Carbon cognitive; Turning guess work into quantitative emissions modelling and representation.

Carbon cognisant approach to project delivery.

David Cole & Nicola Wood

Transitioning to net-zero is a monumental change to the way we live and yet emissions disclosures typically consider only the easy to measure, low impact, attributes.

KBR delivers an analytical carbon lifecycle solution, CleanSPEND^{SM}, that outturns cognitive and insightful carbon footprint analytics for any offshore installation.

Abstract.

The transition to a "Net Zero" world has been described by The United Nations "one of the greatest challenges humankind has faced"[1]. Achieving net zero means cutting greenhouse gas (GHG) emissions to as close to zero as possible, this is different to absolute zero. Where absolute is not reached, any emissions that continue to be produced are offset (or counter balanced) by being absorbed back into the natural carbon cycle through the oceans or forests. To achieve anywhere near to net zero a monumental change is required to the way we live, work, operate and consume natural resources.

To facilitate this change, organisations, institutions and governments are subjected to the rapidly evolving world of carbon emissions disclosures. This evolution is driven partly in response to government policy, but also through the changing way that stakeholders, financial markets and regulators want to engage with emissive industries. Commitments have been made by 28 leading energy operators to reduce emissions in the easy to measure scopes 1 and 2.

However, less than half of the energy operators don't have any kind of targets that cover scope 3 and direct actions to deliver these board level commitments continues to reply on tallying together the easy to measure attributes to come up with subjective results. KBR has spent 2 years collating, measuring, analysing, challenging, and validating project design, execution, and operation data to deliver a carbon accounting solution, CleanSPEND℠, that outturns quantitative carbon footprint calculations for any new offshore installation.

Using a hybrid team of highly experienced engineers, scientists, programmers, mathematicians, and data scientists, the CleanSPEND℠ solution delivers a robust carbon calculation that spans all three emissions scopes across the entire project lifecycle in any design, fabrication, and operation locations. CleanSPEND℠ takes the guess work out of carbon footprint calculation, providing carbon accounting analytics to ensure energy projects deliver on their emissions commitments, make carbon cognisant decisions, and lead the way in the transition to a net-zero world.

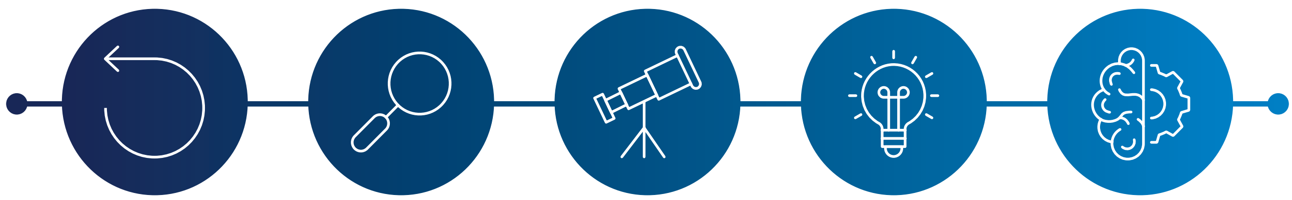
Introduction.

KBR's approach to carbon footprint determination (called CleanSPEND[SM]) was developed through a collaboration between technical experts, scientists and engineers with mathematicians, programmers and data scientists to deliver accurate carbon analysis, backed-up by first-hand experience of project design and operation.

This white paper presents CleanSPEND[SM] which articulates a clear roadmap of carbon emissions identification, quantification, and cognition using a framework of data analytics from descriptive, historical reporting, through to the right sight, what if, analysis.

CleanSPEND[SM] leverages data analytics techniques combined with energy design and emissions data to right sight our clients in their quantification, examination and cognition of their carbon footprint. KBR brings accurate data analytics to deliver accurate, actionable and defendable climate disclosures.

Exhibit 1, illustrates the clear path CleanSPEND[SM] adopts in the journey to identify, quantify and determine the lowest carbon footprint scenario for any offshore oil and gas project.



Hindsight
Describe "**what happened**", quantify and classify emissions that have been produced. Facilitates historical benchmarks.

Oversight
Diagnose "**why it happened**" using data mining to deliver visualisations, trends and patterns.

Foresight
Predict "**what will happen**" if a project design is implemented using machine learning and forecasting capability.

Insight
Prescribing "**what we should do**" to optimise designs to limit GHG intensity, simulate options and provide recommendations.

Right Sight
Cognitive scenario development to determine "**what if**" a design is changed and how we continuously deliver carbon reductions.

Exhibit 1 - KBR CleanSPEND[SM] data analysis approach to carbon emissions determination.

CleanSPEND℠ Data Analysis Approach

1. **Hindsight - what happened?**
   Descriptive analytics is the first step in the clear path to realising the emissions you are responsible for producing as a historical view of what's happened. Leveraging KBR's extensive history of designing offshore oil and gas facilities, we provide a historical benchmark of emissions against which future designs can be compared and deviations assessed.
2. **Oversight - why it happened?**
   Diagnostic analytics that use data mining and graphical visualisations to deliver trends and patterns of why a project has resulted in returning a given carbon footprint.
3. **Foresight - what will happen?**
   Predictive analytics uses machine learning to deliver predictions and forecasts of what will happen if a current design is taken through to completion.
4. **Insight - what we should do?**
   Prescriptive analytics allow the client to optimise the design of a project to deliver the lowest possible carbon footprint. This is facilitated through simulation and the generation of recommendation to decarbonise.
5. **Right sight - what if?**
   Cognitive analytics is the final level of data analytics which leverages the capability to develop "what if" scenarios to learn and deliver truly low carbon energy.

Commitments made - How to deliver.

On the 12th of December 2015, the historic Paris Agreement was finalised in the battle to manage climate change and its negative impact.

World leaders at the UN Climate Change Conference (COP21) set out a long term agreement to support and guide international cooperation such that:

- global greenhouse gas emissions are substantially reduced to limit the global temperature increase,
- countries commitments are reviewed every five year to ensure they remain aligned to the agreement, and,
- financing is provided to developing countries to enhance abilities to adapt to climate change.

The impact of climate change has been without question for many decades manifesting as adverse weather phenomenon, harming farming and agriculture and the survival of endangered species.

The target of limiting global temperature increase to 2°C, whilst pursuing efforts to limit the increase even further to no more than 1.5°C was set out in 2015. To achieve this global greenhouse gas emissions, need to be reduced by 45% by 2023 and reach net zero by 2050. The energy sector is responsible for three-quarters of all global greenhouse gas emissions.

But what does this mean for the energy sector? How do we ensure the delivery of critical energy infrastructure is not delayed whilst also dramatically slashing the carbon intensity of those emissions? How do we do contribute to these goals when we have not challenged what our existing carbon footprint might be.

TODAY 194 PARTIES HAVE JOINED THE PARIS AGREEMENT.[1]

1. United Nations, Climate Action, The Paris Agreement: **www.un.org/en/climatechange/paris-agreement**

Exhibit 2 outlines the commitments major organisations in the energy sector have made in their goals to reduce Scope 1 and 2 emissions and some go as far as also including Scope 3 emissions.

Energy Organisation	Scope 1 & 2	Scope 3	Net-Zero Commitment
BP	20% reduction by 2025, 50% reduction by 2030 compared to 2019 baseline.	20% reduction by 2025, 35-40% by 30% compared to 2019.	2050, across all scopes.
ENI	50% reduction in emissions from upstream activities by 2024, compared to 2018, net zero by 2030. Net zero emissions from all group activities by 2040.	25% reduction of emissions by 2030 compared to 2018 and 65% by 2040. 15% reduction of net carbon intensity of energy products sold by 2030 compared to 2018 and 40% by 2040.	2050, across all scopes.
Repsol	55% reduction by 2030 at operated assets, compared to 2016.	30% reduction in emissions by 2030 compared to 2016.	
Shell	50% reduction by 2030 compared to 2016, on an operated asset.	Reduce intensity by 9-12% by 2024, 20% by 2030, 45% by 2035, and 100% by 2050, compared with 2016.	2050, across all scopes.
Total	40% reduction (at operated facilities) by 2030, compared to 2015.	30% reduction by 2030 compared to 2015.	2050, across all scopes.
Equinor	50% reduction by 2030, compared to 2015. Norwegian operations will reduce emissions by 70% by 2040.	20% by 2030, 40% by 2035 and 100% by 2050.	2050, across all scopes.
ExxonMobil	40% reduction in emissions intensity by 2030 compared to 2016, at operated assets.	20% reduction by 2030.	2050, scope 1 and 2 only.
ConocoPhillips	40% reduction in emission intensity by 2030 compared to 2016, at operated and net equity assets.	None.	2050, scope 1 and 2 only
Chevron	Net zero for upstream emissions by 2050. 50% reduction in methane emissions intensity of scope 1 emissions by 2028.	Reduce scope 3 intensity more than 5% by 2028, compared to 2016 levels.	2050, scope 1 and 2 only.

Exhibit 2 - Scope 1, 2 and 3 emissions commitments from major energy organisations.[3] Source: GlobalData Analysis

These commitments are significant. But before we even begin to deliver on these commitments, we first need to:

- Quantify the level of emissions we are currently producing,
- Understand what the emission categories are, and where our emissions reside,
- Consider not just the relatively easy box of Scope 1 and 2 emissions, but also into the harder to reach, assess, and abate Scope 3 upstream and downstream emission.

Once an organisation knows where it has been in terms of its carbon footprint, only then can we begin to challenge the numbers, identify their sensitivities, and define a lower carbon solution, to make informed carbon cognisant decisions and define a pathway to net zero.

Until now the answer has been limited and extremely varied in approach, primarily turning to:

- The "easy wins," such as changing all logistical movement to sea freight versus the higher GHG intensity of air freight,
- Adopting qualitative approaches which use a non-numerical approach with descriptive or subjective data,
- Rely on paying into carbon offsetting schemes, the validity and effectiveness of which remains to be proven[4].

Qualitative research should not be disregarded, but as the carbon economy progresses, the need for accurate data led reporting based on analytics, verifiable data and mathematical techniques is here. This is driven further by the impact on project profitability, carbon-based taxation and credits, as well as the increasing customer demand for low carbon products.

Creating value on your journey to Net-Zero.

In 2021 KBR Inc. started the journey of answering all these questions, creating insights into carbon emissions and more. For offshore oil and gas projects, including connecting drilling lines and pipework to shore, we define the emissions footprint, from project conception through its design, shipping and fabrication, installation, and commissioning into operations and finally into the decommissioning of the project. This encompasses all emissions scopes as defined by the United Nations climate program throughout the whole life execution.

Alternative solutions in other sectors, such as commercial buildings, have also started to appear since 2021. Work in this sector by organisations such as IES, Mott MacDonald and WSP5 has looked at the impact of constructing office buildings where the range of equipment and material is limited to a much greater extent to structural steel, aluminium, and concrete. But solutions that reach into the complex world of energy projects, where there is an immense variety of equipment, suppliers, fabricators, locations, shipping requirements, operations and maintenance demands have, to date not been available.

As well as providing quantitative insights into the complex world of energy projects, KBR's CleanSPEND℠ solution reaches across all three emissions scopes, something that few have tried to do in any sector.

Case studies - Descriptive and diagnostic carbon data analytics.

Data analytics road maps show a clear relationship between the type of analytics delivered and what answer they address, Exhibit 3 (on the next page). Simple statistics deliver descriptive results, telling the reader what happened. This is the realm of most carbon emission calculations available today, providing retrospective reporting of the carbon emissions that have already been emitted to the atmosphere.

Functionality of CleanSPEND℠ has enabled KBR to undertake original research into the total carbon emissions of existing, operational offshore platforms in comparison to the megajoules of energy they have delivered. By converting all offshore platforms included in this research activity into megajoules of energy, we have been able to compare platforms delivering both oil and gas products at the point of offtake. By including a variety of platform types (deep water, shallow water, bridged linked, including, and excluding accommodation modules) we identify emissions trends and implications as well as outliers against the benchmark. Exhibit 4 (page 12), includes a representative sample of these platforms and illustrates the trend line between platforms.

This type of "descriptive analytics" is a good first step in understanding **WHAT HAS HAPPENED,** what emissions the energy sector is responsible for producing. This research also enables KBR to address the next level of data analytics, **DIAGNOSING WHY** some platforms have higher emissions than others. Clearly design factors will be critical in the final emissions intensity, such as platform size/weight/operating duration and presence of an accommodation module.

But within this high-level classification of platforms, there remains several outlier projects which have distinctly higher emissions factors than their counterparts. Data mining of trends and patterns diagnoses why these projects may be particularly carbon intensive.

Descriptive and diagnostic analytics provided by CleanSPEND℠ are good first steps of what has happened, we now know where we have been, and this enables KBR to deliver projects that will have a better carbon footprint than ever before.

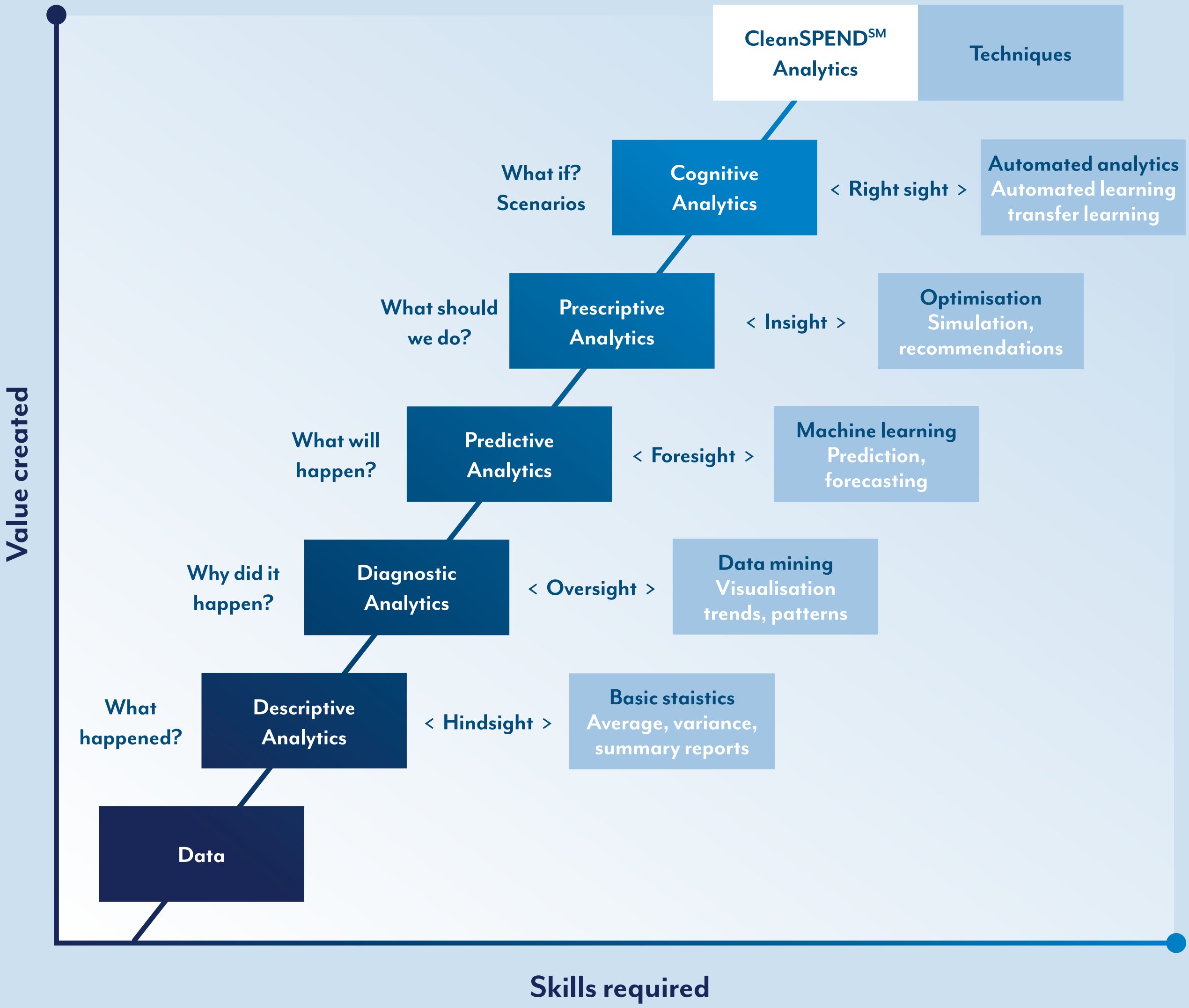


Exhibit 3 - CleanSPEND℠ maximising the application of data analytics techniques creating value, insight, and right sight

Total emissions of platforms against energy produced.

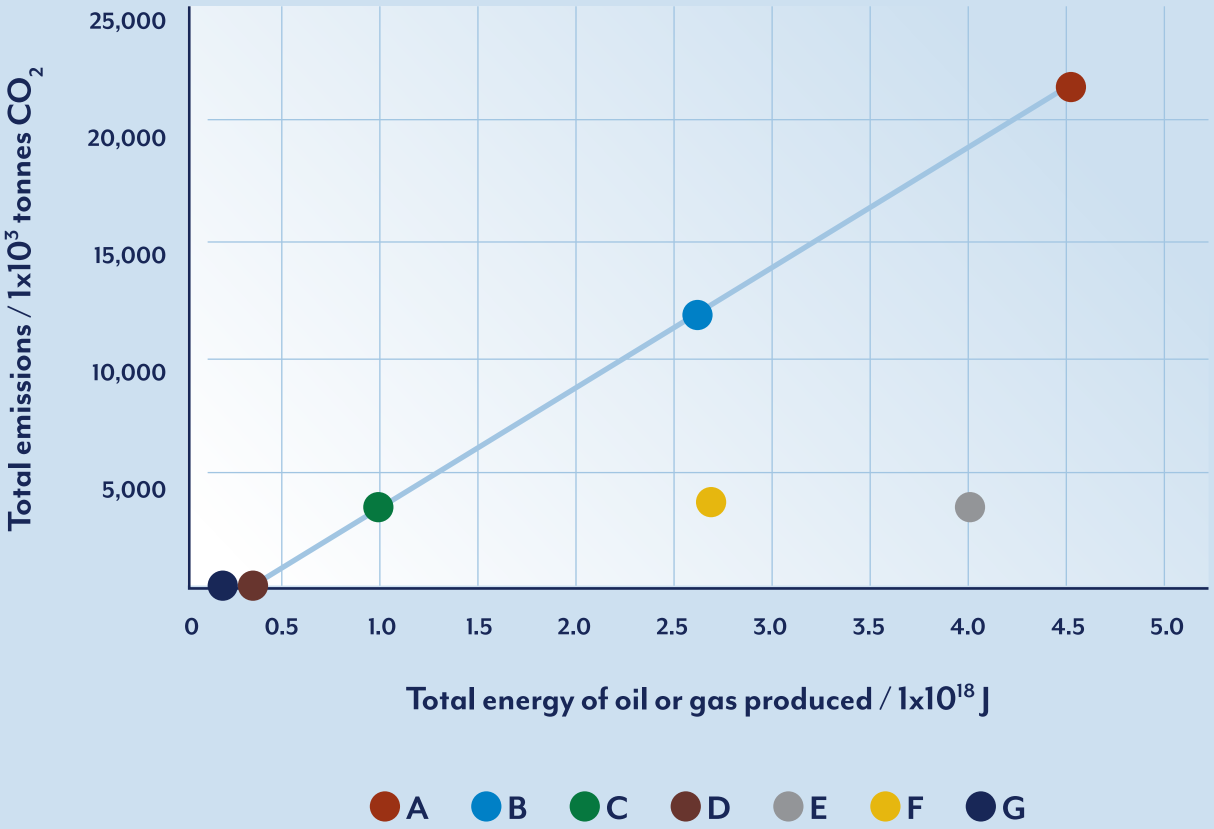


Exhibit 4 - Original research into the total carbon emissions of existing, operational offshore platforms in comparison to the megajoules of energy

The real power of this level of analytics provided by CleanSPEND℠ is the ability to set benchmarks. Having a benchmark of what has been emitted historically helps us to do better in the future, giving us the quantifiable knowledge, such that future energy projects can be better. We will be able to deliver future offshore oil and gas projects at a lower carbon intensity, helping to decarbonise oil and gas as a steppingstone into the energy transition and in the delivery of our net-zero commitments.

Taking data analytics on this path from descriptive analytics through the delivery of predictive analytics (what emissions future offshore project will produce), and into prescriptive and cognitive analytics. This is where CleanSPEND℠ excels.

Prediction, machine learning and analytics determining what will happen.

Through KBR's Automation, Engineering and Sustainability platform (aes.kbr.com)[6] CleanSPEND℠ uses requirements management to obtain the design data necessary to predict **WHAT WILL HAPPEN.** Using predictive analytics driven by machine learning, CleanSPEND℠ delivers foresight to inform what the carbon footprint will be for any offshore project.

The value of predictive analytics is greatest when it is undertaken at the beginning of a project, ideally during the initial conceptual design. As discussed by McKinsey & Company[7], the design phase of any project is the most crucial factor in determining the final emissions outturn. This is summarised by Exhibit 5, carbon emissions influence curve.

Carbon emissions influence curve.

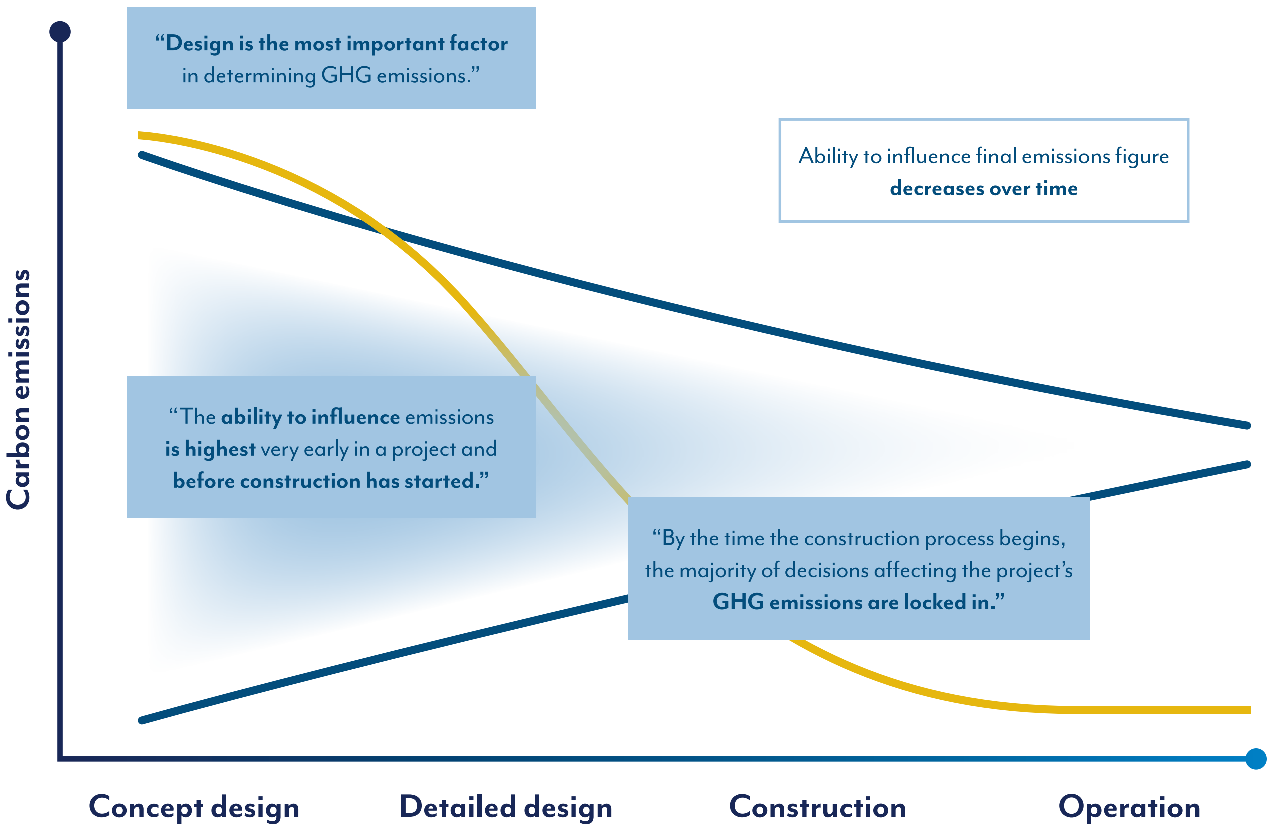


Exhibit 5 - Carbon emissions influence curve

A case study example of CleanSPEND℠ data analytics, was the recent application to the design of a not-normally crewed offshore platform with the objective of providing foresight to the client of what the carbon footprint will be, given the current design parameters. Results from this analysis examined the project at all levels, from the design process itself (such as the location of the chosen design house and their carbon emissions as an organisation), through the procurement and logistics of all the equipment and materials, into the selection of potential fabrication yards and the carbon intensity of their facilities, into the offshore installation and commissioning, and into the operational emissions and eventual decommissioning of the platform.

Exhibit 6 summarises the emissions predicted to be emitted by this case study offshore platform across its whole life broken into the three GHG emissions reporting scopes.

Predictive analysis provides the client with the foresight of what will happen SHOULD they continue with the design of their project as currently defined. The next stage of the CleanSPEND℠ approach to carbon footprint assessment then comes into play through the insights it generates.

Predictive analytics delivering carbon emissions foresight of Platform X, a not normally crewed offshore platform.

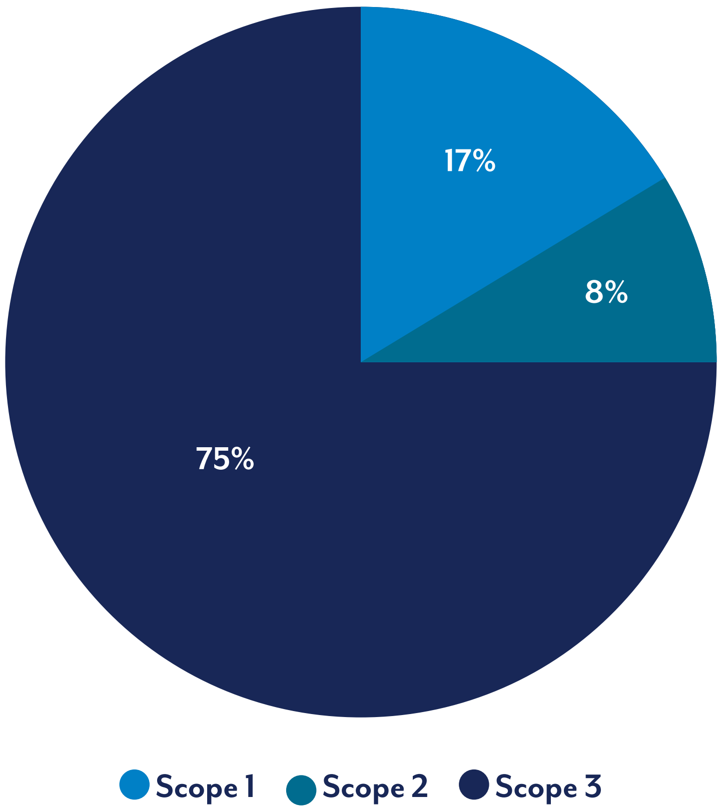


Exhibit 6 - Predictive analytics delivering carbon emissions foresight of Platform X, a not normally crewed offshore platform

Projects benefit from daring to challenge the sensitivities of your carbon footprint.

Prescriptive analytics, identifying **WHAT SHOULD WE DO,** uses optimisation functionality within CleanSPEND[SM] to simulate what might happen if decisions anywhere along the project lifecycle are varied.

The multi-variable simulation functionality within CleanSPEND[SM] provides the ability to generate as many different scenarios as any project might require. This returns accurate insights that would otherwise not be possible and recommendations of what should be done to deliver the lowest possible carbon emissions footprint, whilst ensuring the project always retains a technically acceptable design.

CleanSPEND[SM] has delivered insights to clients through this simulation and optimisation capability such as a recent case study where the client had an expectation that by electrifying an offshore platform would deliver them an offshore platform with net-zero carbon footprint.

In this study we first assessed the total carbon footprint of this processing platform which was planned to be powered through the tradition method of gas turbines, provide accommodation for 100 persons-on-board, and was expected to produce oil over an operating duration of 15 years. The total carbon footprint predicted for this project via CleanSPEND[SM] predictive analytics was approximately 3millions tonnes of carbon (3,000,000tCO_2e) over the full design and operational lifecycle.

Electrification as a solution to reduce this carbon footprint is therefore a reasonable approach, where the operational emissions produced from the gas turbines accounted for two-thirds of the total footprint (circa. 2million tonnes of carbon). The addition of a HVDC platform to one, or a cluster of platforms, can create significant carbon savings versus gas turbine power generation, assuming that the HVDC platform receives renewable energy from shore.

CleanSPEND[SM], using its cognitive analytics to deliver carbon scenarios, generated a scenario of the same platform but with the design adjusted to reflect the revised solution of an offshore HVDC platform supplying power from shore to the processing platform. This included adjusting the overall topsides weight and size and associated quantities of steel to deliver the power generation module. The CleanSPEND[SM] module then went on to account for the implications of the new HVDC platform, this included inter alia:

- Energy demand from the design and manufacture of the platform,
- Shipping and logistics,
- Fabrication and offshore commissioning,
- Maintenance of the HVDC platform including support vessels and spares.

Exhibit 7 summarises the impact on the total carbon footprint of the project by switching from on-platform gas turbine power generation to power from shore to an along-side HVDC platform.

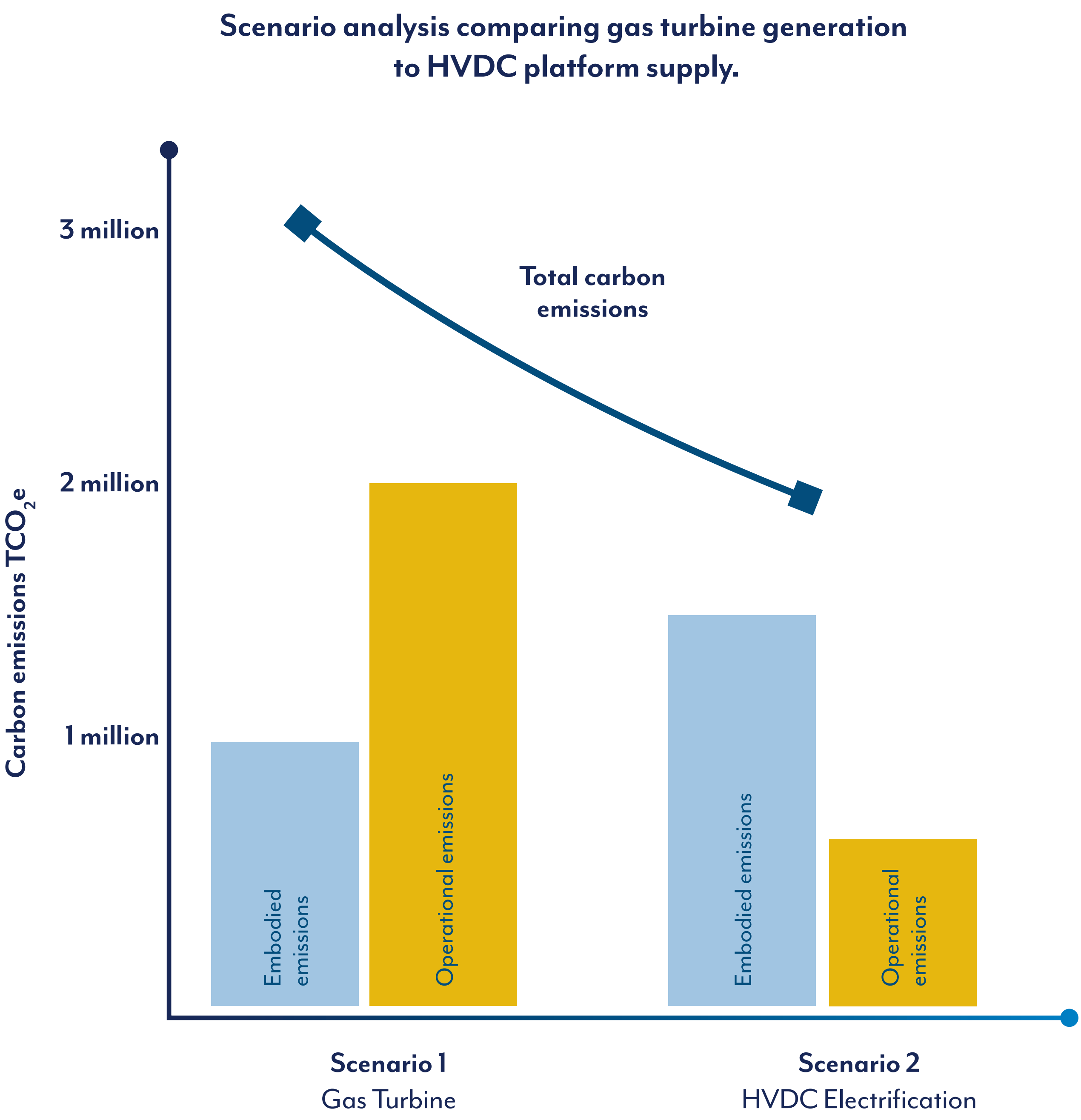


Exhibit 7 - Scenario analysis comparing gas turbine generation to HVDC platform supply

By conducting this scenario analysis in CleanSPEND[SM], we were able to return accurate results which encompassed a vast number of calculations and refinements, a process which if done manually would have been a very time-consuming exercise. By maximising the use of the programming of CleanSPEND[SM], adjustments to any attribute are calculated within the SQL database and delivered as right sight analytics within minutes.

Clearly the addition of the HVDC platform and optimisation of renewable energy from shore delivered a significant reduction in the overall carbon footprint. However, the additional engineering, fabrication and operability requirements meant that the reduction was not as significant as the client anticipated highlighting the need for more work to be done to truly deliver a net-zero, or even low carbon solution for offshore platforms.

Opportunities such as powering offshore platforms via renewable electricity from a HVDC hub is undoubtably an attractive option for reducing the operational carbon intensity. The real benefit comes from the ability to power a cluster of closely located platforms, such as in the North Sea or Gulf of Mexico. The challenge then shifts to reducing the (still sizeable) embodied emissions and sourcing renewable electricity at the giga watts scale required against an energy transition landscape where the demand from other end users, such as green hydrogen, is rapidly increasing.

Conclusion.

The extent of emissions reporting and declarations required from organisations is rapidly growing and evolving. This is being driven by the demand from stakeholders for greener investments, financiers for the potential cost and taxation implications, and regulatory and legislative requirements. The energy sector, which has been responsible for over 73% of 50 billion tonnes of greenhouse gases released each year[8], will be particularly looked upon to improve the accuracy, accountability and reporting of its emissions.

Without considering the whole lifecycle of the energy projects we are developing, the discrete activities we are undertaking and the implications for creating more carbon, it will not be possible to accurately figure out what emissions are being produced. CleanSPEND℠ is a whole lifecycle solution developed by a team of scientists, data scientists, engineers, programmers and mathematicians to provide an accurate account of the full lifecycle emissions, from initial concept to decommissioning and across all three GHG reporting scopes.

By adopting the CleanSPEND℠ carbon cognisant approach you will be able to:

- Benchmark your project against historical projects to ensure you are designing less emissive facilities,
- Diagnose where emissions are being generated and why the differences are occurring, positive and negative,
- Predict what will happen SHOULD a future energy project continue its current emissions trajectory,
- Prescribe the best course of action considering the multitude of design and operational considerations to deliver the lowest overall carbon intensity of a project,
- And finally, use a carbon cognitive approach for all energy projects to simulate what might happen to your emissions footprint if the situation, strategy or environment changes.

CleanSPEND℠ delivers the carbon cognisant approach to design because it uses data driven scientific and mathematical techniques alongside proven engineering design knowhow to deliver, not just foresight, but future proof insights and right sight of your whole project carbon footprint.

To truly reduce emissions, deliver net zero goals and limit climate change to 1.5°C we must first understand the holistic view of the emissions we really are producing or accountable for, then we can identify what emissions can be eliminated. Only once we have worked through the complete project lifecycle and supply chain, we will be able to build a low carbon future and reach net zero.

KBR, delivering smart solutions for a sustainable future.
Get in touch here with the team at KBR to find out more or download our brochure now.

Annex.

The approach to carbon assessment used by CleanSPEND^{SM} is based on the British Standard BS EN 159789 which, whilst designed to be applicable to the construction of new buildings, provides one of the most holistic quantifications of environmental information and reporting communication structures available. The lifecycle methodology is illustrated by Exhibit 8.

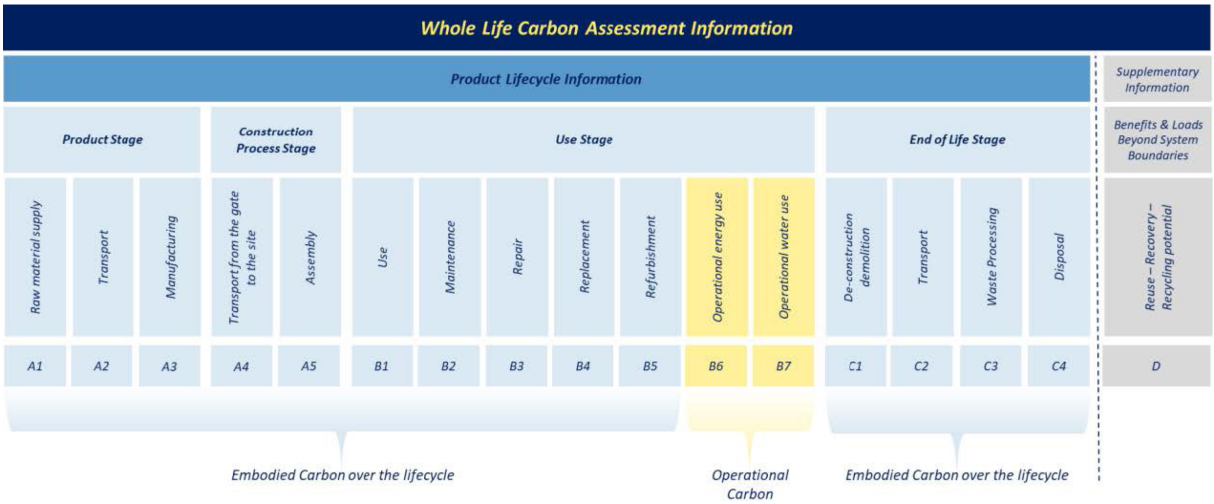


Exhibit 8 - Methodology for the assessment of carbon emissions

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