Fossil fuel equivalence ratios in the oil and gas sector: discussion paper

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Transition Pathway Initiative

LSE Grantham Research Institute on Climate Change and the Environment

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- form the basis for the Climate Action 100+ Net Zero Company Benchmark Disclosure Framework assessments; and
- are published alongside the methods online and fully open access at www.transitionpathwayinitiative.org and on GitHub.

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[1] This figure is subject to market-price and foreign-exchange fluctuations and, as the sum of self-reported data by TPI supporters, may double-count some assets.

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Executive summary

As oil and gas companies face increasing scrutiny of their climate strategies, understanding the methodologies behind their emissions targets is essential. Scope 3 Category 11 emissions from the combustion of sold products represent the majority of the sector's climate impact. In recent years, more companies have started including these emissions in their reduction targets, frequently setting carbon-intensity targets based on the energy they sell. An often-used yet underexplored element in these calculations are Fossil Fuel Equivalence (FFE) ratios.

FFE ratios convert renewable electricity into hypothetical fossil-based primary energy equivalents. This method inflates the energy denominator in intensity calculations, resulting in steeper reported reductions in emissions intensity, despite no change in absolute emissions or actual energy sold. While intended to allow for comparability between renewables and fossil fuels, the use of FFE can obscure the true decarbonisation progress of companies.

This briefing paper demystifies the concept of FFE and analyses whether and how it is applied by 15 oil and gas companies with Scope 3 targets. Five companies disclose using FFE, and among them the methodologies vary significantly. BP, Equinor, TotalEnergies and Repsol provide detailed information on the assumptions underlying their FFE conversions. Shell discloses the use of FFE ratios without specifying the underlying assumptions.

FFE assumptions can significantly affect forward-looking carbon-intensity pathways and companies' apparent alignment with Paris-aligned benchmarks. Our illustrative analysis shows that applying FFEs to TPI's oil and gas benchmarks lowers the benchmark intensities by up to 36%. However, as most companies already exceed these benchmarks, the FFE adjustment currently has limited impact on the alignment of their decarbonisation commitments with the goals of the Paris Agreement.

The use of FFE in companies' carbon-intensity methodologies has implications for investors. Without further transparency on the underlying assumptions, it becomes difficult to assess real-world emissions reductions and compare company strategies. In some cases, assumptions underpinning FFE, such as constant efficiency rates or grid carbon intensities, may not reflect the evolving energy landscape.

Based on our analysis, we recommend that investors:

- Engage with companies to either disclose the assumptions and impact of FFEs on emissions or abandon the use of FFEs completely.
- Interrogate which companies utilise FFE in their current carbon-intensity calculations and in their target-setting. Label such intensity figures and targets as predicated on FFEs in documentation and analysis.
- If companies do not mention the use of FFEs and have a renewable portfolio, the de facto assumption could be that emissions-intensity targets rely on FFEs.
- Adjust oil and gas companies' financed emissions pathways to account for the existence of FFEs. Investors should be aware this may impact on companies' alignment with low-carbon scenarios.
- Signal a preference for targets that cannot be distorted. For oil and gas companies, this means setting both absolute and intensity targets or oil and gas production decline targets.

1. Introduction

Decarbonising the energy system is at the heart of the low-carbon transition. A shift away from fossil fuels towards low-carbon sources of energy is essential to meet the goals of the Paris Agreement (IEA, 2023). In this context, the climate strategies of oil and gas companies have come under scrutiny from investors due to these companies' contribution to global carbon emissions and significant exposure to transition risk. The vast majority of the sector's climate impact results from the combustion of sold products by the end consumer, i.e., Scope 3 Category 11 emissions (Dietz et al., 2021). Consequently, there is a particular focus on companies' plans to decarbonise their product portfolios.

Over the past five years, several frameworks have emerged to assess the progress of oil and gas companies on emissions reductions. The TPI Centre has contributed to these efforts, publishing the first version of its methodology to assess the ambition of companies' decarbonisation efforts in 2019 (Dietz et al., 2019). In the initial round of assessments, no oil and gas companies included Scope 3 Category 11 emissions in their decarbonisation pledges. However, this changed in 2020 when several European majors published their first set of net zero targets.

Oil and gas companies have adopted various approaches to setting reduction targets for their Scope 3 Category 11 emissions, and careful consideration is required when evaluating them. Often, the devil is in the detail, as even slight changes in product definitions, emissions scopes or entity coverage can lead to significantly different assessments. In May 2020, TPI published a briefing paper to clarify several technical details regarding targets set by six European oil and gas companies: BP, Eni, OMV, Repsol, Shell, and TotalEnergies (Dietz et al., 2020). In more recent years, many more oil and gas companies worldwide have followed suit and declared commitments to reduce their Scope 3 emissions from the combustion of their sold products. Among the 37 oil and gas companies engaged by the investor coalition Climate Action 100+, 15 companies included Scope 3 Category 11 in their target setting in 2024.

Against this backdrop, this briefing paper aims to demystify a technical term frequently featured in oil and gas companies' Scope 3 emissions targets: fossil fuel equivalence (FFE) ratios. It will first introduce the concept of FFE and discuss the assumptions underlying it. Then, it will assess the impact of FFE on the alignment of companies' decarbonisation commitments with the goals of the Paris Agreement. Lastly, it derives implications and recommendations for investors' engagement work with oil and gas companies.

The goal of this paper is to enhance stakeholders' understanding of oil and gas companies' decarbonisation commitments and support investors in their engagement efforts. It thereby complements existing assessment standards, such as the Net Zero Standard for Oil and Gas developed by the Institutional Investor Group on Climate Change (IIGCC), for which the TPI Centre published a first round of results in March 2024 (IIGCC, 2023; Sharp et al., 2024).

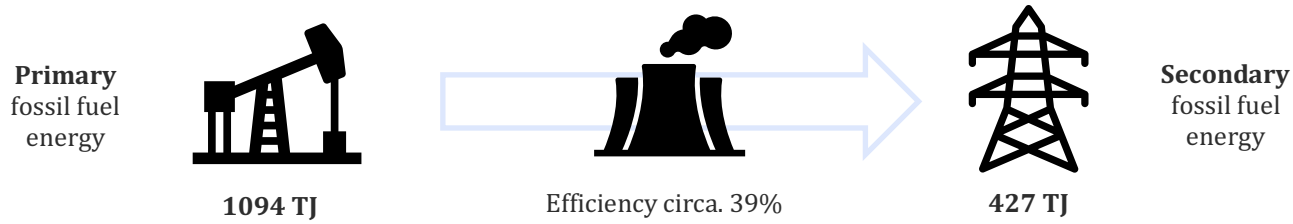
2. What is an FFE ratio?

Carbon emissions reduction targets can be set on either an absolute-emissions or an emissions-intensity basis. In the oil and gas sector, companies often use both methods. For emissions-intensity targets, absolute emissions from the use of energy products are divided by a measure of the energy produced or sold by the company.

Given the variety of energy products sold by integrated oil and gas companies, i.e., those operating at all stages of the value chain, adding up different types of energy necessitates setting energy accounting boundaries and making some conversions. In particular, the distinction between primary and secondary energy is important. Primary energy refers to the energy stored in natural resources prior to any human conversion, e.g., the energy content of 1 billion cubic feet (bcf) natural gas. Secondary energy refers to usable energy after conversion processes, e.g., 100 Megawatt hours (MWh) of electricity generated from the combustion of natural gas.

In the TPI Centre's oil and gas methodologies, all companies are assessed on the basis of sold primary energy. To allow for a holistic analysis of a company, sold secondary energy is converted back into primary energy, accounting for efficiency losses, as illustrated by the following example.

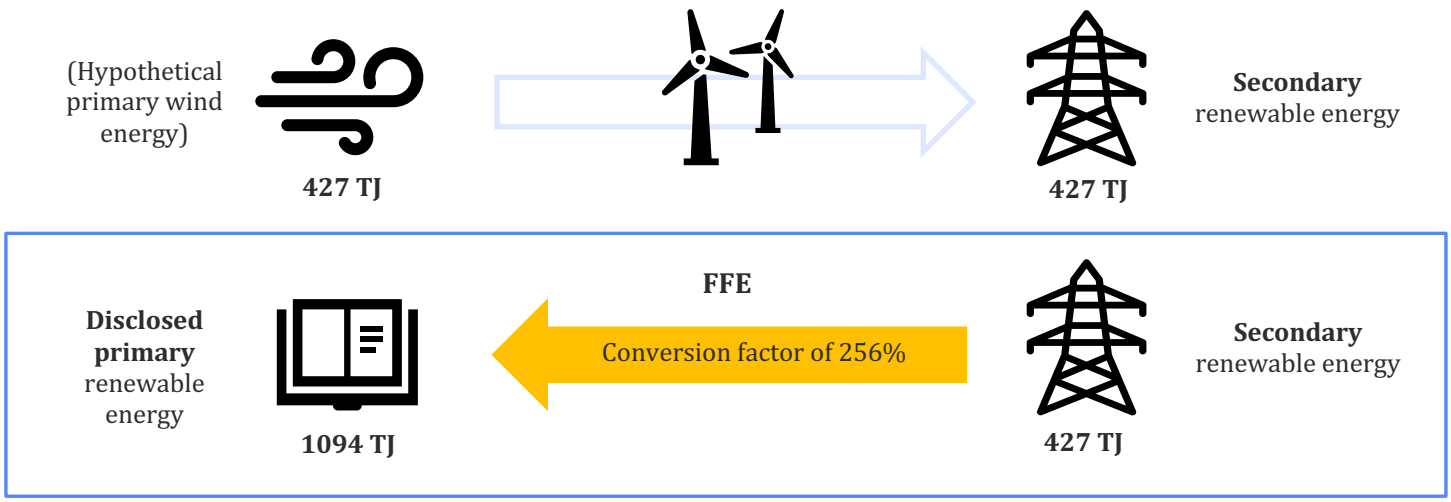
Figure 1 – Fossil fuel primary and secondary energy conversion



- The average net calorific value of 1 bcf (billion cubic feet) of natural gas is 1,094 TJ (Terra Joules).
- The average efficiency rate of a gas power plant in the world is 39%.
- If 1bCF of natural gas is combusted to generate electricity, the final usable energy is 426.66 TJ (1,094 TJ * 0.39). To convert this usable energy into MWh, we divide by 3.6, resulting in approximately 118,517 MWh.
- To compare the sales of 1 bcf of natural gas and 118,517 MWh of gas-powered electricity reported by a company, the 118,517 MWh is converted back into primary energy which is equivalent to 1 bcf of natural gas.

However, the situation is different for electricity generated from renewable sources. This is because there is fundamentally no primary energy for solar or wind power. The energy content of solar power is measurable as soon as it has been converted into electricity through a generator, at which point it is already useable secondary energy. TPI therefore considers electricity generated from renewable sources as primary energy without conversion. This approach is consistent with energy accounting in the world energy balances and emissions reduction scenarios calculated by the International Energy Agency.

Figure 2 - Hypothetical primary and secondary energy for renewable energy and the FFE transformation



The FFE ratio is a different approach to comparing electricity generated from renewable energy to other primary energy sources. Instead of considering the final energy from renewable sources, companies can use it to convert renewable energy into a hypothetical primary energy equivalent. Specifically, it considers how much fossil-based primary energy would be needed to generate an equivalent amount of final energy output. Another way to view FFE is as an indicator of the amount of fossil-based energy that was avoided by generating renewable energy.

Based on feedback TPI has received from companies, the primary rationale for using FFE appears to be to allow for better comparisons with fossil fuel output, which is reported on a primary energy basis. If companies evaluate the impact of individual projects on their carbon intensities, the use of FFE may strengthen the investment case for renewable energy internally. By grossing up renewable energy volumes, using FFE ratios leads to steeper reductions in carbon intensities by increasing the sold energy in the denominator. However, the conversion has no impact on companies' absolute emissions or amount of renewable energy sold.

3. Different flavours of FFE ratios

Of the 37 oil and gas companies engaged by the Climate Action 100+ initiative (CA100+) in 2024, 15 companies include Scope 3 Category 11 emissions in their target setting. Since FFE apply only to sold energy products, they are irrelevant for absolute emissions reduction targets. Among the 12 companies that set carbon-intensity targets – where sold energy products form the denominator – five explicitly disclose using FFE in their calculations. Table 1 summarises the approaches taken by the 15 CA100+ companies with Scope 3 Category 11 emissions reduction targets. Several differences in the FFE methodologies across companies stand out.

Table 1 – Scope 3 target setting and FFE approach of CA100+ companies.

Company Name	HQ region	2025 target	2030 target	2050 target	Includes FFEs	Details FFE calculation
BP	Europe	10%	15%	100%	Y	Y
Eni	Europe	-	15%	100%	N	-
Equinor	Europe	-	20%	100%	Y	Y
Origin Energy	Australasia	-	40%	100%	Not disclosed	Not disclosed
Repsol	Europe	-	28%	-	Y	N
Shell	Europe	9%	20%	100%	Y	N
ENEOS	Asia	1%	8%	50% (2040)	Not disclosed	Not disclosed
Ecopetrol	South America	-	-	50%	Not disclosed	Not disclosed
TotalEnergies	Europe	-	25%	100%	Y	Y
Chevron	North America	-	5%	-	Not disclosed	Not disclosed
Marathon Petroleum	North America	-	15% (abs)	-	-	-
OMV	Europe	6%	20%	100%	Not disclosed	Not disclosed
Phillips 66	North America	-	15%	-	Not disclosed	Not disclosed
Sasol	Africa	-	20% (abs)	100%	-	-
SK Innovation	Asia	-	75% (25% abs)	100%	-	-

This table illustrates the approaches taken by 15 CA100+ oil and gas companies regarding the inclusion of FFEs in their Scope 3 target setting as of 1/11/24. The colour coding indicates the alignment of these companies' carbon emissions reduction targets with a 1.5 Degrees Scenario based on the CA100+ Net Zero Company Benchmark (green = aligned; red = not aligned/unable to assess). The analysis is based on company disclosures. Companies were asked to provide feedback on the accuracy of the information.

4. Impact of FFE ratios on carbon intensities

The exact value of the current FFE depends on assumptions about the carbon intensity of the hypothetical primary fossil-based energy. For instance, assuming coal is the primary energy source will result in a higher FFE ratio compared to assuming it is natural gas.

Companies typically base their FFE calculations on the efficiency of thermal power plants in various regions worldwide. Only BP, TotalEnergies and Equinor provide sufficient detail on their FFE calculations to understand the magnitude of their current FFE value:

- **BP** assumes an FFE of 40.5% for the period 2020-2025, based on the assumed efficiency rate of a standard thermal power plant (BP, 2024: p.104). In practice, this implies that 100 MWh of sold renewable electricity will be counted as (100/0.405 =) 247 MWh in BP's sold energy denominator.
- **Equinor** assumes an FFE of 36.8%, also based on the assumed efficiency rate of a standard thermal power plant (Equinor, 2022: p.26). In practice, this implies that 100 MWh of produced renewable electricity will be counted as (100/0.368 =) 272 MWh in Equinor's produced energy denominator.
- **TotalEnergies** assumes a value of 38% (TotalEnergies 2024: p.16). In practice, this implies that 100 MWh of sold renewable electricity will be counted as (100/0.38 =) 263 MWh in TotalEnergies' sold energy denominator.
- **Repsol** includes a "location-based emission shift" term that creates a similar effect by subtracting avoided emissions due to renewable electricity sales from its total carbon footprint (Repsol, 2024: p.77).[2]
- **Eni** explicitly uses the physical energy content of renewable electricity rather than an FFE calculation (Eni, 2020: p.7).
- **Shell** has disclosed that it uses FFE conversions but has not detailed the specific values that it uses (Shell, 2023: p.70). **Origin, ENEOS, Ecopetrol, Chevron, OMV and Phillips 66** have not disclosed whether they use FFE conversions.
- **Marathon Petroleum**, **Sasol** and **SK Innovation** have set only absolute Scope 3 targets (Marathon, 2022: p.8; Sasol, 2023: p.41; SK Innovation, 2021: p.12).

[2] In recent disclosures, Repsol has adopted a traditional FFE calculation methodology (Repsol, 2025: p.116). As these disclosures were published after the feedback period for this discussion paper, they will be reviewed as part of TPI's next Carbon Performance assessment cycle.

5. Evolution of FFE ratios in the future

Low-carbon scenarios typically assume efficiency gains in energy generation over time. Conceptually, the FFE ratio should therefore vary over time. As electricity generation becomes more efficient, the FFE ratio is expected to increase. Most companies do not disclose details on their forward-looking assumptions, which suggests that they may assume a constant FFE in their calculations. BP is the only company that clarifies the impact of efficiency gains, assuming an FFE of 45% by 2050 which represents a 4.5 percentage point increase compared to 2020.

In addition to efficiency gains, low-carbon scenarios assume global climate targets will be met through the replacement of fossil energy with renewables in the global energy mix. This transition might also impact forward-looking FFE factors. If the electricity grid becomes largely fossil-free by 2050, the hypothetical fossil-based primary energy equivalent becomes less relevant. Specifically, if the FFE calculation assumes that renewable electricity replaces fossil electricity in the grid, the FFE adjustment should become negligible over time due to the reduced share of fossil-based electricity. TPI has not found any commentary from companies on the impact of grid decarbonisation on forward-looking FFE calculations. Only Repsol notes that the impact of its "location-based emission shift" term will reduce over time as electricity grids decarbonise.

6. Impact of FFE ratios on companies' alignment

TPI calculates historical and current carbon intensities of oil and gas companies by applying emissions factors to their energy sales. As renewable energy sales are typically reported as final energy, e.g., electricity sales in MWh, the historical and current intensities in company pathways do not include FFE.

However, assessing the impact of FFE on companies' emissions targets and therefore on their future carbon intensities is challenging. As discussed above, companies' disclosure of the specific FFE methodologies used is limited and does not always allow for the calculation of companies' current and future FFE values. Additionally, the effect of FFE depends considerably on the anticipated share of renewable energy in companies' future energy portfolios—a figure that is rarely disclosed.

While it is difficult to accurately estimate companies' future carbon intensities net of FFEs, it is possible to use FFE values to adjust the decarbonisation benchmarks against which companies are compared instead. Below we provide an illustrative example to approximate the impact of FFEs on companies' alignment. Specifically, we apply BP's FFE value of 40.5% for 2020 and 45% for 2050 to renewable energy sources (solar, wind and hydro), with linear interpolation for the years in between. This means we scale up the renewable energy component in the denominator of the benchmark – total energy – by a factor of 1/0.405 = 2.47 for 2020 and a factor of 1/0.45 = 2.22 for 2050. The increase in the denominator shifts the intensity pathways downwards (Figure 1). The adjustment has a considerable effect on the benchmarks in the short and medium term.

Figure 2 – The impact of the FFE adjustment on the current TPI Oil and Gas Benchmark.

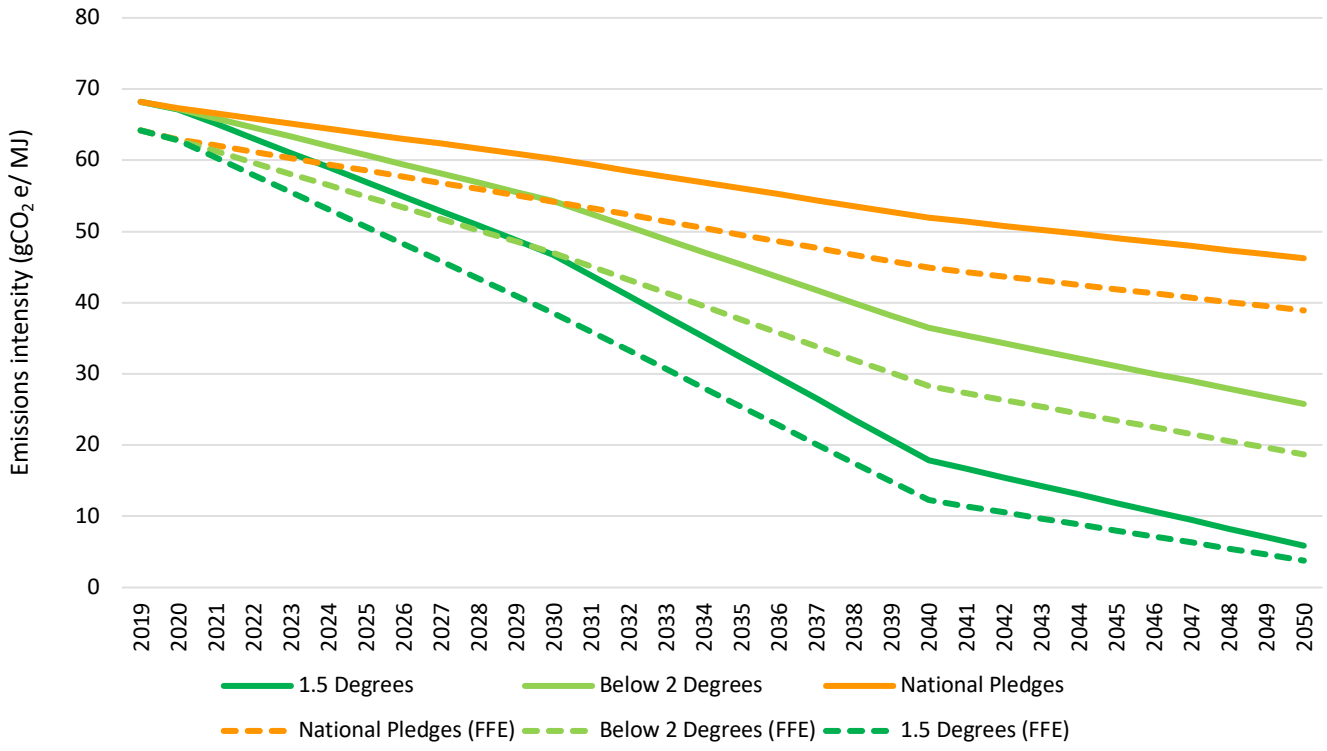


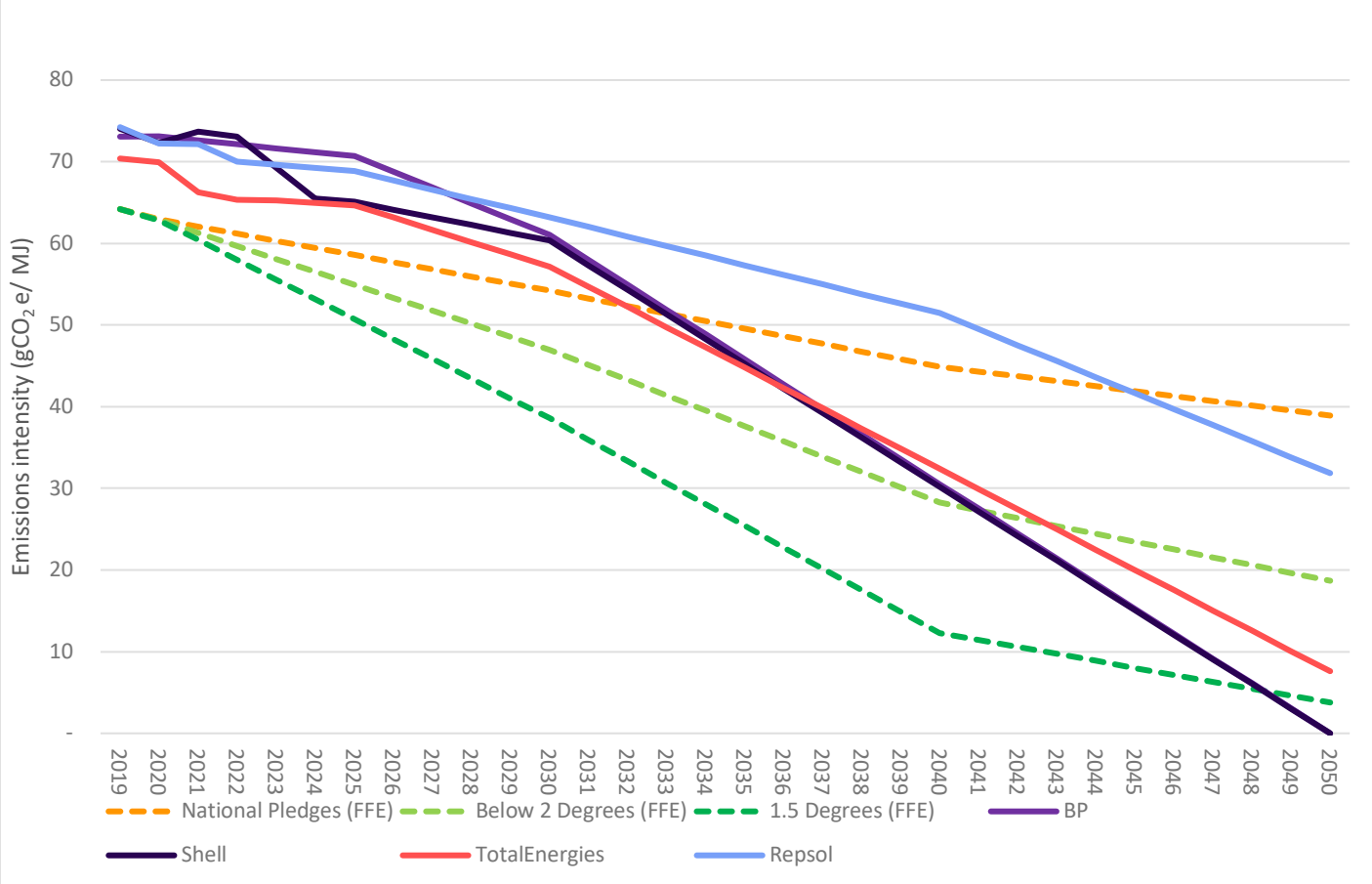
Table 2 shows the effect of the FFE adjustment in different years and scenarios. The impact of the adjustment grows over time and is strongest in the 1.5C scenario, where it reduces the 2050 carbon intensity by 36% from 5.88 to 3.78 gCO2e/MJ.

Table 2 – The percentage impact of the FFE adjustment on the benchmark.

	2025	2035	2050
National Pledges	-8%	-12%	-16%
Below 2C	-10%	-17%	-28%
1.5C	-11%	-21%	-36%

Figure 2 presents the results of assessing the four companies that explicitly use FFEs against the adjusted benchmarks.[3] Since the companies' emissions pathways are already above the unadjusted TPI benchmarks, reducing those benchmarks through the FFE adjustment has minimal effect on companies' alignment category. The only change is to TotalEnergies in the short term – it moves from being aligned with the National Pledges scenario to not being aligned with any scenario. However, the FFE adjustment does have a significant quantitative effect, particularly in the short and medium term.

Figure 3 – The impact of the FFE adjustment on companies' alignment with the TPI benchmarks.



These results suggest that FFE can affect alignment assessments of companies' emissions targets. This raises the question of whether relevant benchmarks should account for FFE, as illustrated above. However, due to the variety of approaches companies take to FFE, it is unclear which ratio should be used for the adjustment. More importantly, while such an adjustment might allow for fairer comparisons between the benchmarks and companies that include FFE in their target setting, it unfairly penalises those that set targets without FFE.

[3] We are not displaying Equinor's targets since they rely on customer mitigation actions which cannot be assessed using the TPI Carbon Performance methodology for the oil and gas sector.

Alternatively, company pathways could be adjusted to exclude FFE from the target calculations. However, as explained above, this would require disclosure of the specific FFE ratios used and the projected future share of renewable energy in companies' product portfolios. Since neither piece of information is normally disclosed, this approach is not currently feasible.

Above all, FFE conversions do not directly represent the energy consumed and produced in the global economy. For these reasons, TPI does not apply this approach in its Carbon Performance assessments.

7. Implications for investors

The analysis in the previous section demonstrates the key issue that FFE presents for investors: real-world emissions reductions associated with the intensity targets of the world's largest oil and gas companies become difficult to calculate. As demonstrated above, FFE ratios can have a material impact on companies' forward-looking decarbonisation pathways. While the degree of alignment that companies achieve (e.g., aligned with National Pledges) does not change substantially at the moment, it could in the future as the gap between companies' ambitions and specific scenarios or temperature outcomes narrows. Investors looking to understand transition risk or invest with a temperature goal in mind may struggle to do so while FFE calculations remain opaque.

Moving beyond the potential mismatch between company disclosures and the benchmarks, the use of FFE ratios means the output of individual projects and their impact on emissions accounting may also be mismatched. Individual energy projects are usually disclosed either on a capacity basis or with targets for energy sold. Without clarity on the methodology used for FFE calculations, investors will not be able to replicate companies' carbon-intensity calculations. Investors should also be aware that these calculations come in a variety of forms, such as Repsol's partial substitution method, or avoided emissions.

As long as FFE calculations remain black boxes, their underlying methodologies cannot be interrogated. The few disclosed methodologies contain assumptions that are unlikely to reflect the reality of the transition, such as the maintenance of constant efficiency ratios and grid intensities. These assumptions further inflate the impact of FFEs on future emission intensity reductions. This has the potential to lead to less real-world decarbonisation than necessary from companies in the short term, often referred to as the crucial decade for climate change (IPCC, 2023). As oil and gas companies could align through artificially inflating the contribution of renewables, investors may expect a more pronounced shift in their business models than the targets actually imply.

8. Recommendations for investors

Given the impact of FFE calculations on the ambition of companies' emissions targets, investors should consider addressing them as a high priority. The use of FFE ratios is common and a concerted effort will be required to shine a light on their impact on emissions accounting. Investors could consider the following steps:

- Engage with companies to either disclose the assumptions and impact of FFEs on emissions or abandon the use of FFEs completely.
- Interrogate which companies utilise FFE in their current carbon-intensity calculations and in their target-setting. Label such intensity figures and targets as predicated on FFEs in documentation and analysis.
- If companies do not mention the use of FFEs and have a renewable portfolio, the de facto assumption could be that emissions-intensity targets rely on FFEs.
- Adjust oil and gas companies' financed emissions pathways to account for the existence of FFEs. Investors should be aware this may impact on companies' alignment with low-carbon scenarios.
- Signal a preference for targets that cannot be distorted. For oil and gas companies, this means setting both absolute and intensity targets or oil and gas production decline targets.

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