ENGINEERING THE 'NET' IN 'NET ZERO'

CARBON CAPTURE & STORAGE

WHITE PAPER

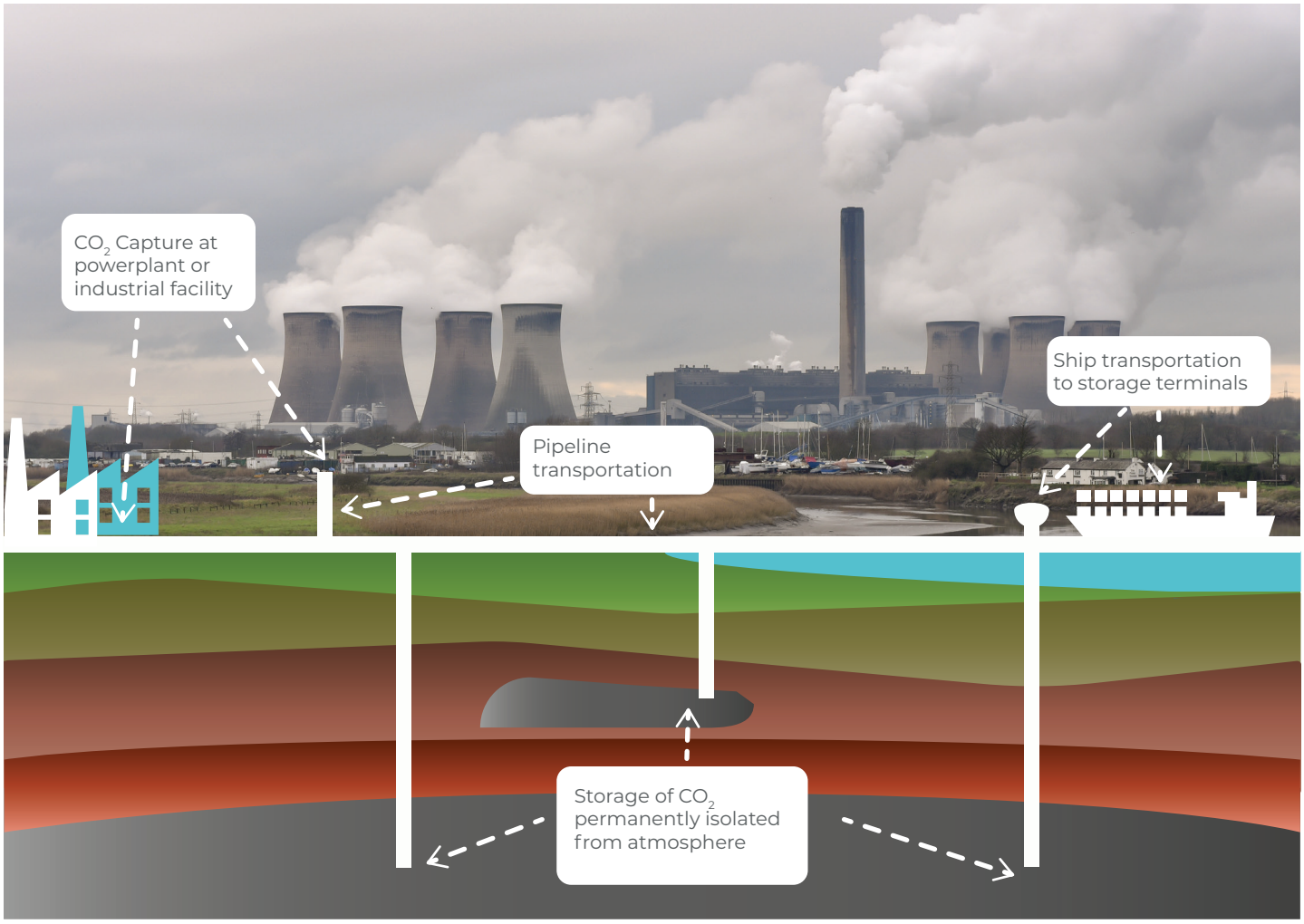
SyntheSys TECHNOLOGIES

SYSTEMS ENGINEERING FOR CARBON CAPTURE & STORAGE

The experience of living in the modern western world is one of everything having been hyper-optimised for our comfort and convenience. If you're reading this at your desk, it is worth reflecting on how many hours of work and flashes of hard-won creativity went into engineering, even the most innocuous item on your desk, and which was probably manufactured half a world away. The globalised economy has been a success in terms of raising living standards, but it has come at the cost of environmental sustainability. With the spectre of climate change looming large, we must now turn our attention to decarbonising the economy and moving to 'net zero'. Carbon Capture and Storage (CCS) is a key technology in this transition, and engineers will play a vital role in making CCS a reality. CCS involves capturing carbon dioxide emissions from power plants and other industrial sources, and then transporting and storing them underground. This presents a huge technical challenge, but it is one that we must meet if we are to avoid ongoing - and catastrophic - climate change.

As we've seen time and time again, our economy is vulnerable to disruptions. Whether it's a change in the operating environment or an unexpected zigzag in a variable, even the slightest change can have a big impact. But, despite all the challenges we've faced, we've always found a way to rebound and come back stronger than before. In fact, this century has been one of the most prosperous periods in history.

Looking forward, we need to build an economy that is resilient to disruptions and can thrive in any operating environment. That means moving towards a zero-waste, zero-carbon economy - an economy that is powered by clean energy



and produces no pollution or waste. It's an ambitious goal, but it's one that we must strive for if we want to ensure a prosperous future for all.

The natural world is amazing. For centuries, life has found ways to survive in a changing environment. But, with the discovery of climate change, we realised that these two complex systems could no longer be treated as independent. We have to understand the natural world and how it works if we're going to protect it. Hence the commitment to achieve zero net emissions by 2050. It's a daunting task, but it's one that we have to tackle head on if we want to preserve the planet for future generations. We know it won't be easy, but together, we can make a difference.

As any engineer will tell you, zero is a tough number to achieve. But when it comes to the zero net emissions of greenhouse gases by 2050 that are necessary to avoid catastrophic climate change, zero is precisely what we must aim for. That means zero emissions from all sources, including those from forestry and agriculture. It also means zero emissions from deforestation, land clearing, and other land-use changes. And it means zero emissions from international aviation and shipping. In other words, it means achieving net zero emissions across the globe. But zero is achievable. We have the technology and the know-how to get there. What we need now is the political will to make it happen.

Systems engineering is a discipline of engineering that is concerned with how the structure of complex systems affects their large-scale behaviour. Systems engineering is about drawing on the science of finding patterns in organised complexity, and the analysis of the emergent behaviour of systems. It can provide many insights into how this sort of complexity can be zeroed, predicted, managed and addressed. The systems approach is an important tool for managing net zero projects because it allows for the identification of project objectives, requirements, and risks. It also helps to create a baseline for measuring progress and determining whether the project is on track to meet its goals.

In addition, it can help to optimise resources and improve communication between team members. With these principles, we can create better systems that are more efficient, resilient, and adaptable to change.

This thinking process is about much more than just energy or water conservation. It's about understanding how all the different parts of a system interact with each other, and how changes in one part of the system can impact other parts of the system. It's about finding ways to make the system as a whole more efficient and effective, while also reducing negative environmental impacts.

Systems thinking is an important tool for anyone who wants to create lasting positive change in the world. By understanding how systems work, we can find ways to make them work better for everyone involved. We can create more efficient systems that use less resources, and we can find ways to eliminate waste and pollution altogether. We can also design systems that are more resilient to external shocks, such as climate change.

We often think of the journey to zero as a difficult one, full of sacrifices and difficult choices. However, it is important to remember that many of the technologies and practices that we need to adopt in order to achieve zero

emissions are already available to us. It is simply a matter of making the commitment to act and work together towards our goal. There are many challenges ahead, but by working together and staying focused on our goal, we can achieve a zero-carbon future.

Trying to engineer a route to the end goal is a costly task. Using systems engineering within your processes allows businesses to future proof their projects and drive down potential costs. Having a greater understanding of a project's life cycle creates an environment that welcomes integration of innovation. Being able to manage configuration in such a way means that advancing technologies can be integrated smoothly.

Better Process

Systems Engineering in Practice

Systems engineering techniques are fundamentally about finding ways to analyse, model and plan the behaviour of a system as a whole. The context above and beyond the details of individual components. By having a suite of processes and tools designed to model and anticipate the structure of a system, projects start out with the right solution being built in the right way, and that the solution will interact appropriately with its context. This drives down cost by reducing the risk of mistakes and unanticipated defects, while simultaneously driving up quality, tying engineering activity more closely to precisely defined stakeholder needs.

The energy sector is looking at ways to integrate systems engineering as the route towards tackling forever growing complexity. Although there's a good understanding of net zero goal, it becomes hard for companies to face challenges on their way through this process due to managing change which can be both time-consuming and expensive. Both of these headwinds are undesirable to teams making progress with what needs to be done now.

Having an established system that understands these issues would help everyone involved move faster, while staying safe throughout any storms ahead. This creates an environment where your team can be confident when there are challenges and integrate innovations efficiently.

Systems engineering has developed a wide range of processes and tools for modelling and simulation, requirements analysis, scheduling, and all parts of the life cycle, tailored to better manage the development of complex systems. Although not designed with any particular industry in mind, it has been in longest use in the aerospace and defence sector, where complex interdependent systems have been standard for decades.

These methods are particularly well adapted to circumstances in which requirements change during a development process, as they can much more straightforwardly assess the impact of those changes on the system as a whole. Systems engineers can use their models and plans to anticipate many of these issues, like a system's positives or arising negatives. They also help prevent you from generating significant sunk costs by taking an approach that includes whole life cycles, only to end up needing to make massive updates to older versions - midlife upgrades will be much simpler this way.

MANAGING CONFIGURATION

The process of systems engineering is often used in order to determine the requirements for a system. A 'baseline' set of configurations will be created and any deviations from this - such as changes or additions - will be incorporated to reflect impacts on future outcomes on an ongoing basis so that robust decisions can be made for years of any system's lifespan. When you need to reuse requirements, you don't have to just duplicate the entire set of requirements. You can reuse those components that are already defined. This will save time and effort. In an energy context, being able to track the changes in project requirements and configurations over time means that your engineers don't have to start from scratch every time they work on a new project. They can use the knowledge they already have to get started more quickly and efficiently.

Setting goals is the first step in turning the invisible into the visible. Tony Robbins zero-ed in on this when he said, "If you don't set a goal, you can't score." And yet, even with this zero-based approach to setting goals, many people still struggle with the logistics of putting their goals into writing and creating an actionable plan to achieve them.

The key to success lies in thinking like an engineer; systems engineering provides the framework for thinking about and designing complex engineering systems. In systems engineering, the whole is greater than the sum of its parts; it's an iterative process that takes into account all aspects of a system to optimise it for a specific purpose or goal.

For example, if your goal as an engineering function is to provide your customers with a modular product, systems engineering gives you that capability. Having a system that supports flexibility within standardisation to suit the customer requirements boosts efficiency of the configuration management process.

In other words, systems engineering provides a roadmap for achieving your goals. So, if your goal is to achieve net zero emissions, systems engineering can help you get there by zeroing in on the most efficient and effective way to design and operate.

Furthermore, in an environment where compliance and certification drive a lot of engineering decisions, this modular approach to requirements management enables you to apply those constraints consistently across multiple engineering projects without having to solve the same problems repeatedly.

What this All Means

Carbon capture and storage is vital to mitigating climate change, but it's also a complex process. That's where systems engineering comes in.

Systems engineering can help integrate many different types of projects, making the whole process more efficient and less likely to run into problems.

At SyntheSys, we're experts in working at the intersection of two large-scale projects and we're interested in helping you do the right things to get closer to net zero in your business.

If you're looking for help getting your project right first-time with flawless execution, don't hesitate to get in touch - details overleaf.

LET'S TALK

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