in emissions potential due to the removal of less dense hydrocarbons from its portfolio.

- Global independent E&P **Hess** (NYSE: HES) managed to cut its potential emissions from undeveloped proved reserves in half over the last decade, while simultaneously ramping up its total PUDs from 19% to 30% over the same period (undeveloped proved/total proved). The firm accomplished this feat by de-emphasizing oil and boosting natural gas and NGL reserves.

Differences like these can result in small changes to the portfolio rebalancing, whereby the incremental return from the more fine-grained focus on emissions potential, rather than just undeveloped proved reserves, can allow investors to potentially earn incremental return (1000 basis points in our rebalancing, see Figure 12). With a relatively small pool of companies (30) the benefits to the rebalancing become more evident in the out years as removal of the largest emitters have a more pronounced effect. The

differences between the remaining companies narrow and the sorting more fully captures the differences outlined above (as seen in the Year 1 & 2 returns of the rebalancing).

Conclusion:

Interestingly, over the last decade, virtually all the E&P companies seem to realize the potential negative effects of growing undeveloped proved reserves in the current environment, as only 3 companies saw a rise in the proportion of these reserves to total proved resources over the period -- and 2 of the 3 started from a base of zero (i.e., they started with no undeveloped proved reserves). The sole company to grow its proved undeveloped as a percentage of total proved over the period was Exxon Mobil (NYSE: XOM), and only by a small amount, from 27% to 33%. Notably, the company also reduced its potential emissions from these reserves 43% by halving oil and gas volumes and boosting NGLs.

In addition to the potential portfolio implications outlined, there are individual security analysis benefits to utilizing a metric that tracks the potential emissions associated with undeveloped proved reserves, including the following:

- **Carbon Scoring** – As discussed earlier in this report, many hydrocarbon demand scenarios are now linked to emissions levels, where maximum allowable amounts are established in order to meet global warming targets. The implicit assumption is that countries, financiers and governments will increasingly adopt varying degrees of regulatory pressure and incentives to "enforce" these targets. Increasingly, investment services and portfolio software providers are scoring an individual company's alignment with temperature benchmarks, sometimes referred to as "carbon scoring" where the analysis contrasts the company's stated targets against a benchmark. Carbon scoring then highlight how much reduction is still required of the company,

or if the firm is exceeding targets. Those that exceed targets are typically awarded higher scores. As an example, Bloomberg's carbon scoring method has seen higher scores correlate with company outperformance.[37] Calculating the emissions potential of undeveloped proved reserves would allow analysts to quantify a PUD threshold, or a level of undeveloped reserves that might affect the firm's ability to meet or exceed its stated emissions goals. Putting this number in sharp relief would help investors understand the challenges and risks.

- **Precision** -- Increasingly analysts incorporating higher discount rates as a "blunt force" margin of safety when valuing some oil and gas investments. A few investors we spoke with are utilizing an additional 200-500 basis points on top of the calculated rate for more extreme physical and transition risks. In some circles, for upstream producers, industry standard oil and gas PV10 is now closer to PV15. This creates a significantly higher hurdle for the standard EV/PV10 heuristic in evaluating investment opportunities. Understanding the trajectory of the emissions potential of PUDs for an individual security can allow analysts to accept their calculated rate without a blunt instrument margin of safety, but with a valuation adjustment to reflect the idiosyncratic risk of either growing or declining emissions potential of undeveloped proved assets for the valuation target.

- **Corporate Strategy** – Clearly delineating emissions targets and the potential inherent in a firm's undeveloped proved reserves can help a company understand where it fits in a country, regional, or global strategy. Having quantifiable metrics allows companies to manage what they measure, helping to explore the way in which carbon offsets or operational emissions reductions can

[37] https://www.bloombergquint.com/markets/big-oil-learns-carbon-scores-matter-to-investors-green-insight

> balance against future expected emissions. If these potential emissions can be aggregated at a market level, it will improve market efficiency with respect to the overall trajectory of emissions in coming years, as well as the context of an individual company's efforts within that overall path.

Numerous institutional investor surveys over the last year have indicated that investors understand the potential materiality of climate change in the valuation of companies. In the Robeco 2021 Global Climate Survey of the 300 largest institutional investors, with a total of $23.4 trillion in assets under management, 71% of respondents asserted that climate change was either a "significant factor" or "at the center" of investment policy (47% and 26% respectively).[38] In addition, in the Greenwich 2021 survey of 101 investors with greater than $3B in assets, it was reported that 58% of respondents actively incorporated climate change considerations into their investment process, with approximately 75% doing so because the practice "improves risk-adjusted returns".[39]

Despite majorities in both surveys acknowledging the importance of climate risk, a significant number cited the need for more reliable data, models and disclosures to effectively evaluate the risks. The lack of perceived in-house expertise was a strong limiting factor (40% of investors in the Greenwich survey), as many investors didn't feel they had the requisite expertise to isolate the elements that impacted firm value. Of the respondents in the Greenwich survey roughly 31% utilized carbon emissions data as a factor in their internal analysis[40], leaving considerable room for more efficient pricing of this factor as adoption increases. As demonstrated in this report, under the right circumstances, investors can use these data to inform their analysis and generate potentially superior returns.

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[38] https://www.robeco.com/docm/docu-202103-robeco-global-climate-survey.pdf

[39] https://cdn.pficdn.com/cms/pgim4/sites/default/files/2021-04/Seeking-Higher-Ground-Institutional-Investors-Respond-Climate-Change.pdf

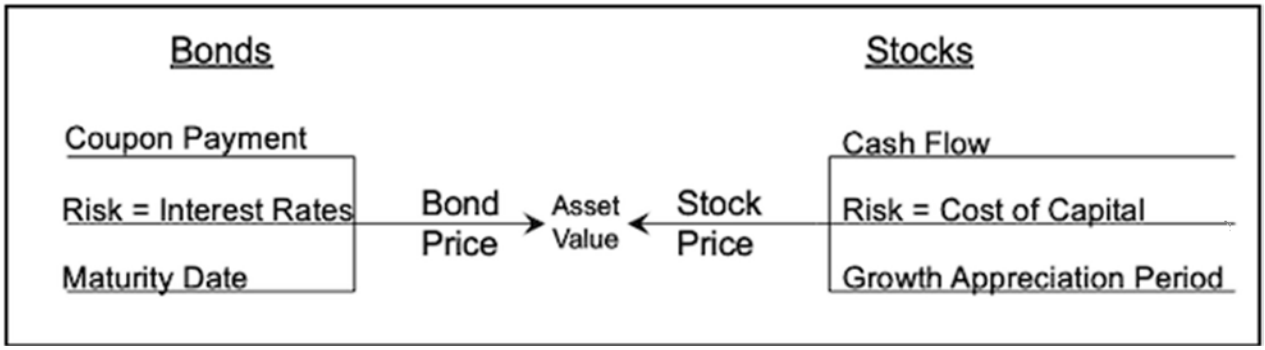
[40] Of the 58% of respondents that actively incorporated climate change considerations, 54% of those utilized carbon emissions data in their internal analysis

Appendix I: Reverse Discounted Cash Flow [Source: New Constructs LLC][41]

Bad DCF models are misleading. We won't argue that, but DCF analysis remains extremely helpful when used to reverse engineer what companies must do to justify their stock price, aka "expectations investing". The right way to use DCF models is not to try to predict the future, but to quantify the future that the stock price is predicting.

Our DCF starts with the principle that stocks can be valued in the same way as bonds. As shown in Figure 1, the drivers of future cash flow between the two types of securities are analogous. The only difference is that the future cash flows for bonds are contractually determined while the future cash flows for stocks are undetermined. However, if one accepts the premise that the value of an asset equals the present value of future cash flows, then it follows that reverse DCF models can quantify the future cash flows required to justify stock prices.

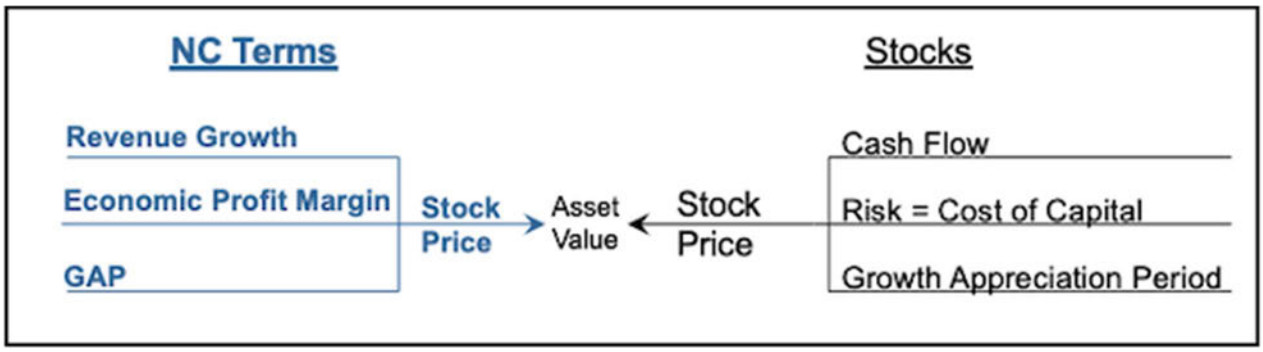
Appendix Figure 1: The Basic Valuation Recipe: Same for Stocks and Bonds



In Figure 2, we categorize the drivers of a stock's implied future cash flows into more intuitive terms.

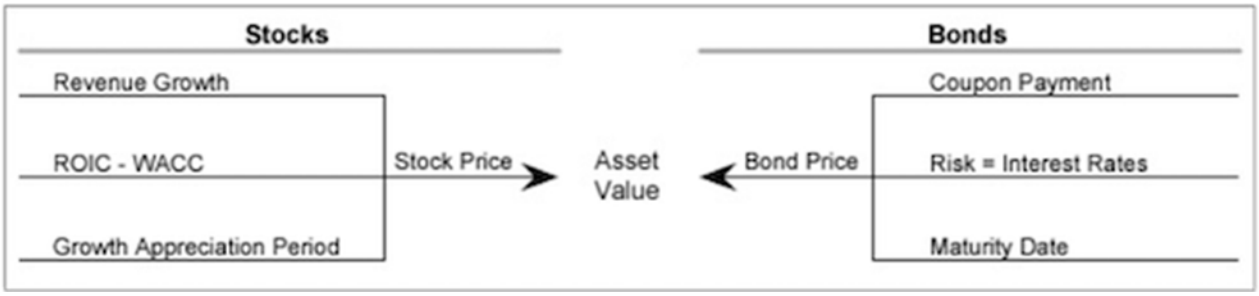
[41] https://www.newconstructs.com/how-new-constructs-discounted-cash-flow-model-works/

Appendix Figure 2: Simpler Terms for Measuring Cash Flows



We think it is easier to think about the future cash flows implied by stocks prices in these terms because they capture the core drivers of business success: Revenue Growth: how fast will the business grow? ROIC – WACC: how profitable with the business be? Growth Appreciation Period (GAP): for how long will the business grow profits? In Figure 3, we match the more intuitive drivers for equity cash flows with the drivers of bonds. With this understanding, we can focus on using our reverse DCF to get the answers to these questions from Mr. Market.

Appendix Figure 3: The New Constructs Valuation Recipe: Same for Stocks and Bonds



Most of the time, we forecast Revenue Growth and ROIC – WACC over a very long forecast horizon, not just five or 10 years (more details below). Then, we solve for the Growth Appreciation Period (GAP) needed for the DCF model to produce a stock price equal to the current stock price. In other words, we

provide forecasts for three of the four variables in the equation and solve for the 4th variable. Our DCF models do not rely on static forecast horizons such as five or ten years as do traditional DCF models. Our models are dynamic, which means we calculate values for the stock based on multiple forecast horizons. The key to this approach is a terminal value in each forecast horizon that assumes zero growth (e.g., NOPAT/WACC not WACC-g) after the forecast horizon. Rather than trying to capture all the future growth in cash flows in a static time frame (e.g., five years), our models calculate the value attributable to shareholders over 100 forecast periods.[42]

[42] See webinar: https://www.youtube.com/watch?v=3T9Pl1W8GcQ

Appendix II: IPCC Emissions Factors Background

The Intergovernmental Panel on Climate Change (IPCC) is a body composed of sovereign nations assembled under United Nations auspices that provides the world with objective, scientific information relevant to understanding the risk of human-induced climate change, as well as its natural, political, and economic impacts and possible response options.

In its Guidelines for National Greenhouse Gas Inventories published in 2006[43], the IPCC included "Default CO_2 Emissions Factors for Combustion" (DEFC, acronym ours, see Appendix Figure 4). The carbon content of different fossil fuels and the reserves from which they originate can vary considerably both among and within primary fuel types on a per mass or per volume basis. However, the IPCC's measurement of effective CO_2 emissions of fuels upon combustion as reflected in the DEFC avoids this complication.

Fossil fuel combustion processes are optimized to derive the maximum amount of energy per unit of fuel consumed, which delivers the maximum amount of CO_2. Efficient fuel combustion ensures oxidation of the maximum amount of carbon available in the fuel. CO_2 emission factors for fuel combustion are therefore relatively insensitive to the combustion process itself and hence are primarily dependent exclusively on the carbon content of the fuel.

For these reasons and due to the global credibility of the IPCC, the U.S. Environmental Protection Agency (U.S. EPA) uses the DEFC in its the basis for the Emission Factors for Greenhouse Gas

[43] https://www.ipcc-nggip.iges.or.jp/public/2006gl/

Inventories[44] used by the U.S. EPA Center for Corporate Climate Leadership, which has in turn been used by ExxonMobil[45] and other companies to calculate their Scope 3 greenhouse gas emissions[46].

In June 2016, the oil industry sustainability group IPIECA published "Estimating petroleum industry value chain (Scope 3) greenhouse gas emissions. Overview of methodologies[47]." The document draws on the WRI and the World Business Council for Sustainable Development (WBCSD) GHG Protocol Scope 3 Standard to outline approaches used by the oil and gas industry to estimate scope 3 emissions. Exxon drew on the IPIECA methodology to report its Scope 3 emissions noted earlier[48]. The document is also available on the website of the American Petroleum Institute (API)[49].

The IPCC effective CO_2 emission factors are also the reference coefficients for ISO Standard 14064[50] on the quantification and reporting of greenhouse gas emissions. These are also the metric used in the Carbon Disclosure Project (CDP) Scope 3 disclosure guidance for oil companies[51].

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[44] https://www.epa.gov/sites/production/files/2020-04/documents/ghg-emission-factors-hub.pdf

[45] ExxonMobil has participated in the Intergovernmental Panel on Climate Change (IPCC) since its inception in 1988. https://corporate.exxonmobil.com/-/media/Global/Files/energy-and-carbon-summary/Energy-and-carbon-summary.pdf

[46] https://corporate.exxonmobil.com/-/media/Global/Files/energy-and-carbon-summary/Energy-and-Carbon-Summary.pdf Page 43

[47] https://www.ipieca.org/resources/good-practice/estimating-petroleum-industry-value-chain-scope-3-greenhouse-gas-emissions-overview-of-methodologies/

[48] https://corporate.exxonmobil.com/Sustainability/Energy-and-Carbon-Summary/Scope-3-emissions

[49] https://www.api.org/~/media/Files/EHS/climate-change/Scope-3-emissions-reporting-guidance-2016.pdf

[50] http://www.iso.org/iso/catalogue_detail?csnumber=38381; WK Associates submitted a June 14, 2021 comment to the SEC endorsing the IPCC effective CO_2 emissions factors as a tool for evaluating the emissions potential of oil

[51] https://b8f65cb373b1b7b15feb-c70d8ead6ced550b4d987d7c03fcdd1d.ssl.cf3.rackcdn.com/cms/guidance_docs/pdfs/000/000/469/original/CDP-Scope-3-Category11-Guidance-Oil-Gas.pdf?1479754082

Appendix Figure 4: IPCC Default CO_2 Emissions Factors for Combustion

Fuel		heating Value	CO_2 emission factors for fuel consumption data that have been supplied on different measurement bases					
			Energy basis	Mass basis	Fuel density information[1] Of liquids (kg/litre fuel)	Of gases (kg/m^3 of fuel)	Liquid basis	Gas basis
		TJ/Gg	kg/TJ	kg/tonne			kg/ litre	kg/m^3
Oil products	Crude oil	42 3	73300	3100 59	0.8		2.480472	
	Orimulsion	27 5	77000	2117.5				
	Natural Gas Liquids	44 2	64200	2837 64				
	Motor gasoline	44 3	69300	3069 99	0.74		2.2717926	
	Aviation gasoline	44 3	70000	3101	0.71		2.20171	
	Jet gasoline	44 3	70000	3101	0.71		2.20171	
	Jet kerosene	44.1	71500	3153.15	0.79		2.4909885	
	Other kerosene	43 8	71900	3149 22	0.8		2.519376	
	Shale oil	38.1	73300	2792.73	1		2.79273	
	Gas/Diesel oil	43	74100	3186.3	0.84		2.676492	
	Residual fuel oil	40.4	77400	3126 96	0.94		2.9393424	
	Liquified Petroleum Gases	47 3	63100	2984 63	0.54		1.6117002	
	Ethane	46.4	61600	2858 24		1.3		3.715712
	Naphtha	44 5	73300	3261 85	0.77		2.5116245	
	Bitumen	40 2	80700	3244.14				
	Lubricants	40 2	73300	2946 66	1		2.94666	
	Petroleum coke	32 5	97500	3168.75				
	Refinery feedstocks	43	73300	3151.9				
	Refinery gas	49 5	57600	2851.2				
	Paraffin waxes	40 2	73300	2946 66				
	White Spirit/SBP	40 2	73300	2946 66				
	Other petroleum products	40 2	73300	2946 66				
Coal products	Anthracite	26.7	98300	2624 61				
	Coking coal	28 2	94600	2667.72				
	Other bituminous coal	25 8	94600	2440 68				
	Sub bituminous coal	18 9	96100	1816 29				
	Lignite	11 9	101000	1201.9				
	Oil shale and tar sands	8 9	107000	952.3				
	Brown coal briquettes	20.7	97500	2018 25				
	Patent fuel	20.7	97500	2018 25				
	Coke oven coke	28 2	107000	3017.4				
	Lignite coke	28 2	107000	3017.4				
	Gas coke	28 2	107000	3017.4				
	Coal tar	28	80700	2259.6				
	Gas works gas	38.7	44400	1718 28				
	Coke oven gas	38.7	44400	1718 28				
	Blast furnace gas	2.47	260000	642.2				
	Oxygen steel furnace gas	7.06	182000	1284 92				
Natural gas	Natural gas	48	56100	2692.8		0.7		1.88496
Other wastes	Municipal waste (Non biomass fr	10	91700	917				
	Industrial wastes	NA	143000	NA				
	Waste oils	40.2	73300	2946.66				
Biomass	Wood or Wood waste	15.6	112000	1747.2				
	Sulphite lyes (Black liqour)	11.8	95300	1124.54				
	Other primary solid biomass fuels	11.6	100000	1160				
	Charcoal	29.5	112000	3304				
	Biogasoline	27	70800	1911.6				
	Biodiesels	27	70800	1911.6				
	Other liquid biofuels	27.4	79600	2181.04				
	Landfill gas	50.4	54600	2751.84		0.9		2.476656
	Sludge gas	50.4	54600	2751.84				
	Other biogas	50.4	54600	2751.84				
	Municipal wastes (Biomass fracti	11.6	100000	1160				
	Peat	9.76	106000	1034.56				

These emission factors are 'cross-sector'; that is, they can be used by reporting entities from any sector, such as the manufacturing, energy or institutional in

Notes: 1, Fuel density data come from GHG Protocol's tool for stationary combustion

Appendix III: Emissions Embedded in Reserves (EER) metric

The full background and methodology for calculating the Emissions Embedded in Reserves (EER) metric is presenting in a study[52] submitted on June 14, 2021 to the U.S. Securities and Exchange Commission (SEC) for its Climate Disclosure comment request period.

[52] https://www.sec.gov/comments/climate-disclosure/cll12-8916955-245033.pdf

W.K. Associates, Inc.
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[redacted]

June 14, 2021

The Honorable Gary Gensler, Chair
Commissioner Hester M. Peirce
Commissioner Elad L. Roisman
Commissioner Allison H. Lee
Commissioner Caroline A. Crenshaw

U.S. Securities and Exchange Commission 100 F Street, NE
Washington, DC 20549

Re: Request for Comment on Climate Change Disclosures

Dear Chair Gensler and Commissioners,

We are writing to share research that responds to the request for comment on Climate Disclosure made on March 15, 2021[1]. The following comment outlines a proposal to amend the SEC's 2010 Modernization of Oil and Gas Reporting Rule (as it relates to Item 1202 of Regulation S-K)[2] to require oil and gas reserves disclosures that the effective CO_2 emissions that they represent in a scientifically valid and user-friendly manner. The comment seeks to answer the following questions put forth in the March 15, 2021 request:

1. What information related to climate risks can be quantified and measured? How are markets currently using quantified information? Are there specific metrics on which all registrants should report (such as, for example, scopes 1, 2, and 3 greenhouse gas emissions, and greenhouse gas reduction goals)? What quantified and measured information or metrics should be disclosed because it may be material to an investment or voting decision?

2. Do climate change related impacts affect the cost of capital, and if so, how and in what ways? How have registrants or investors analyzed risks and costs associated with climate change? What are registrants doing internally to evaluate or project climate scenarios, and what information from or about such internal evaluations should be disclosed to investors to inform investment and voting decisions? How does the absence or presence of robust carbon markets impact firms' analysis of the risks and costs associated with climate change?

4. What are the advantages and disadvantages of establishing different climate change reporting standards for different industries, such as the financial sector, oil and gas, transportation, etc.? How should any such industry-focused standards be developed and implemented?

5. What are the advantages and disadvantages of rules that incorporate or draw on existing frameworks, such as, for example, those developed by the Task Force on Climate-Related Financial Disclosures (TCFD), the Sustainability Accounting Standards Board (SASB), and the Climate Disclosure Standards Board (CDSB)? Are there any specific frameworks that the Commission should consider? If so, which frameworks and why?

[1] https://www.sec.gov/news/public-statement/lee-climate-change-disclosures
[2] https://www.sec.gov/rules/final/2008/33-8995.pdf

7. What is the best approach for requiring climate-related disclosures? For example, should any such disclosures be incorporated into existing rules such as Regulation S-K or Regulation S-X, or should a new regulation devoted entirely to climate risks, opportunities, and impacts be promulgated? Should any such disclosures be filed with or furnished to the Commission?

The following is an outline of our proposal:

Emissions Data Use in Assessing Climate Risk in Securities Analysis

Oil and gas greenhouse gas (GHG) emissions data is both quantifiable and readily accessible to investors. For example, more than 70 metrics and targets aligned with the Task Force on Climate-related Financial Disclosures (TCFD) can be accessed on a Bloomberg Terminal[3]. These metrics consist of governance and operations data, which includes Scope 1, Scope 2 and Scope 3 emissions totals by year. See Figure 1 below.

Figure 1
GHG Emissions Data Available on Bloomberg Terminal

Source: Bloomberg

Bloomberg Terminal users can also evaluate potential future capital expenditures at risk in the oil and gas industry using the 2D Scenario Analysis Tool, created by Carbon Tracker and powered by Rystad Energy's asset-level data[4]. The model can evaluate scenarios reported by companies themselves, or can be used to identify opportunities in companies already transitioning to low-carbon strategies (see Figure 2).

[3] https://data.bloomberglp.com/professional/sites/10/Climate-related-Analysis-Brochure.pdf
[4] Utilizing a 2 degree Celsius scenario.

Figure 2
Company Capital Expenditures Scenario Analysis

Source: Bloomberg

Market participants with access to the Bloomberg Terminal and Rystad may use these information tools to inform their allocations and proxy votes, but both are costly, with a Bloomberg and Rystad subscription priced at roughly $25,000 and $15,000 per year, respectively. While Bloomberg has been providing emissions data since 2017, many market participants are making investment decisions about oil and gas securities without this critical information. In addition, at a recent investor event, Bloomberg acknowledged that the quality, accuracy and uniformity of emissions-related disclosures could all use improvement in order to better serve investors and price risks accurately[5].

An additional tool utilized by market participants for assessing climate risk is software that analyzes the underlying constituents of an investor's portfolio to assess both the physical and transition risks associated with climate change. Some prominent providers of these tools are listed in Figure 3 below[6]:

[5] Emerging Markets Investors Alliance Webinar: "Pricing Climate Risks" June 3, 2021
[6] WK Associates counted over two dozen software packages currently on the market.

Figure 3
Company Capital Expenditures Scenario Analysis

Provider	Methodology	Type of Risk	Output
Carbon Delta	Climate Value-at-Risk	Physical & Transition	Company/Portfolio Level: Cost of reaching emission reduction targets Expected costs of physical risks
Carbone 4	Carbon Impact Analytics CIARA	Physical & Transition	Company/Portfolio Level: Carbon impact of underlying firms (Scope 1,2,3) Overall vulnerability and financial value at risk
FourTwenty Seven	Corporate Physical Climate Risk Scores	Physical	Company/Portfolio Level: Exposure to climate hazard, country risks impacting portfolio, company dependence on natural resources threatened by climate change
Trucost	Carbon Earnings at Risk	Transition	Company/Portfolio Level: Stress test a company's ability to absorb future future carbon prices and assess earnings at risk
ISS ESG	Carbon Risk Rating	Physical & Transition	Company/Portfolio Level: Evaluates company carbon efficiency and exposure to carbon risks related to its industry

Source: WK Associates

These software tools rely on accurate and complete data, reported by companies and 3rd party providers across all emissions scopes, to successfully price potential risks. In discussions with providers, accurate Scope 3 data from the oil and gas industry was observed to perform a valuable "check" on aggregate emissions totals, given the downstream effect of refined petroleum products on all transportation activity.

Scenario analysis, such as the services offered for Bloomberg Terminal users and select software providers, requires the use of Scope 3 Greenhouse Gas (GHG) emissions data. The GHG emissions Scope 1, 2 and 3 concept was introduced in 2001 by the World Resources Institute (WRI) and World Business Council for Sustainable Development as part of their Greenhouse Gas Protocol Corporate Accounting and Reporting Standard[7]. The objective of the emissions scopes was to create a method for companies to measure and report the emissions associated with their businesses based on proximity to core operations.

Scope 1 and Scope 2 GHG Emissions

Scope 1 emissions originate from operations that are directly owned and controlled by a company. Scope 2 apply to indirect operational emissions. In the oil and gas exploration and production (E&P) segment operational emissions include those from the use of company vehicles and equipment to

[7] https://ghgprotocol.org/corporate-standard

emissions caused by methane leakage and gas flaring. Scope 2 emissions are one step beyond a company's immediate control, such as carbon pollution related to the electricity and heat the company purchases from utilities. These emissions can be mitigated by sourcing inputs from a power grid with lower carbon intensity, or through on-site renewables.

Scope 1 and 2 emissions reduction efforts have been the focus of the oil and gas sector for more than a decade[8]. While admirable, Scope 1 and Scope 2 emissions only represent about 10 percent of an average E&P's carbon footprint[9]. Scope 1 and Scope 2 emissions also lack standardization, which makes comparability a challenge[10].

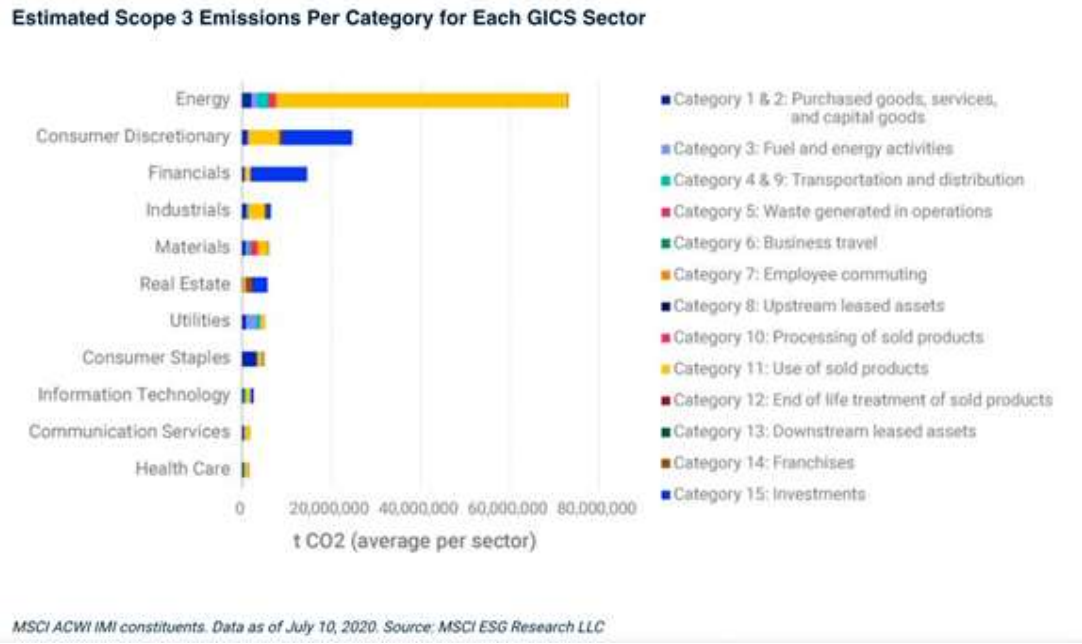
Scope 3 GHG Emissions

Scope 3 emissions are those generated from value chain activities that are not accounted for and reported in the company's Scope 1 and 2 corporate inventories[11]. Put differently, a company's Scope 3 carbon emissions include everything beyond its direct operations and electricity use, including supply-chain operations and end-product usage by customers[12]. In many sectors the emissions that originate from a company's corporate value chain are difficult to ascertain and quantify. However, in the energy sector, especially in oil, gas and coal production, Scope 3 emissions are comprised primarily of the expected GHG emissions attributable to a company's reserves. As such, they fall into Category 11 or the "use of sold products" classification of Scope 3 inventories, as indicated in the calculation guidance provided by the GHG Protocol[13].

Scope 3 emissions can represent the largest source of emissions for companies and present the most significant opportunities to influence GHG reductions. For instance, Scope 3 emissions account for roughly 70-90% of lifecycle emission from oil products and 60-85% of those from natural gas, according to the IEA (International Energy Agency)[14]. Further, a July 2020 study of the MSCI ACWI Investable Market Index, which includes roughly 99% of the global equity market, found that the Scope 3 emissions of the integrated oil and gas industry are more than six times the level of its Scope 1 and 2 emissions[15]. In addition, the Scope 3 emissions of the energy sector far outpace those of any other Global Industry Classification Standard (GICS) category, especially with respect to use of products sold (See figure 4).

[8] https://www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/equinor-s-move-to-halve-carbon-intensity-scope-3-emissions-both-praised-panned-56984504
[9] https://www.morningstar.com/articles/961748/understanding-the-emissions-challenge
[10] https://www.morningstar.com/articles/961748/understanding-the-emissions-challenge
[11] https://www.api.org/~/media/Files/EHS/climate-change/Scope-3-emissions-reporting-guidance-2016.pdf
[12] https://www.msci.com/www/blog-posts/scope-3-carbon-emissions-seeing/02092372761
[13] https://ghgprotocol.org/sites/default/files/standards_supporting/Chapter11.pdf
[14] https://www.iea.org/reports/world-energy-outlook-2018
[15] https://www.msci.com/www/blog-posts/scope-3-carbon-emissions-seeing/02092372761

Figure 4
Scope 3 Emissions (GICS)



Source: MSCI

The fossil fuel sector's Scope 3 emissions are also a key input for the financial service industry's "financed emissions" calculation. In a 2020 study, the Carbon Disclosure Project (CDP) found that almost all financial institutions' climate impact and risks are driven by the fossil fuel exploration and production activities they finance. The CDP study of 85 financial institutions with $27 trillion in assets under management found that their financed emissions were more than 700 times greater than their own operational emissions[16].

In recognition of the very significant GHG emissions reduction opportunity represented by Scope 3 emissions, energy companies have improved their disclosure and goal-setting against this metric. Figure 5 features information compiled by Reuters in January 2021 that summarizes the public reduction targets for Scope 1, 2, and 3 GHG emissions by nine major integrated oil and gas companies.

[16] https://6fefcbb86e61af1b2fc4-c70d8ead6ced550b4d987d7c03fcdd1d.ssl.cf3.rackcdn.com/cms/reports/documents/000/005/741/original/CDP-Financial-Services-Disclosure-Report-2020.pdf?1619537981

Figure 5
Oil Major GHG Reduction Commitment, as of January 2021

Company	Scope 1 Targets	Scope 2 Targets	Scope 3 Targets	Link to Executive Pay	Details
British Petroleum	Yes	Yes	Yes	Yes	Bring net GHG emissions from its equity barrels from well to petrol station to zero by 2050. Reduce GHG intensity of all products it sells by 50% by 2050
Chevron	Yes	No	No	Yes	Lower upstream oil net GHG emission intensity by 5-10%. Upstream natural gas net GHG emission intensity by 2-5% by 2023. Methane intensity target.
ConocoPhillips	Yes	Yes	No	No	Reduce GHG emissions intensity by up to 15% (CO2e per boe) by 2030 per boe vs 2017 levels.
Eni	Yes	Yes	Yes	Yes	Reduce absolute emissions by 80% and emissions intensity by 55% by 2050. Includes products purchased from third parties 2030 net zero carbon target in Scope 1 and 2 for upstream activities, overall group by 2040. Methane reduction target.
Equinor	Yes	Yes	Yes	Yes	Reduce net GHG emissions to zero by 2050, including Scope 3 emissions from customers' use of Equinor's equity production volumes. Reduce upstream CO2 per boe produced to below 8 kg by 2025. Achieve carbon neutral global operations by 2030. Reducing absolute greenhouse gas emissions from operated fields and onshore plants in Norway towards net zero by 2050 without offsets. To ensure no routine flaring and near zero methane emissions by 2030. Reduce net carbon intensity to zero by 2050.
Exxon	Yes	Yes	No	Yes	Reduce methane emissions intensity by 40% to 50% versus 2016 levels by 2025. Eliminate routine flaring and cut upstream scope 1 and scope 2 gas emissions by 30% by 2030. Report Scope 3 emissions. Performance share award pay tied to managing risks related to climate change.
Repsol	Yes	Yes	Yes	Yes	Reduce net carbon emissions to zero by 2050 (incl. Scope 3 from own barrels produced). Reduce carbon intensity vs 2016 by 10% by 2025 (per gigajoule), 20% by 2030, 40% by 2040 Reduce absolute emissions by 3 mln tonnes by 2025 (incl. Scope 3). Reduce methane emissions by 25% by 2025.
Shell	Yes	Yes	Yes	Yes	Ambition to be zero-emissions energy business by 2050 (Scope 1, 2, 3). Reduce net carbon footprint (an intensity-based measure of carbon emitted per energy unit) of all products sold by at least 3% vs 2016 by 2022 and by 65% by 2050 (Scope 3). Use of nature-based offsets and carbon capture technology.
Total	Yes	Yes	Yes	Yes	Worldwide Scope 3 emissions lower in 2030 vs. 2015. Overall Scope 1, 2, 3 emissions intensity reduction by at least 60% by 2050. Overall Scope 1, 2 emissions to net zero by 2050. European Scope 1, 2, 3 emissions down 30% by 2030 in absolute terms, 100% by 2050. Five mln tonnes/year of carbon sinks by 2030. Methane intensity targets.

Source: Reuters[17]

Scope 3 Emissions and Access to Capital

Access to capital is a significant reason for the urgency with which major energy companies have set GHG emissions reduction targets. In a February 2021 letter to its clients, Blackrock, the world's largest asset manager with $8 trillion in assets under management, outlined various ways that GHG emissions disclosures influence its investment decision-making and proxy voting[18]. These include creating a watch list of companies with significant climate-related risk. In the case these companies do not take strong steps toward aligning their business plans -- including their Scope 3 emissions disclosure and reduction -- with a 2ºC climate mitigation strategy the company will vote against

[17] https://www.reuters.com/article/climate-change-carbon-targets/update-2-big-oils-climate-targets-idUSL1N2JH32C
NOTE: 1) Scope 1 refers to emissions from a company's direct operations, such as a diesel generator on an offshore platform
2) Scope 2 are emissions from the power a company uses for its operations, such as gas-powered electricity purchased
3) Scope 3 includes emissions from products sold, such as gasoline sold at petrol stations or jet fuel sold to an airline
4) BOE stands for barrels of oil equivalent

[18] https://www.blackrock.com/corporate/investor-relations/blackrock-client-letter

management on climate-related proxy proposals and potentially exit holdings based on a determination that they would present a risk to clients' returns[19].

Another demonstration of the use of Scope 3 emission by investors is the work of the Transition Pathway Initiative (TPI). The Transition Pathway Initiative is an asset-owner led collaborative which assesses companies' preparedness for the transition to a low carbon economy[20].

In coordination with the Grantham Research Institute on Climate Change and the Environment at the London School of Economics and Political Science (LSE), TPI publishes data based on a variety of disclosures including Scope 3 emissions[21]. These are intended to help investors assess the alignment of their portfolios with the goals of the Paris Agreement**.** A total of 104 investment organizations, with more than $26 trillion in assets under management, have committed to using TPI data to inform their investment research and aid in company engagement. TPI has published case studies on how the Dutch asset manager Robeco, UK-based Brunel Pension Partnership, private equity firm PineBridge Investments, Swedish insurance company Länsförsäkringar AB, the UK's Universities Superannuation Scheme (USS), and the Church of England Pensions Board all use TPI data, including Scope 3 emissions, in both investment decision-making and proxy voting[22].

It is worth noting that a November 2020 TPI report funded by Aberdeen Standard Investments, BNP Paribas Asset Management, Legal & General Investment Management, Robeco, and Neuberger Berman found that the energy sector remains slow in implementing new operational and strategic carbon management practices[23]. The 2020 assessment of the energy sector, comprising 163 companies in coal mining, electricity, and oil and gas production and distribution, used Scope 3 emissions data to create carbon performance metrics showing that only 5 of the 53 oil and gas companies reviewed had performance and policy indicators aligned with the Paris Pledges. And no oil and gas producer was aligned with 2°C warming targets outlined by the United Nations[24].

The SEC itself has indicated its understanding of the importance of Scope 3 disclosures in its very recent treatment of shareholder proposals. In March 2021, the SEC denied ConocoPhillips' and Occidental's requests to exclude Scope 3 disclosure shareholder proposals from their proxy materials[25].

How to Calculate Oil and Gas Scope 3 Emissions

Given its consequence in assessing climate risk in the energy sector, our research strongly points to the need for the broad availability of Scope 3 emissions data. While access to comprehensive Scope 3 emissions data is limited, an adjustment of the SEC's 2010 Modernization of Oil and Gas Reporting Rule[26] (specifically regarding Item 1202 of Regulation S-K), including the application of internationally respected scientific information to routinely reported reserves information, would allow a much broader group of market participants to access these material data and enhance the market's efficiency in pricing the risks of climate change overall.

Scope 3 emissions calculation and reporting for companies with fossil fuel reserves can take several forms. For example, the approach described by the World Resources Institute (WRI) in its paper *A Recommended Methodology for Estimating and Reporting the Potential Greenhouse Gas Emissions from Fossil Fuel Reserves*, is a comprehensive translation of fossil fuel reserves into expected CO_2 emissions as well as detailed accounting for Categories 1, 2, 3 and 5 emissions, as noted in Figure 4.

[19] https://www.blackrock.com/corporate/investor-relations/blackrock-client-letter
[20] https://www.transitionpathwayinitiative.org/overview
[21] https://www.transitionpathwayinitiative.org/publications/65.pdf
[22] https://www.transitionpathwayinitiative.org/publications/66.pdf?type=Publication
[23] https://www.transitionpathwayinitiative.org/publications/61.pdf?type=Publication
[24] https://www.transitionpathwayinitiative.org/publications/61.pdf?type=Publication
[25] https://www.ft.com/content/50b52600-dd43-427c-88a6-149cf790cb70
[26] https://www.sec.gov/rules/final/2008/33-8995.pdf

Methodology for Estimating the Potential Greenhouse Gas Emissions from Fossil Fuel Reserves

In 2016, WRI published a working paper titled *A Recommended Methodology for Estimating and Reporting the Potential Greenhouse Gas Emissions from Fossil Fuel Reserves*[27], as supplemental guidance to the GHG Protocol. This working paper outlines a recommended methodology corporate accounting and disclosure of potential CO_2 emissions from fossil fuel producers' reserves or Scope 3 emissions for companies with fossil fuel reserves.

As noted in the working paper, the first draft of this methodology was prepared based on desk research and consultations with exchange regulators and reserves auditing firms. A second draft was developed based on feedback from 15 select experts, as well as an open comment period during which 20 submissions were received. The experts were drawn from reserves auditing firms, the SEC, companies including Shell and Equinor, industry associations including IPIECA (International Petroleum Industry Environmental Conservation Association), voluntary reporting programs, nongovernmental organizations, and academia. As such, it is the most comprehensive and thoroughly reviewed methodology for calculating GHG emissions that we have come across.

The methodology begins with the recommended use of the Petroleum Resource Management System (PRMS) (for oil and gas) and the Committee for Mineral Reserves International Reporting Standards (CRIRSCO) template (for coal), or consistent national codes, to quantify the size of fossil fuel reserves. It goes on to suggest inclusion of other emissions considerations, such as the amounts of fossil fuels used as fuel in internal operations, those lost through flaring, venting, and fugitive activities or employed in CO_2 EOR processes, and those lost through CH4 (methane) leakage.

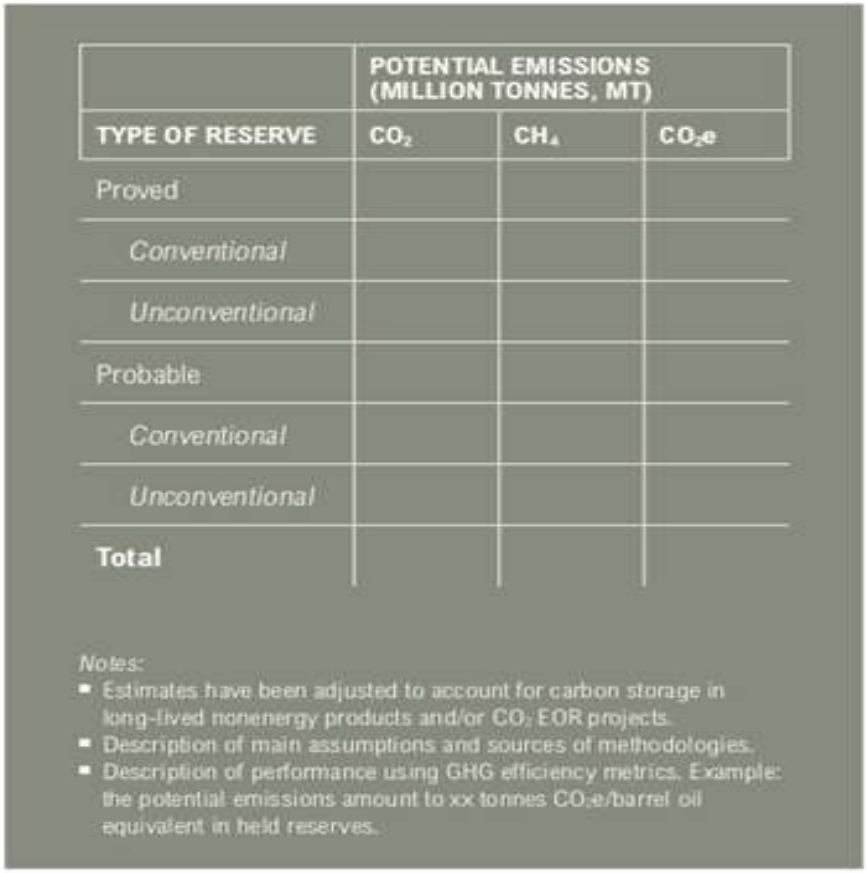
The WRI methodology also recommends disclosure of emissions in terms of the proven and probable reserves from which they originate and suggests that the Intergovernmental Panel on Climate Change (IPCC)[28] Tier 1 emissions factors be used to calculate potential GHGs emissions and CO_2 equivalents. The WRI guidance also suggests the resulting CO_2 emissions factors from proven and probably fossil fuels reserves be reported in similar fashion to Figure 6.

[27] https://ghgprotocol.org/sites/default/files/standards/WRI16_WorkingPaper_FF.pdf

[28] The Intergovernmental Panel on Climate Change (IPCC) was established by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) in 1988. It was later endorsed by the United Nations General Assembly through Resolution 43/53. The IPCC was the winner of the 2007 Nobel Peace Prize and has been recognized by the world's leading authority by organizations such as the Royal Society, Britain's most prestigious scientific institute. Its main objective is to assess scientific, technical and socio-economic information relevant to the understanding of human induced climate change, potential impacts of climate change and options for mitigation and adaptation. Its research is done by a group of leading scientists from industry (including representatives from ExxonMobil and other companies), government and civil society. Summaries of this work are subject to line-by-line approval by all 120 participating governments. Typically this involves the governments of more than 120 countries.[The IPCC has completed four assessment reports, developed methodology guidelines for national greenhouse gas inventories, special reports and technical papers. The IPCC National Greenhouse Gas Inventories Programme was managed from 1991 by the IPCC WG I in close collaboration with the Organisation for Economic Co-operation and Development (OECD) and the International Energy Agency (IEA).

Data from the IPCC 2014 climate assetment report show that the major sources of emissions have been coal (34%), oil (25%), gas (10%), cement (2%) and land-use (29%)

Figure 6
WRI Suggested Format for Disclosure of Potential GHS Emissions and CO2 Equivalents



	POTENTIAL EMISSIONS (MILLION TONNES, MT)		
TYPE OF RESERVE	CO_2	CH_4	CO_2e
Proved			
Conventional			
Unconventional			
Probable			
Conventional			
Unconventional			
Total			

Notes:
- Estimates have been adjusted to account for carbon storage in long-lived nonenergy products and/or CO_2 EOR projects.
- Description of main assumptions and sources of methodologies.
- Description of performance using GHG efficiency metrics. Example: the potential emissions amount to xx tonnes CO_2e/barrel oil equivalent in held reserves.

Source: WRI

The WRI reporting methodology translates proven and probably fossil fuel reserves into expected CO_2 emissions, while adding additional CO_2 equivalents that arise from activities such as venting and other fugitive emissions. The translation of proven and probable reserves to expected CO_2 emissions is made possible through the application of the IPCC's effective CO_2 emission factors.

The Intergovernmental Panel on Climate Change (IPCC)

The Intergovernmental Panel on Climate Change (IPCC) is an intergovernmental body of the United Nations dedicated to providing the world with objective, scientific information relevant to understanding the scientific basis of the risk of human-induced climate change. In addition, the IPCC examines the physical, political, and economic impacts of climate change, and possible response options.

In its Guidelines for National Greenhouse Gas Inventories published in 2006[29], the IPCC included "Default CO_2 Emissions Factors for Combustion" (see Figure 7). The carbon content of different fossil fuels and the reserves from which they originate can vary considerably, both among and within primary fuel types on a per mass or per volume basis. However, the IPCC's measurement of effective CO_2 emissions of fuels upon combustion as reflected in the Default CO_2 Emissions Factors for Combustion avoids this complication.

[29] https://www.ipcc-nggip.iges.or.jp/public/2006gl/

Fossil fuel combustion processes are optimized to derive the maximum amount of energy per unit of fuel consumed, which delivers the maximum amount of CO_2. Efficient fuel combustion ensures oxidation of the maximum amount of carbon available in the fuel. CO_2 emission factors for fuel combustion are therefore relatively insensitive to the combustion process itself and are solely dependent on the carbon content of the fuel.

For these reasons, as well as the global credibility of the IPCC, the U.S. Environmental Protection Agency (U.S. EPA) uses the Default CO2 Emissions Factors for Combustion in its calculation of Emission Factors for Greenhouse Gas Inventories[30]. This calculation is used by the U.S. EPA Center for Corporate Climate Leadership, which has in turned been used by ExxonMobil[31] and other companies to calculate their Scope 3 GHG emissions[32].

In June 2016, the oil industry sustainability group IPIECA published "Estimating petroleum industry value chain (Scope 3) greenhouse gas emissions. Overview of methodologies[33]." The document draws on the WRI and the World Business Council for Sustainable Development (WBCSD) GHG Protocol Scope 3 Standard to outline approaches used by the oil and gas industry to determine company's Scope 3 emissions. Exxon drew on the IPIECA methodology to report its Scope 3 emissions noted earlier[34]. The document is also available on the website of the American Petroleum Institute (API)[35].

The IPCC effective CO_2 emission factors are also the reference coefficients for ISO Standard 14064[36] on the quantification and reporting of greenhouse gas emissions. Finally, these are also the metric used in the Carbon Disclosure Project (CDP) Scope 3 disclosure guidance for oil companies[37].

[30] https://www.epa.gov/sites/production/files/2020-04/documents/ghg-emission-factors-hub.pdf
[31] ExxonMobil has participated in the Intergovernmental Panel on Climate Change (IPCC) since its inception in 1988. https://corporate.exxonmobil.com/-/media/Global/Files/energy-and-carbon-summary/Energy-and-carbon-summary.pdf
[32] https://corporate.exxonmobil.com/-/media/Global/Files/energy-and-carbon-summary/Energy-and-Carbon-Summary.pdf Page 43
[33] https://www.ipieca.org/resources/good-practice/estimating-petroleum-industry-value-chain-scope-3-greenhouse-gas-emissions-overview-of-methodologies/
[34] https://corporate.exxonmobil.com/Sustainability/Energy-and-Carbon-Summary/Scope-3-emissions
[35] https://www.api.org/~/media/Files/EHS/climate-change/Scope-3-emissions-reporting-guidance-2016.pdf
[36] http://www.iso.org/iso/catalogue_detail?csnumber=38381
[37] https://b8f65cb373b1b7b15feb-c70d8ead6ced550b4d987d7c03fcdd1d.ssl.cf3.rackcdn.com/cms/guidance_docs/pdfs/000/000/469/original/CDP-Scope-3-Category11-Guidance-Oil-Gas.pdf?1479754082

Figure 7
IPCC Default CO2 Emissions Factors for Combustion

TABLE 1.4
DEFAULT CO_2 EMISSION FACTORS FOR COMBUSTION [1]

Fuel type English description		Default carbon content (kg/GJ)	Default carbon oxidation factor	Effective CO_2 emission factor (kg/TJ) [2]		
				Default value [3]	95% confidence interval	
		A	B	C=A*B*44/12*1000	Lower	Upper
Crude Oil		20.0	1	73 300	71 100	75 500
Orimulsion		21.0	1	77 000	69 300	85 400
Natural Gas Liquids		17.5	1	64 200	58 300	70 400
Gasoline	Motor Gasoline	18.9	1	69 300	67 500	73 000
	Aviation Gasoline	19.1	1	70 000	67 500	73 000
	Jet Gasoline	19.1	1	70 000	67 500	73 000
Jet Kerosene		19.5	1	71 500	69 700	74 400
Other Kerosene		19.6	1	71 900	70 800	73 700
Shale Oil		20.0	1	73 300	67 800	79 200
Gas/Diesel Oil		20.2	1	74 100	72 600	74 800
Residual Fuel Oil		21.1	1	77 400	75 500	78 800
Liquefied Petroleum Gases		17.2	1	63 100	61 600	65 600
Ethane		16.8	1	61 600	56 500	68 600
Naphtha		20.0	1	73 300	69 300	76 300
Bitumen		22.0	1	80 700	73 000	89 900
Lubricants		20.0	1	73 300	71 900	75 200
Petroleum Coke		26.6	1	97 500	82 900	115 000
Refinery Feedstocks		20.0	1	73 300	68 900	76 600

Source: IPCC

Oil and Gas Reserves and Effective CO_2 Emissions Data

Fossil fuel reserves data is the other half of the effective CO_2 emissions calculation. Oil and gas reserves reporting guidance exists in Regulation S-K and Regulation S-X under the Securities Act of 1933 and the Securities Exchange Act of 1934, as well as Industry Guide 2. Accounting Standards Codification (ASC) 932[38] provides the specifics for the calculation of reserves required for disclosure.

Fossil Fuel Reserves Calculation

The general term 'reserves' typically refers to oil and gas and mineral resources that are commercially viable and are further broken down into the sub-categories of proved (P1), probable (P2) and possible (P3). Environmental and social considerations are specifically addressed in determining the commercial viability of a reserve under the Petroleum Resource Management System (PRMS) developed by the Society of Petroleum Engineers (2007).

Under the PRMS, new extraction projects can generally be categorized as reserves, provided that the projects will start within five years. Also, if reserves were deemed to be subject to a combustion constraint, they should be re-classified as contingent resources (that is, contingent on their ability to

[38] https://www.fasb.org/cs/BlobServer?blobcol=urldata&blobtable=MungoBlobs&blobkey=id&blobwhere=1175820075990&blobheader=application/pdf
https://www.sprioilgas.com/blog/sec-oil-and-gas-reserve-reporting-an-in-depth-explanation

be utilized). Contingent resources are those discovered, but not commercially viable, and otherwise reflect the same profile of probabilities that apply to "normal" reserves and prospects.

The Committee for Mineral Reserves International Reporting Standards (CRIRSCO) template has similarities to the PRMS system. The CRIRSCO template includes social and environmental aspects in its 'Modifying Factors', where consideration of mining, metallurgical, economic, marketing, legal, environmental, social and governmental factors are all determinative if a measured or inferred resource can be classified as a reserve. First, all companies falling under a reporting code are required to consider environmental factors in their justification of whether or not reserves can be extracted. Second, the "competent person" is reminded that consideration of environmental factors should form part of their professional duty to the public.

Proved and probable mineral reserves (CRIRSCO template) have the same approximate level of associated confidence as proved and probable petroleum reserves. PRMS distinguishes between conventional and unconventional resources, while CRISCO does not. Broadly speaking, unconventional resources are not influenced by the normal hydraulic effects of a reservoir and require enhanced extraction techniques. Unconventional resources include extra-heavy oil, bitumen, tight gas, coal bed methane, shale gas, oil shale, and gas hydrates.

Many firms have reserve committees that oversee resource reporting. Any of the senior management sign-offs, such as those required under the U.S. Sarbanes-Oxley Act (2002), also require assurance that the evaluator has followed appropriate due diligence.

Under International Financial Reporting Standards (IFRS) there are no requirements for the reporting of reserves and resources for oil, gas or mining operations. Under US GAAP (Generally Accepted Accounting Principles) it is only oil and gas firms that must disclose proven reserves information, but not probable reserves (in contrast with Canada). However, many SEC-registered issuers disclosure probable reserves information. These gaps in disclosure deny many market participants the information necessary to make optimal investment decisions, but this shortcoming is beyond the scope of this document.

Use of Oil and Gas Reserves Data in Securities Analysis

The SEC requires oil and gas reserves disclosure because these data play a very significant role in the proper assessment of a security's risk exposure. Oil and gas reserves are the most important assets of any oil and gas company and reserves represent most of the value of an exploration and production company[39]. In fact, IHS Energy analysis has found that about 80 percent of the value of most publicly traded oil and gas companies is based on their proved reserves[40].

Among other things, securities analysts use reserves as the basis for calculating unit-of-production depreciation, depletion and amortization rates, impairment testing and decommissioning cost estimates. For example, a decrease in estimated proved reserves would increase depreciation and depletion and amortization expenses, while an increase in reserves would reduce each of these. In addition, the timing of reserves depletion may impact the provision for decommissioning cost estimates.

Trends in fossil fuel reserves data may also indicate downside risk for specific securities. For example, recent data published by researchers at Simon Fraser University show that the growth of these reserves has a negative effect on firm value[41]. These conclusions were reached by analyzing a sample of 679 North American oil and gas firms for the period 1999 to 2018. The study's evidence is consistent with markets penalizing future investment in undeveloped reserves growth due to climate policy risk.

[39] https://mercercapital.com/energyvaluationinsights/the-fair-market-value-of-oil-gas-reserves/
[40] https://ihsmarkit.com/research-analysis/do-investments-in-oil-and-gas-constitute-systemic-risk.html
[41] https://www.nber.org/system/files/working_papers/w26497/revisions/w26497.rev0.pdf

SEC's 2010 Modernization of Oil and Gas Reporting Rule

In 2010, the SEC published a rule called the Modernization of Oil and Gas Reporting[42], which was intended to provide investors with a more meaningful and comprehensive understanding of oil and gas reserves to aid valuation. The rule's amendments were designed to update the oil and gas disclosure requirements to align them with then current practices and changes in technology.

Among those changes was the requirement to disclose proven and probable reserves based on their final product, including those from "non-traditional" sources. In this case, non-traditional resources include bitumen, shale and coalbed methane. The SEC's guidance was that these disclosures could be made in tables such as Figure 8 with "Synthetic Oil" and "Synthetic Gas" used as a catchall for unconventional resources (such as oil sands, shale and coalbed methane).

The ability to book more proved undeveloped reserves under the Modernization of Oil and Gas Reporting rule, along with the opportunity to recognize large proved undeveloped reserves in unconventional resource plays, means that undeveloped reserves had greater impact on a company's financial results and resulting valuation. Consequently, the Modernization of Oil and Gas Reporting rule has had the effect of capitalizing additional high carbon reserves from "non-traditional" sources. This boosted the valuation of oil and gas companies that went on to provide more high carbon fuels to the market.

Providing reserves to CO_2 emissions data in Section 13 disclosures would help mitigate the unintended consequences of the 2010 rule. Disclosing oil and gas reserves in terms of the CO_2 emission they represent would allow market participants to accurately price and compare the climate risks of different issuers. In fact, the Commission indicated such differentiation had applications to investment analysis in its 2010 rule when it said, "We believe that with this separate disclosure, investors will be able to identify resources in projects that produce synthetic oil or gas that may be more sensitive to economic conditions from other resources[43]." Today a significant portion of that sensitivity is to the economic conditions created by the climate risk associated with high carbon resources.

[42] https://www.sec.gov/rules/final/2008/33-8995.pdf
[43] Ibid. Pages 23, 24.

Figure 8
Current SEC Oil and Gas Reserves Disclosure Guidance

Summary of Oil and Gas Reserves as of Fiscal-Year End
Based on Average Fiscal-Year Prices

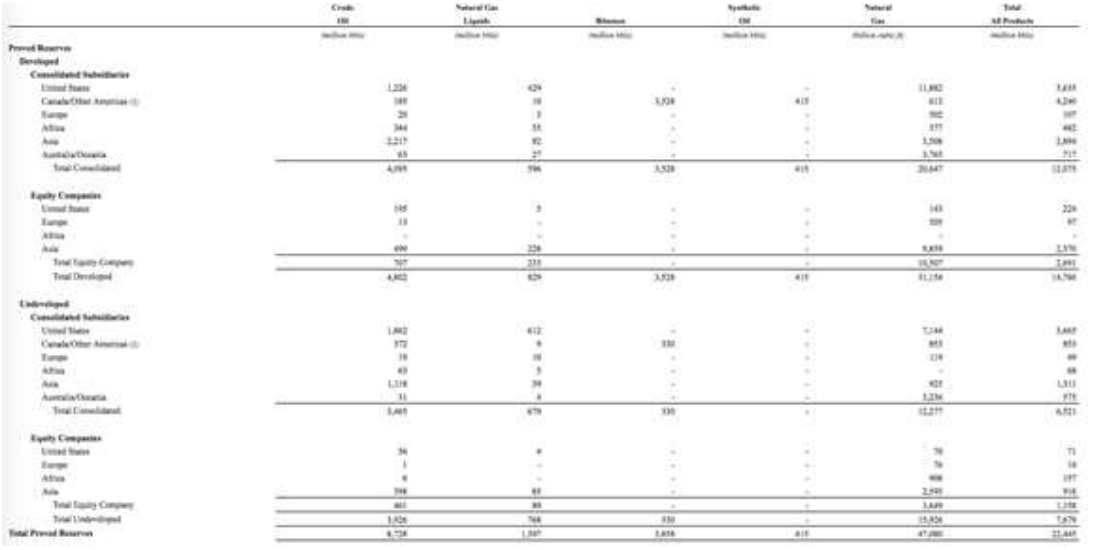
	Reserves				
	Oil	Natural Gas	Synthetic Oil	Synthetic Gas	Product A
Reserves category	(mbbls)	(mmcf)	(mbbls)	(mmcf)	(measure)
PROVED					
Developed					
Continent A					
Continent B					
Country A					
Country B					
Other Countries in Continent B					
Undeveloped					
Continent A					
Continent B					
Country A					
Country B					
Other Countries in Continent B					
TOTAL PROVED					
PROBABLE					
Developed					
Undeveloped					
POSSIBLE					
Developed					
Undeveloped					

Source: SEC

In its Form 10-K filing made for its fiscal year ending December 31, 2019, ExxonMobil satisfied the oil and gas reserves disclosure requirement with the table below (Figure 9)[44]. The data is confined to developed and undeveloped proven reserves. Reserves information is typically presented at a summary level by country or continent, as shown in ExxonMobil's table.

[44] https://www.sec.gov/ix?doc=/Archives/edgar/data/34088/000003408820000016/xom10k2019.htm Page 6

Figure 9
Exxon Reserves Disclosure Form



	Crude Oil (million bbls)	Natural Gas Liquids (million bbls)	Bitumen (million bbls)	Synthetic Oil (million bbls)	Natural Gas (million cubic ft)	Total All Products (million bbls)
Proved Reserves						
Developed						
Consolidated Subsidiaries						
United States	1,226	429	-	-	11,882	3,433
Canada/Other Americas (1)	195	10	3,528	415	613	4,240
Europe	20	3	-	-	502	107
Africa	364	35	-	-	377	462
Asia	2,217	92	-	-	3,508	2,894
Australia/Oceania	65	27	-	-	3,765	717
Total Consolidated	4,095	596	3,528	415	20,647	12,075
Equity Companies						
United States	195	5	-	-	143	224
Europe	13	-	-	-	509	97
Africa	-	-	-	-	-	-
Asia	499	228	-	-	9,858	2,370
Total Equity Company	707	233	-	-	10,507	2,691
Total Developed	4,802	829	3,528	415	31,154	14,766
Undeveloped						
Consolidated Subsidiaries						
United States	1,892	612	-	-	7,144	3,105
Canada/Other Americas (1)	372	6	330	-	853	853
Europe	19	10	-	-	119	49
Africa	93	5	-	-	-	98
Asia	1,318	39	-	-	925	1,511
Australia/Oceania	31	8	-	-	3,256	575
Total Consolidated	3,665	679	330	-	12,277	6,521
Equity Companies						
United States	56	9	-	-	70	73
Europe	1	-	-	-	76	14
Africa	6	-	-	-	908	157
Asia	398	85	-	-	2,595	916
Total Equity Company	461	85	-	-	3,649	1,158
Total Undeveloped	4,126	764	330	-	15,926	7,679
Total Proved Reserves	8,728	1,597	3,858	415	47,080	22,445

Source: SEC 10K filing

Proposed Changes to the 2010 Modernization of Oil and Gas Reporting Rule

Given the credibility of the IPCC effective CO_2 emissions factors and the importance of accurate reserves data in securities analysis, we suggest that they be utilized to create a quantifiable and measurable indication of the future CO_2 emissions represented by proven and probable reserves reported in annual disclosures included in 10-K statements.

GHG emissions reporting is essential to investors' understanding of material climate risk considerations. Scope 3 emissions data for oil and gas companies would both advance the objectives of the SEC's 2010 Interpretive Guidance Regarding Disclosure Related to Climate Change and update its oil and gas reserves disclosure guidance to reflect the changing economics and related risks of fossil fuels development and marketing.

In February 2021, a worldwide database of fossil fuel reserves called the Global Registry of Fossil Fuels was launched by the Carbon Tracker Initiative and Global Energy Monitor[45]. The organizations note that existing databases on fossil fuel reserves and production lack detail, are proprietary, or are solely for industry use. If the SEC were to mandate more accurate accounting of fossil fuel reserves and their associated effective CO_2 emissions, it also would be a significant contribution to efforts to understand the climate impact of future energy consumption globally.

Format of Proposed Effective CO2 Emission Disclosure

Figure 10 (below) reflects a merging of ExxonMobil's actual reserves disclosures in its 2020 10-K and the format for effective CO_2 emissions disclosures outlined above. The calculation of the effective CO_2 emissions of proven and probable oil and gas reserves involves the multiplication of the oil equivalent of each type of a company's reserves by the corresponding IPCC effective CO_2 emission factor.

- **Effective CO_2 Emissions from Oil and Gas Reserves Calculation**
  Million BBLS oil or equivalent * Effective CO_2 Emissions Factor = Expected CO_2 Emissions

[45] https://carbontracker.org/climate-risks-from-oil-gas-and-coal-production-must-be-added-up-to-avoid-locking-in-the-climate-emergency/

In Figure 10 and in ExxonMobil's FY2020 10-K, natural gas reserves are converted to an oil-equivalent basis at six billion cubic feet per one million barrels. As noted in the WRI methodology, separate calculations should be made for proven and probable reserves.

Figure 10
Proposed Effective CO2 Emissions Disclosure

Sample Effective CO2 Emissions Disclosure (Based on format used by ExxonMobil in its Form 10-K - https://www.sec.gov/ix?doc=/Archives/edgar/data/0000034088/000003408821000012/xom-20201231.htm)

Disclosure of Reserves
Summary of Oil and Gas Reserves at Year-End 2020

Calculation: Million BBLS oil or equivalent * Effective CO2 Emissions Factor = Expected CO2 Emissions

Natural gas is converted to an oil-equivalent basis at six billion cubic feet per one million barrels, as used in the Exxon 10-K.

	Crude Oil (Millions BBLs)		Natural Gas Liquids (Millions BBLS)		Bitumen (Millions BBLS)		Synthetic Oil (Millions BBLS)		Natural Gas (Millions BBLS - Oil Equivalent)		Oil-Equivilent Total for All Products	
		IPCC Effective Emissions Factor (kg/TJ)2		IPCC Effective Emissions Factor (kg/TJ)2		IPCC Effective Emissions Factor (kg/TJ)2		IPCC Effective Emissions Factor (kg/TJ)2		IPCC Effective Emissions Factor (kg/TJ)2		Effective CO2 Emissions (kg/TJ)2
		73,300 See IPCC CO2 Emissions Factors Ta		64,200 See IPCC CO2 Emissic		80,700 See IPCC CO2 Emissic		84,735 See IPCC CO2 Emission		56,100 See IPCC CO2 Emission		-
		Effective CO2 Emissions		Effective CO2 Emissions		Effective CO2 Emissions		Effective CO2 Emissions		Effective CO2 Emissions		
Proven Reserves												
Developed												
Consolidated												
United States	1,029	75,425,700	444	28,504,800					1,729	97,006,250	3,202	200,936,750
Canada	288	21,110,400	5	321,000	76	6,133,200	311	26,352,585	79	4,413,200	759	58,330,385
Europe	11	806,300	2	128,400					67	3,730,650	79	4,665,350
Africa	314	23,016,200	31	1,990,200					53	2,973,300	398	27,979,700
Asia	2,215	162,359,500	84	5,392,800					554	31,070,050	2,853	198,822,350
Australia/Ocea	44	3,225,200	23	1,476,600					557	31,266,400	624	35,968,200
Total Consolid	3,901	285,943,300	589	37,813,800	76	6,133,200	311	26,352,585	3,039	170,459,850	7,915	526,702,735
Equity Companies												
United States	107	7,843,100	4	256,800					14	776,050	125	8,875,950
Canada	8	586,400							49	2,739,550	57	3,325,950
Africa												
Asia	432	31,665,600	214	13,738,800					1,499	84,075,200	2,144	129,479,600
Total Equity C	547	40,095,100	218	13,995,600					1,561	87,590,800	2,326	141,681,500
Total Develope	4,448	326,038,400	807	51,809,400	76	6,133,200	311	26,352,585	4,600	258,050,650	10,241	283,363,000
Undeveloped												
Consolidated												
United States	930	68,169,000	412	26,450,400					511	28,648,400	1,853	123,267,800
Canada	209	15,319,700			5	403,500	133	11,269,755	15	832,150	362	27,825,105
Europe	11	806,300	5	321,000					7	392,700	23	1,520,000
Africa	42	3,078,600							0.3	18,700	42	3,097,300
Asia	935	68,535,500	40	2,568,000					164	9,219,100	1,139	80,322,600
Australia/Ocea	30	2,199,000	8	513,600					465	26,086,500	503	28,799,100
Total Consolid	2,157	158,108,100	465	29,853,000	5	403,500	133	11,269,755	1,162	65,197,550	3,922	264,831,905
Equity Companies												
United States	24	1,759,200							3	177,650	27	1,936,850
Europe	1	73,300							11	626,450	12	699,750
Africa	6	439,800							153	8,573,950	159	9,013,750
Asia	393	28,806,900	59	3,787,800					398	22,299,750	850	54,894,450
Total Equity C	424	31,079,200	59	3,787,800					565	31,677,800	1,048	66,544,800
Total Undevelc	2,581	62,158,400	524	33,640,800	5	403,500	133	11,269,755	1,727	96,875,350	4,970	204,347,905
Total Proven R	7,029	515,225,700	1,331	85,450,200	81	6,536,700	444	37,622,340	6,327	354,926,000	15,211	999,760,940

(1)Other Americas includes proved developed reserves of 119 million barrels of crude oil and 138 billion cubic feet of natural gas, as well as proved undeveloped reserves of 179 million barrels of crude oil and 77 billion cubic feet of natural gas.

Source: Exxon filing and WK Associates

Limiting Emissions Estimates to Sales Quantities of Oil and Gas Reserves

Exhaustive calculations of oil and gas Scope 3 emissions may require looking beyond the sales quantities reported in reserves estimates, as illustrated in the proposed methodology. However, the purpose of this calculation is to determine the potential economic impact of the effective CO_2 emissions represented by proven and probable fossil reserves. If the purpose were to calculate of the contribution of oil and gas industry emissions to the total amount of greenhouse gases present in the atmosphere, a more comprehensive approach would be necessary.

Distinctions Between Combusted and Manufactured Reserves

A portion of sales quantities of fossil fuel reserves are not combusted, but used in the manufacture of products, such as petrochemicals, asphalts, lubricants, waxes and pigments. However, under the PRMS, oil and gas quantities are defined in terms of sales quantities measured at the reference point, which is typically the point of sale to third parties, or where custody is transferred to the producing entity's downstream operations[46]. Our method also assumes this will be the point at which carbon pricing, through a tax or similar means, will be assessed. In this circumstance, the economic impact of combusted reserves and those used in manufacturing is equivalent and we believe there is no need to account for the storage of carbon in non-fuel products.

Adjustment of Reserve Types in 2010 Modernization of Oil and Gas Reporting Rule

The Modernization of Oil and Gas Reporting Rule of 2010 changed reserves reporting categories from the type of each reserve to its end product. This change blurs the line between upstream and downstream oil and gas operations that is often an important consideration for investors. It also complicates the attribution of reserves to the IPCC effective CO_2 emissions factors that would help investor understand the emission they may create.

To assist investors in understanding the economic considerations specific to each reserve type and to accommodate the accurate attribution of the effective CO_2 emissions, the reserve types would have to be changed to a manner consistent with the "Default CO_2 Emissions Factors for Combustion" of the IPCC's Guidelines for National Greenhouse Gas Inventories[47]. For example, the Modernization of Oil and Gas Reporting Rule allows for disclosure of reserves in a catch-all category called "Synthetic Oil", which does not correspond directly to an individual category in the IPCC's Guidelines for National Greenhouse Gas Inventories.

In some cases, PRMS guidelines may not allow for reserves categorization that is perfectly consistent with the IPCC categories. For instance, under PRMS, if natural gas is sold wet (i.e., without the removal of NGLs), then the NGLs are included in the reserve estimate for natural gas. In such cases, and consistent with the WRI methodology[48], reporting companies may simply use emission factors for the reported reserve type (natural gas in this case).

Consistency with SEC and Congressional Climate Risk Disclosure Priorities

Although the SEC need not have a legislative mandate to update the 2010 Modernization of Oil and Gas Reporting Rule with the disclosure of effective CO_2 emissions factors[49], the Climate Risk Disclosure Act includes a section that aligns very well with the methodology outlined in this comment letter. In July 2019, Senator Elizabeth Warren[50] and Congressman Sean Casten[51] introduced The

[46] https://files.wri.org/d8/s3fs-public/A_Recommended_Methodology_for_Estimating_and_Reporting_the_Potential_Greenhouse_Gas_Emissions_from_Fossil_Fuel_Reserves.pdf

[47] https://www.ipcc-nggip.iges.or.jp/public/2006gl/

[48] https://files.wri.org/d8/s3fs-public/A_Recommended_Methodology_for_Estimating_and_Reporting_the_Potential_Greenhouse_Gas_Emissions_from_Fossil_Fuel_Reserves.pdf Page 9.

[49] https://www.americanprogress.org/issues/economy/reports/2021/06/10/500352/sec-broad-authority-require-climate-esg-disclosures/

[50] https://www.congress.gov/bill/116th-congress/senate-bill/2075

[51] https://www.congress.gov/bill/116th-congress/house-bill/3623

Climate Risk Disclosure Act, because:

"Investors lack access to basic information about the potential impact of the climate crisis on American companies[52]."

The Climate Risk Disclosure Act references a mandate for disclosures under Section 13 of the Securities Exchange Act of 1934 that include "the potential amount of direct and indirect greenhouse gas emissions that are embedded in proved and probable hydrocarbon reserves, with each such calculation presented as a total, as well as in subdivided categories, by the type of reserve"[53]. A complete excerpt from the Act is in the Figure below:

Figure 11
The Climate Risk Disclosure Act

(2) require that a covered issuer, with respect to a disclosure required under subsection (s) of section 13 of the Securities Exchange Act of 1934 (15 U.S.C. 78m), as added by section 5

(a) Climate Risk Disclosure Rules. Not later than 2 years after the date of enactment of this Act, the Commission, in consultation with the appropriate climate principals, shall issue rules with respect to the information that a covered issuer is required to disclose pursuant to subsection (s) of section 13 of the Securities Exchange Act of 1934 (15 U.S.C. 78m), as added by section 5

(C) if the covered issuer engages in the commercial development of fossil fuels, include in the disclosure—

(III) the potential amount of direct and indirect greenhouse gas emissions that are embedded in proved and probable hydrocarbon reserves, with each such calculation presented as a total and in subdivided categories by the type of reserve

Source: CRS

The IPCC-based effective CO_2 emissions factors from oil and gas reserves would address the mandate outlined in this proposed legislation.

In February 2010, the SEC issued "Interpretive Guidance Regarding Disclosure Related to Climate Change"[54]. In that guidance the Commission identified four existing items in Regulation S-K that may require disclosure related to climate change: description of business, legal proceedings, risk factors, and management's discussion and analysis of financial condition and results of operations, or MD&A. All of these are backward-looking and non-quantifiable considerations.

During its review of Regulation S-K completed in February 2020, the SEC passed on the opportunity to update this guidance[55]. At that time, SEC Commissioner Allison Lee expressed disappointment with this decision and pointed out "investors are overwhelmingly telling us, through comment letters and petitions for rulemaking, that they need consistent, reliable, and comparable disclosures of the risks and opportunities related to sustainability measures, particularly climate risk[56]."

Inclusion of CO_2 emissions factors for oil and gas reserves in SEC disclosure requirements would enable the Commission to substantially enhance its climate risk disclosure guidance, as represented by its 2010 "Interpretive Guidance Regarding Disclosure Related to Climate Change".

[52] https://www.warren.senate.gov/imo/media/doc/The%20Climate%20Risk%20Disclosure%20Act%20of%202019%20-%20One%20Pager.pdf
[53] https://www.congress.gov/bill/116th-congress/senate-bill/2075/text
[54] https://www.sec.gov/rules/interp/2010/33-9106.pdf
[55] https://www.natlawreview.com/article/sec-indicates-it-will-not-modify-climate-change-disclosure-criteria
[56] https://www.sec.gov/news/public-statement/lee-mda-2020-01-30

Comparison Effective CO2 Emissions Disclosure Proposal to Voluntary Standards

The following is an overview of the guidance of five leading climate risk disclosure standards regarding effective CO_2 emissions and related risks represented by the fossil fuel reserves of oil, gas and mining companies.

The standards reviewed include the Global Reporting Initiative (GRI) Sector Standards for Oil, Gas and Coal; the Greenhouse Gas Protocol; the Sustainability Accounting Standards Board (SASB) Oil and Gas Exploration and Production[57] and Coal Company[58] standards; the Task Force on Climate-Related Financial Disclosures (TCFD) guidance for the Energy Sector; and the Climate Disclosure Standards Board (CDSB) Framework.

Key Points

1. The standards with specific guidance for the disclosure of CO_2 emissions represented by fossil fuel reserves (GRI, GHG Protocol and SASB) validate the assumptions of the effective CO2 emissions of oil and gas reserves proposal outlined in this comment.

2. None of the standards or their guidance contradict this proposal in methodology or application.

3. The GHG Protocol and the GRI include reference to a 2016 World Resources Institute (WRI) working paper titled *A Recommended Methodology for Estimating and Reporting the Potential Greenhouse Gas Emissions from Fossil Fuel Reserves*. This working paper, which was referenced earlier in this comment letter, presents a methodology that is consistent with our proposal, but which includes more extensive GHG emissions inputs.

4. The TCFD Energy Sector guidance included no specific reference to disclosing effective CO_2 emissions in oil and gas reserves, but it did include disclosure of Scope 3 emissions, which could be understood to include the emissions addressed by this proposal. The CDSB Framework included no guidance directly relevant to this proposal, but it is a reporting framework that references other reporting standards such as the TCFD.

Global Reporting Initiative (GRI)

The Global Reporting Initiative (GRI) is an international independent standards organization that provides reporting guidance for companies and public entities on issues such as climate change, human rights and corruption. GRI was formed by Ceres and Tellus Institute with the support of the United Nations Environment Program (UNEP) in 1997. In 2019, GRI started an effort to develop disclosure standards by sector and began the project with the oil, gas and coal industries. The sector guidance development process has included a comment period on an exposure draft that closed on October 6, 2020[59]. (The Sector Standard: Oil and Gas is expected to be released in mid-2021 and the Sector Standard: Coal is expected to be released by the end of 2021.)

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[57] https://www.sasb.org/wp-content/uploads/2018/11/Oil_Gas_Exploration_Production_Standard_2018.pdf
[58] https://www.sasb.org/wp-content/uploads/2018/11/Coal_Operations_Standard_2018.pdf
[59] In October 2020, PWYP US submitted comments on the GRI Oil and Mining Sector Reporting exposure draft that included the following feedback regarding risk disclosure related to fossil fuel reserves.

Climate resilience and transition

In the last bullet point of the third section under "What to report" (Line 513) GRI should specify that this disclosure should include both proven and probable reserves sorted by reserves type.

The use of proven and probable fossil fuels reserves sorted by reserves type as the basis to assess carbon risk is a forward looking metric, which has advantages over historic metrics such as CO2 emissions.

The reserve type should be indicated in a manner consistent with the "Default CO2 Emissions Factors for Combustion" of the IPCC's Guidelines for National Greenhouse Gas Inventories (https://www.ipcc-nggip.iges.or.jp/public/2006gl/). Aligning the disclosure of proven and probable reserves with the IPCC's categories will aid in the quantification of the effective CO2

The GRI Oil and Mining Sector Reporting exposure draft includes general references to the risks posed by the development of existing fossil fuel reserves. It also features more specific consideration in its Climate Resilience and transition section. Specifically, it recommends disclosure of the following.

"Investments in exploration of new oil and gas reserves and development of new fields (percentage of total CAPEX) Estimated reserves by resource type and emission potential of these reserves[60]*."*

GRI suggests referring to WRI's working paper *A Recommended Methodology for Estimating and Reporting the Potential Greenhouse Gas Emissions from Fossil Fuel Reserves* to calculate emission potential of fossil fuel reserves. The paper is summarized in the GHG Protocol section of this document.

Greenhouse Gas Protocol (GHG Protocol)

The Greenhouse Gas Protocol (GHG Protocol) is a partnership between WRI and the World Business Council for Sustainable Development (WBCSD) Corporate Standard. It first published reporting standards in 2001 and has evolved these to help companies and public entities account for emissions throughout their value chains.

The GHG Protocol divides emissions into three scopes. Scope 1 is direct GHG emissions, Scope 2 covers indirect GHG emissions from consumption of purchased electricity, heat or steam; and Scope 3 is indirect emissions from value chain activities. Each emission scope is further broken down into upstream and downstream activities. The effective CO_2 emissions from fossil fuel reserves could be considered Scope 3 emissions from a downstream activity, as the emissions from combusted reserves would fall under "Use of Sold Products".

Sustainability Accounting Standards Board (SASB)

The Sustainability Accounting Standards Board (SASB) is a non-profit organization, founded in 2011 to develop sustainability accounting standards. Just as the International Accounting Standards Board (IASB) and the Financial Accounting Standards Board (FASB) have established International Financial Reporting Standards and Generally Accepted Accounting Principles (GAAP), respectively, SASB's mission "is to establish industry-specific disclosure standards across ESG topics that facilitate communication between companies and investors about financially material information."

SASB has Oil and Gas Exploration and Production[61] and Coal Company[62] standards that include guidance relevant to fossil fuels reserves disclosure.

The SASB oil and gas reserves calculation recommendation is that the reporting entity should follow guidance published by the U.S. Securities and Exchange Commission (SEC) in its Oil and Gas Reporting Modernization (Regulation S-X Section §210.4-10) for the classifying of reserves as proved and probable. For coal reserves, SASB's definition is consistent with the SEC Industry Guide 7, Description of Property by Issuers Engaged or to Be Engaged in Significant Mining Operations[63], which states the following:

1. Reserves, as that part of a mineral deposit which could be economically and legally extracted or produced at the time of the reserve determination

emissions represented by the reserves of a fossil fuel company, which should be an important consideration in determining their exposure of regulatory and demand risks related to climate change.

[60]

[61] https://www.sasb.org/wp-content/uploads/2018/11/Oil_Gas_Exploration_Production_Standard_2018.pdf
[62] https://www.sasb.org/wp-content/uploads/2018/11/Coal_Operations_Standard_2018.pdf
[63] https://www.sec.gov/about/forms/industryguides.pdf

2. Proved reserves, as reserves for which (a) quantity is computed from dimensions revealed in outcrops, trenches, workings, or drill holes; grade and/or quality are computed from the results of detailed sampling, and (b) the sites for inspection, sampling, and measurement are spaced so closely and the geographic character is so well defined that size, shape, depth, and mineral content of reserves are well established.
3. Probable reserves are reserves for which quantity and grade and/or quality are computed from information similar to that used for proven (measured) reserves, but the sites for inspection, sampling, and measurement are farther apart or are otherwise less adequately spaced. The degree of assurance, although lower than that for proven (measured) reserves, is high enough to assume continuity between points of observation.

Guidance for Reporting Estimate CO_2 Emissions from Reserves

The SASB Oil, Gas and Coal standards have guidance for reporting the estimated CO_2 emissions represented by proven and probable reserves. The SASB standard suggests reporting estimated carbon dioxide emissions embedded in proved hydrocarbon reserves in Metric tons (t) CO_2-e. The standard suggests calculating the estimated potential carbon dioxide emissions from proved hydrocarbon reserves using the following formula, derived from a study titled *Greenhouse-gas emission targets for limiting global warming to 2 °C*[64] published in the journal *Nature* in April 2009 by Malte Meinshausen et al, outlined in the Figure below.

Figure 12
Emission Targets

$E = R \times V \times C$, where:

2.1.1 E are the potential emissions in kilograms of carbon dioxide (kg CO_2);

2.1.2 R are the proved reserves in gigagrams (Gg);

2.1.3 V is the net calorific value in terajoules per gigagram (TJ/Gg); and

2.1.4 C is the effective carbon dioxide emission factor in kilograms CO_2 per terajoule (kg/TJ).

Source: Malte Meinshausen

The SASB standard also suggests the following:

"In the absence of data specific to the entity's hydrocarbon reserves, carbon content shall be calculated using default data for each major hydrocarbon resource published by the Intergovernmental Panel on Climate Change (IPCC) in its 2006 IPCC Guidelines for National Greenhouse Gas Inventories. The entity shall use default carbon content values per unit of energy that is listed in IPCC Table 1.3 Default Values of Carbon Content, Volume 2: Energy, Chapter 1. The entity shall use calorific values per weight of hydrocarbon contained in IPCC Table 1.2 Default Net Calorific Values (NCVs) and Lower and Upper Limit of the 95% Confidence Intervals, Volume 2: Energy, Chapter 1. For other assumptions required to estimate the carbon content of hydrocarbon reserves, the entity shall rely on guidance from the IPCC, Greenhouse Gas Protocol, U.S. Energy Information Agency (EIA), or the International Energy Agency (IEA)."

The SASB standards for Oil, Gas and Coal go on to suggest reporting of the sensitivity of hydrocarbon reserve levels to future price projection scenarios that account for a price on carbon emissions. The

[64] https://www.nature.com/articles/nature08017

standard suggests disclosing sensitivity analyses of a report's reserves using the International Energy Agency (IEA) in its World Energy Outlook (WEO) scenarios in a manner similar to the following Figure

Figure 14
Sensitivity of Reserves to Prices

Table 3. Sensitivity of Reserves to Prices by Principal Product Type and Price Scenario

PRICE CASE	PROVED RESERVES			PROBABLE RESERVES		
(Scenario)	Oil (MMbbls)	Gas (MMscf)	Product:A (measure)	Oil (MMbbls)	Gas (MMscf)	Product:A (measure)
Current Policies Scenario (base)						
New Policies Scenario						
Sustainable Development Scenario						

Source: Malte Meinshausen

Both reporting standards also use the proximity of reserves to areas of significant sustainability importance as a suggested reporting metric. For example, a suggested metric for Biodiversity Impacts is "percentage of proved and probable reserves in or near sites with protected conservation status or endangered species habitat". The Oil, Gas and Coal standards suggest reporting the percentage of proven and probable reserves "in or near areas of conflict" and "in or near indigenous land". Finally, both standards also recommend reporting of the percentage of proven and probable reserves in countries that have the 20 lowest rankings in Transparency International's Corruption Perception Index.

Task Force on Climate-related Financial Disclosures (TCFD)

The Task Force on Climate-Related Financial Disclosures (TCFD) is an organization that was established in December 2015 by the Financial Stability Board (FSB), an international body that monitors and makes recommendations about the global financial system. The TCFD, which is chaired by Michael Bloomberg, has published a set of voluntary climate-related financial risk disclosures for various business sectors. The TCFD's first guidance document was published in 2017[65]. It includes climate disclosure guidance for the Financial Services Sector and Energy Sector that have relevance to the effective CO2 emissions in fossil fuel reserves. The TCFD's guidance indicates that GHG emissions should be calculated in line with the GHG Protocol methodology to allow for aggregation and comparability across organizations and jurisdictions.

Energy Sector Guidance

The TCFD recommendations for Energy Sector reporters include the following regarding historical GHG emissions but include no reference to fossil fuel reserves[66].

- Estimated Scope 3 emissions, including methodologies and emission factors used
- Describe current carbon price or range of prices used
- 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

[65] https://assets.bbhub.io/company/sites/60/2020/10/FINAL-TCFD-Annex-Amended-121517.pdf
[66] https://www.tcfdhub.org/Downloads/pdfs/E10%20-%20Energy%20-%20metrics.pdf

Financial Services Guidance

The TCFD Carbon Footprinting and Exposure Metrics for Financial Services companies also provide potentially useful insights for the calculations of potential GHG emissions as a proportion of investment assets. TCFD offers four suggested methods for carbon footprinting and exposure metrics, using issuer's Scope 1 and Scope 2 GHG emissions as the carbon quantity input[67]. None of these calculations or other TCFD data guidance includes fossil fuel reserves data, but it is possible they could be adjusted to do so.

Method 1 - Weighted Average Carbon Intensity

Portfolio's exposure to carbon-intensive companies, expressed in tons CO2e / $M revenue. Metric recommended by the Task Force.

$$\sum_{n}^{i}\left(\frac{\text{current value of investment}_i}{\text{current portfolio value}} * \frac{\text{issuer's Scope 1 and Scope 2 GHG emissions}_i}{\text{issuer's \$M revenue}_i}\right)$$

Method 2 - Total Carbon Emissions

The absolute greenhouse gas emissions associated with a portfolio, expressed in tons CO2e.

$$\sum_{n}^{i}\left(\frac{\text{current value of investment}_i}{\text{issuer's market capitalization}_i} * \text{issuer's Scope 1 and Scope 2 GHG emissions}_i\right)$$

Method 3 - Carbon Footprint

Total carbon emissions for a portfolio normalized by the market value of the portfolio, expressed in tons CO2e / $M invested.

$$\frac{\sum_{n}^{i}\left(\frac{\text{current value of investment}_i}{\text{issuer's market capitalization}_i} * \text{issuer's Scope 1 and Scope 2 GHG emissions}_i\right)}{\text{current portfolio value (\$M)}}$$

Method 4 - Carbon Intensity

Total carbon emissions for a portfolio normalized by the market value of the portfolio, expressed in tons CO2e / $M invested.

$$\frac{\sum_{n}^{i}\left(\frac{\text{current value of investment}_i}{\text{issuer's market capitalization}_i} * \text{issuer's Scope 1 and Scope 2 GHG emissions}_i\right)}{\sum_{n}^{i}\left(\frac{\text{current value of investment}_i}{\text{issuer's market capitalization}_i} * \text{issuer's \$M revenue}_i\right)}$$

[67] https://www.tcfdhub.org/Downloads/pdfs/E09%20-%20Carbon%20footprinting%20-%20metrics.pdf

Climate Disclosure Standards Board (CDSB)

The Climate Disclosure Standards Board (CDSB) is an international consortium of business and environmental NGOs including Ceres, GHG Protocol Initiative, the World Resources Institute (WRI) and SASB that was created during the 2007 World Economic Forum in Davos. The Carbon Disclosure Project (CDP) acts as CDSB's secretariat. The CDSB Framework does not include specific reporting guidance itself but organizes existing reporting standards including the Task Force on Climate-related Financial Disclosures (TCFD) and the International Financial Reporting Standards.

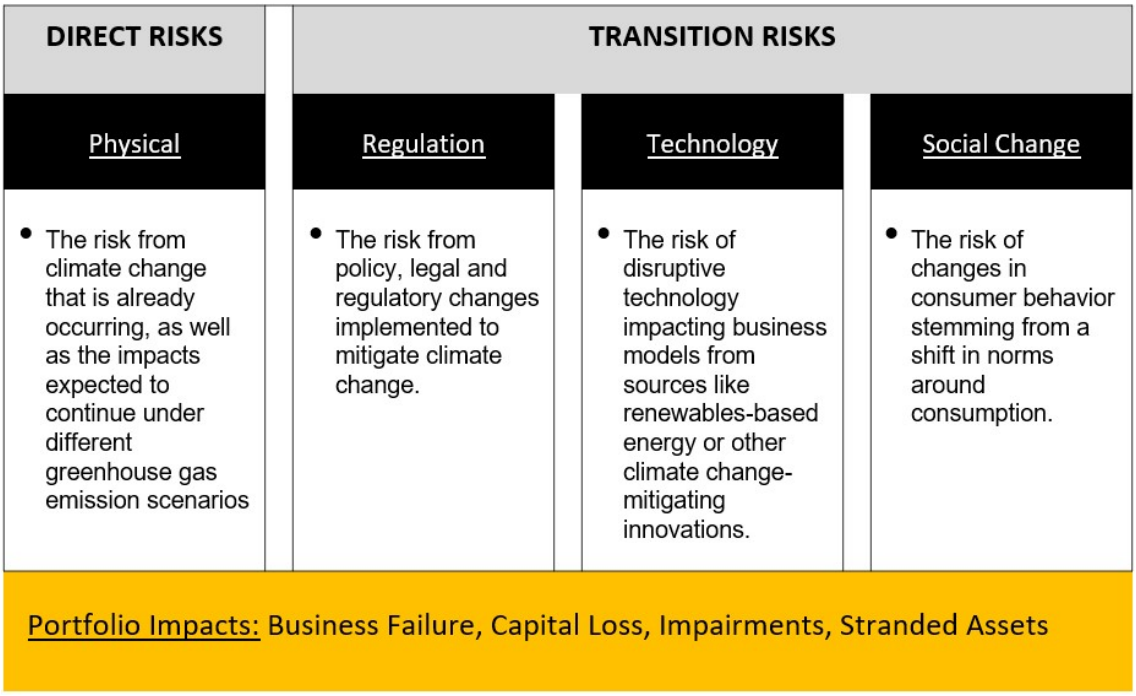
Climate Risk Disclosure

The CDSB Risks and Opportunities section identifies areas that would be broadly relevant to the disclosure of the effective CO_2 emissions of oil and gas reserves[68]. However, it lacks specific guidance about those disclosures. Instead, it references reporting principles and guidance from other organizations. For example, it points reporters to the guidance of Carbon Tracker regarding whether an organization's natural capital dependencies are subject to known limits, e.g., planetary boundaries. Carbon Tracker's CO_2 budget research could apply to this guidance.

Application of Effective CO2 Emissions Data to Securities Analysis

As discussed at the outset, investors are attempting to price climate risks in an environment of significant uncertainty. Figure 15 below highlights the broad categories of risks that portfolio investors face. All four of the risk channels outlined below can result in unexpected capital loss for the exposed firm.

Figure 15
Climate Risk Disclosure Act



Source: WK

Each channel transmits effects in a slightly different manner:

- **Physical Risks**: Physical impacts on property, plant and equipment (e.g. heatwave, drought, storm, flood, fire, sea level rise) can incur significant capital losses. Effects include, property

[68] https://www.cdsb.net/sites/default/files/cdsb_framework_2019_v2.2.pdf

damage, potential for lower productivity in regions with outdoor labor, greater energy expenditures, lower agriculture output due to declining crop yields, higher and more frequent costs associated with cleanup, remediation and insurance around extreme weather events

- **Regulatory Risk**: Regulatory impacts can include tax changes and new licensing regimes.

- **Social Risks**: Changing patterns of consumption and customer behavior impacts both investors and companies. Demand shifts force re-pricing of commodities, goods and services resulting in potential impairments and stranded assets.

- **Technology Risks**: Competition from disruptive technology has implications for CAPEX requirements and can drive margins lower. Investment horizons shorten and incumbent industries are forced to adapt.

Increasingly, analysts in fixed income are incorporating higher discount rates as a "blunt force" instrument to ensure a margin of safety when investing. In discussions with institutional investors, these discounts to the cost of capital range between 200-500 basis points. Firms facing the more extreme physical and transition risks are awarded higher discount rates. Therefore, in an analysis of upstream producers, industry standard oil and gas PV10 is sometimes closer to PV15, under select circumstances. A common heuristic employed when evaluating upstream investment opportunities is to compare the firm's enterprise value to PV10. If those reserves are discounted at a significantly higher rate, the resulting present value is lower, narrowing the field of opportunity under this metric.

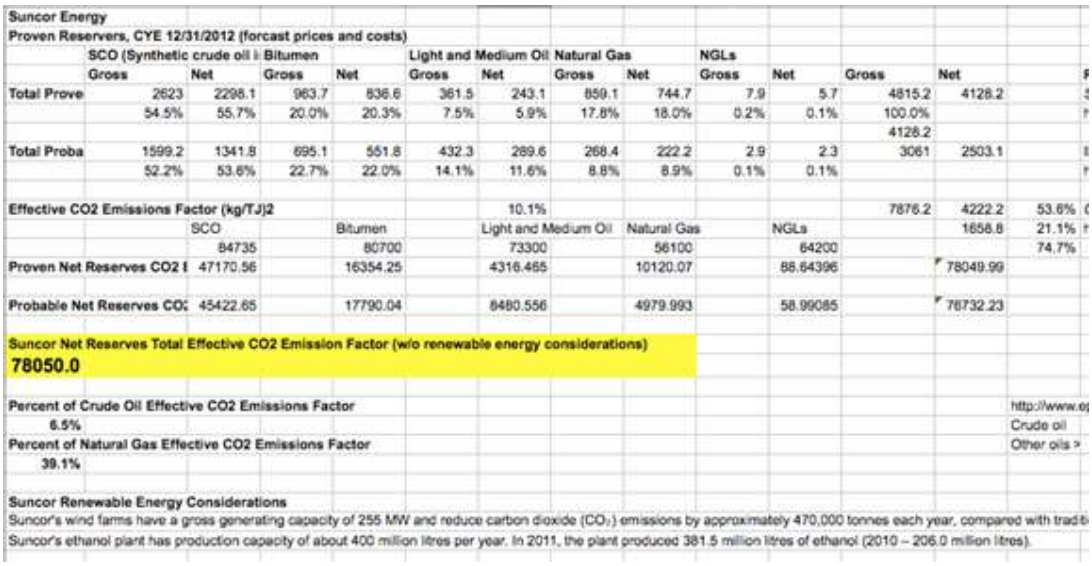
The CFA institute, a respected accreditation body for securities analysts, recommends that analysts and PMs model the impact of carbon pricing at $50-$100/tCO2 by 2030. While the impact on valuation is dependent on the industry, as well as the particular carbon pricing scheme and various emissions allowances, the direct effect will be higher production costs. And the indirect effects will come through higher energy inputs, which can pressure margins. Investors are also questioning integrated oil price assumptions in a potentially lower demand environment. This can lead to the modeling of potential impairments and stranded assets.

Against this backdrop a tool that can clarify the aggregate downstream emissions potential for the transportation segment (via the aggregation of emissions from reserves) would provide tremendous clarity on the scope of potential risks. The numbers, if ultimately available through improved disclosures, would be a valuable input for physical risk models, climate risk portfolio software tools, as well as analysis of individual upstream producers.

Applicaton of Data from Effective CO_2 Emissions Methodology

The result of the effective CO_2 emissions calculation described above is a number that can be compared to data from peer companies or to a benchmark. Benchmarks could include the effective CO_2 emissions of a company if its reserves were made up entirely of crude oil or natural gas. The follwing is an example of how the methodology could be applied to the FY2012 reserves disclosure of Suncor Energy, a firm in the spotlight at the time of the Modernization rule.

Figure 16
Suncor Energy Reserves Disclosure, FY2012



Suncor Energy
Proven Reservers, CYE 12/31/2012 (forcast prices and costs)

	SCO (Synthetic crude oil i		Bitumen		Light and Medium Oil		Natural Gas		NGLs				
	Gross	Net	Gross	Net	Gross	Net	Gross	Net	Gross	Net	Gross	Net	
Total Prove	2623	2298.1	963.7	836.6	361.5	243.1	859.1	744.7	7.9	5.7	4815.2	4128.2	
	54.5%	55.7%	20.0%	20.3%	7.5%	5.9%	17.8%	18.0%	0.2%	0.1%	100.0%		
											4128.2		
Total Proba	1599.2	1341.8	695.1	551.8	432.3	289.6	268.4	222.2	2.9	2.3	3061	2503.1	
	52.2%	53.6%	22.7%	22.0%	14.1%	11.6%	8.8%	8.9%	0.1%	0.1%			

Effective CO2 Emissions Factor (kg/TJ)2			10.1%			7876.2	4222.2	53.6%
	SCO	Bitumen	Light and Medium Oil	Natural Gas	NGLs		1658.8	21.1%
	84735	80700	73300	56100	64200			74.7%
Proven Net Reserves CO2 E	47170.56	16354.25	4316.465	10120.07	88.64396		78049.99	
Probable Net Reserves CO2	45422.65	17790.04	8480.556	4979.993	58.99085		76732.23	

Suncor Net Reserves Total Effective CO2 Emission Factor (w/o renewable energy considerations)
78050.0

Percent of Crude Oil Effective CO2 Emissions Factor
6.5%
Percent of Natural Gas Effective CO2 Emissions Factor
39.1%

Suncor Renewable Energy Considerations
Suncor's wind farms have a gross generating capacity of 255 MW and reduce carbon dioxide (CO_2) emissions by approximately 470,000 tonnes each year, compared with tradi
Suncor's ethanol plant has production capacity of about 400 million litres per year. In 2011, the plant produced 381.5 million litres of ethanol (2010 – 206.0 million litres).

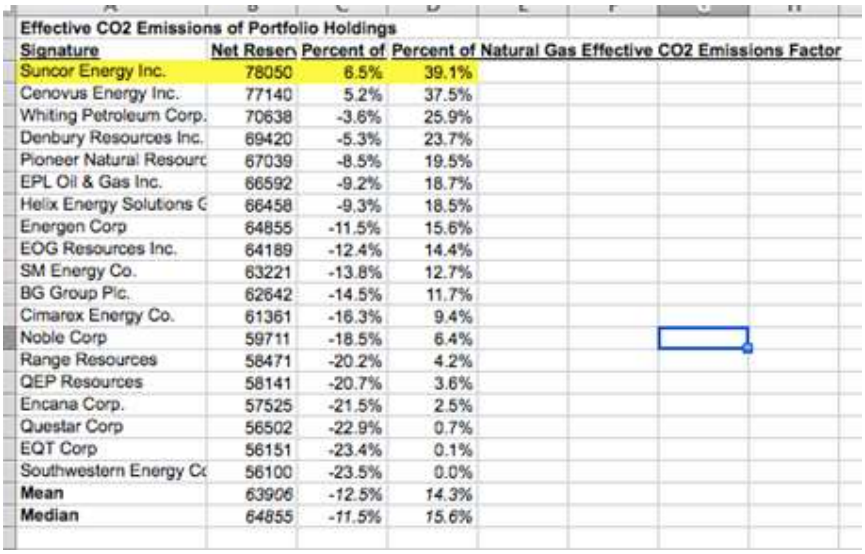
Source: WK Associates

As described above, each type of oil-equivalent proven and probable reserves total is multiplied by its corresponding IPCC effective CO_2 emissions factor, as indicated in Figure 7. In this case, these emissions factors were totalled and then calculated on a weighted basis by reserves type. The result is an effective CO_2 emissions fact of all of Suncor's reserves. Once a company's effective CO_2 emissions factor is calculated, it is benchmarked against the IPCC data to determine if it is higher or lower than a benchmark based on the effective CO_2 emissions factor of crude oil. High-carbon fuels are generally understood to be those with carbon content higher than crude oil. The precedent for using a crude oil as a benchmark for carbon content includes the Energy Independence and Security Act of 2007, which prohibits the U.S. federal government agencies from buying fuels with carbon content higher than crude oil.

Using this methodology, we can see that Suncor's FY2012 reserves CO_2 emissions factor is 78,050 (kg/TJ)2. When that number is compared to the emissions factors listed in Figure 7, we see it is a 6.5% higher factor than if all its reserves were crude oil and 39.1% higher than if all of Suncor's reserves were solely natural gas.

As Figure 17 demonstrates, effective CO_2 emission data could be applied to portfolio decision-making. In the example provided, the oil and gas exploration and production company holdings in a particular portfolio are compared based on their effective CO_2 emissions score. These data indicate that Suncor Energy and Cenovus Energy both have effective CO_2 emissions score above a crude oil benchmark. This information could help securities analysts screen portfolios for holdings that present material climate risks in this manner.

Figure 17
Comparison of Total Effective CO2 Factors



Effective CO2 Emissions of Portfolio Holdings			
Signature	Net Reser	Percent of	Percent of Natural Gas Effective CO2 Emissions Factor
Suncor Energy Inc.	78050	6.5%	39.1%
Cenovus Energy Inc.	77140	5.2%	37.5%
Whiting Petroleum Corp.	70638	-3.6%	25.9%
Denbury Resources Inc.	69420	-5.3%	23.7%
Pioneer Natural Resourc	67039	-8.5%	19.5%
EPL Oil & Gas Inc.	66592	-9.2%	18.7%
Helix Energy Solutions G	66458	-9.3%	18.5%
Energen Corp	64855	-11.5%	15.6%
EOG Resources Inc.	64189	-12.4%	14.4%
SM Energy Co.	63221	-13.8%	12.7%
BG Group Plc.	62642	-14.5%	11.7%
Cimarex Energy Co.	61361	-16.3%	9.4%
Noble Corp	59711	-18.5%	6.4%
Range Resources	58471	-20.2%	4.2%
QEP Resources	58141	-20.7%	3.6%
Encana Corp.	57525	-21.5%	2.5%
Questar Corp	56502	-22.9%	0.7%
EQT Corp	56151	-23.4%	0.1%
Southwestern Energy Co	56100	-23.5%	0.0%
Mean	*63906*	*-12.5%*	*14.3%*
Median	*64855*	*-11.5%*	*15.6%*

Source: WK Associates

Use of Effective CO2 Emission Data in Estimating Carbon Tax Impacts

Assuming the implementation of an economy-wide carbon tax based on fossil fuel production, effective CO_2 emissions factors would be an essential tool in understanding a security's exposure to such a tax on a forward-looking basis.

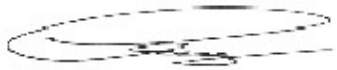
Use of Effective CO2 Emission Data in Reserves Decline Estimations

In a net asset value (NAV) approach to oil and gas securities valuation, the reserves of a company are drawn down to zero through the subtraction of year-over-year production. The resulting NAV can be compared to company estimates and the NAV calculations of other oil and gas producers. The effective CO_2 emissions of reserves could be included in the calculation of the decline of the reserves in a NAV, thereby reflecting reserves based diminished by the marketability of higher carbon reserves.

We are grateful that the Commission has undertaken this effort to understand the need for climate data and we look forward to seeing how input from this comment period is reflected in your next steps on these critical issues. Whatever action the Commission chooses to take, it is our recommendation that any climate data disclosure the SEC requires should be mandatory and not grounded in a principles-based approach. While the voluntary disclosure standards referenced in this comment have been beneficial, the consistency and standardization necessary to optimize the usefulness of climate data to investors is only possible through mandatory reporting. As indicated above, we also believe this reporting should be included in issuers' standard annual reports, such as Form 10-K or 20-F.

Thank you for the opportunity to share these insights based on our experience and consultation with colleagues in the securities field. We welcome the opportunity to engage further on any of these issues.

Sincerely,



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