Spring 2023

Cover Photo taken by
Rohail Hamza (Imperial College London)

Vol.4

A new Net Zero Laboratory is coming soon to the department! Find out more on Pg.7 to 8!

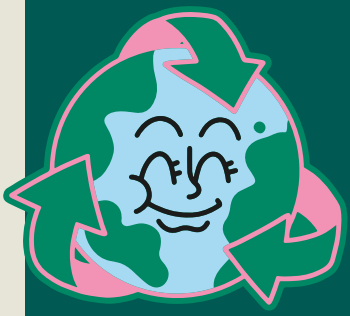
The Sustainability Issue

Thinking about a career in sustainability? Check out Pg. 18 to 30!

PIPELINE

"Bees are key to the sustainability of this planet!"
Rohail Hamza,
Pipeline Photo competition winner

IMPERIAL CHEM ENG SOCIETY



The Sustainability Issue

Hi again ChemEngers! In this special issue of Pipeline, we bring you the sustainability issue where you can find insightful articles that emphasise the need for us to take more responsibility of the environment and what the department does to tackle these concerns.

THANK YOU!

Thank you so much for keeping up with us throughout the year. It has been a pleasure to put together these beautiful issues for you to read and enjoy!
Love, The Pipeline Team

Marieke De Bock

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Oluwakemi Akinnola

Wei Jen Chin

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EDITOR'S NOTE

Hi everyone, Colleen here!

The Pipeline 22/23 collection has come a long way since its first issue back in Autumn 2022. When I took over Pipeline last July, my goals were to broaden the horizons of Chemeng students through useful insights into relevant industries and trends, and to encourage a well-balanced student life through "words of wisdom" and food for thought. **We've released 4 issues in total** and I hope this year's collection of Pipeline issues have achieved those goals. **This would not have been possible without my team** (all the bright faces you see on pg. 3!), who I've had the joy of working with in curating, proofreading and designing the Pipeline issues. I genuinely could not have asked for a better team.

Now, I am happy to present the latest issue of Pipeline: **The Sustainability Issue**! This issue aims to bring greater awareness about sustainability and answer **how we, as chemical engineers, can contribute to this growing cause**.

Prof. Omar is excited to announce that **the Chemical Engineering Department is building a new Net-Zero Laboratory** (pg. 7-9) that will be integrate research around carbon capture, renewables, energy efficiency and other net zero-related themes.

Furthermore, Katya Longinova interviews **Dr. Jasmin Cooper, a member of the department's sustainability committee** that was formed in May 2022 (pg. 9-12). Next, our department's resident **circular economy** expert, **Prof. Jason Hallet**, breaks down what circular economy is in an article written by Wei Jen Chin (pg. 13-17).

If you've been thinking about having **a career in sustainability** but don't know where to start, we have two Chemical Engineering alumni share their career journeys in sustainability. **Dean Posthuma is a process engineer in Photanol, a biotech start-up** that develops a technology platform to engineer cyanobacteria strains to produce commodity chemicals that traditionally come from fossil fuels (pg. 18-23). **Maria Zagorulko is a senior development and operations engineer working in Naked Energy, a solar thermal start-up** that is leading the global innovation in solar thermal and solar PVT (pg. 24-28).

Last but not least, check out the **light-hearted sustainability section** filled with **vegan recipes** by Isabelle Beddows and Eylul Akgok (pg. 32-34) and a special **poem on sustainability** by Gots Narongchartsopon (pg. 35)!

We hope you enjoy reading this issue. The Pipeline team has put a lot of effort into this amidst our hectic coursework deadlines. Finally, I would like to **thank all our readers for the support** and hope to see Pipeline continue to release engaging and insightful content. Farewell and all the best in your future endeavours :)

Colleen Handriani Wijaya

SUSTAINABILITY

Engineering a Net-zero Future

Prof. Omar K. Matar, FREng
Head of Department of Chemical Engineering
Imperial College London

Achieving net zero by 2050 is crucial for the world's economic growth, productivity, security, and well-being. **Chemical engineers have an integral role in realising a new, low-carbon world and helping to re-imagine the sustainable systems and technologies of the future for the good of the planet and humanity.** To this end, the Department of Chemical Engineering at Imperial is creating **a new Net-Zero Laboratory (NZL)** to **integrate research around carbon capture, renewables, energy efficiency** and other net zero-related themes. These mechanisms and technologies are often considered in isolation, and the NZL will bring them together via a systems-based approach.

The NZL will occupy 500 square meters on the top floor of the Roderic Hill Building directly opposite the iconic Royal Albert Hall and will **itself be sustainably constructed using low-carbon materials**. It will feature integrated and challenge-oriented spaces to set the standard for net-zero research globally. This will be based on sustainable research practices in dedicated, truly fit-for-purpose spaces – designed around workflows with themed preparative, analytical equipment and unit operations – leading to higher productivity and researcher satisfaction.

The NZL will combine novel experimental facilities: **materials synthesis and characterisation, small and medium-scale experimentation and reconfigurable facilities** with all the necessary services

to **build a multidisciplinary community of researchers delivering innovation in net zero.** These researchers will **collaborate internationally** with other academics and work closely with **a consortium of multinationals, SMEs, policy makers, and NGOs to drive global impact.** More than twenty academics in the Department of Chemical Engineering are active in research to enable the transition to net zero, with **a combined experience of over 400 years in renewables; carbon capture storage and utilisation; energy storage; chemistry; biomaterials; recycling and the circular economy; and systems engineering.** They have authored over 4,000 papers and have been widely recognised for their work through over 100 international prizes, awards, and medals.

The NZL researchers will address net-zero challenges in four key areas:

1. Sustainable Chemical Manufacturing

Transforming the chemicals industry by re-imagining how chemicals can be manufactured using bioresources and biorefining.

2. Industrial Decarbonisation

The right decisions about decarbonisation of energy and manufacturing to reduce carbon emissions while minimising economic disruption and ensuring energy security.

3. Negative Emissions Technologies

Unique approaches for direct air carbon capture technologies.

4. Sustainable Energy Storage Solutions

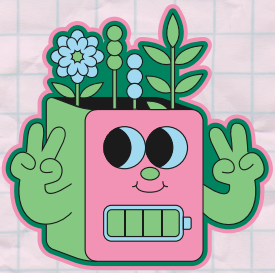
Engineering the batteries of the future.

The exciting work to be carried out in the NZL will complement the work of the **Department's Sustainability Committee**, which was established in October 2021. This Committee aims to **define and oversee the management of environmental risks and emissions reduction in the Department using systems thinking**.

This is currently carried out by outlining and benchmarking the carbon footprint of the Department and by evaluating the alternatives for **carbon mitigation** whilst sitting within a wider sustainability plan. All of these tasks are being achieved by **actively engaging with all relevant stakeholders** to gather data, analyse mitigation alternatives, and ensure sustainability is integral to decision-making.

CHEMICAL ENGINEERING DEPARTMENT'S

Sustainability Committee

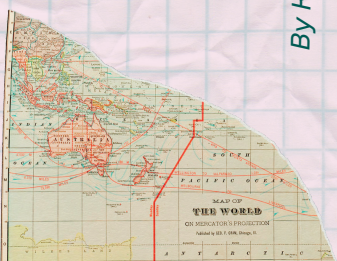


By Katya Longinova, 4th year UG

Sustainability is at the forefront of everyone's minds. Rightfully so, after all, climate change and continued sustainable development are some of the **biggest challenges of the 21st century**. However, for many people, myself included, it can be cripplingly overwhelming to try to think about sustainability as a bigger picture.

We were taught as kids that we can help fight climate change by remembering to turn off the lights when we leave a room or making sure not to leave the tap running while we brush our teeth. These small actions of ours could help save the planet. As we got older, we learned that all those things are still important, but tragically, **solving the climate crisis isn't quite that simple**. There are **thousands of factors**, most of them completely **outside of our individual control**. It's easy to feel hopeless in the face of those odds.

Sometimes, in order to stay motivated and do more, we all need to **feel like our actions are tangibly contributing to the change we want to see.** For instance, on the scale of our university.



This is why I was thrilled to hear about the **Chemical Engineering Department's initiative to form a Sustainability Committee** to address these issues on the scale of our department here at Imperial. The committee was **formed by Head of Department, Omar Matar, in May 2022,** making it a very new initiative, but one with exciting prospects.

I sat down with committee member Dr. Jasmin Cooper to talk about the committee and its goals. Dr. Cooper is a **research associate** here in the department. She did her PhD at University of Manchester, where she **studied the economic, environmental, & social impacts of developing a shale gas industry in the UK from a life cycle analysis (LCA) perspective**, making her a perfect person to chat with about the sustainability committee.

The **committee's overarching goal** is simple: **to estimate the department's carbon footprint and use it to develop a departmental sustainability strategy going forward**. Within this, Dr. Cooper mentioned a **couple of specific goals**:

- To **devise** a general carbon data collection and reporting framework
- To **set** benchmarks and targets for carbon intensities in the department

Dr. Jasmin Cooper, ChemEng Dept Sustainability Committee Member

- To **manage** carbon risks and reduce emissions using systems-based approaches
- To **ensure** that sustainability is an integral part of the procurement process for purchased goods

To begin to achieve any of these, however, **data is needed in order to calculate the department's carbon footprint**. To do this, it's important to **understand the difference between emission types**. There are three main categories of carbon emissions:

Scope 1: these are emission that are **produced directly by the department**. For instance, any vehicles belonging to the department which are producing CO2 count as a Scope 1 emission.

Scope 2: these are the emissions mostly associated with **energy use**. The department isn't producing the electricity keeping the lights on directly, but the emissions generated from that electricity production do still count toward the department's carbon footprint.

Scope 3: these are the emissions that the **department has no direct control over**, typically associated with the carbon footprint of the purchases the department makes, including supply chain emissions.

Naturally, Scope 1 and 2 emissions are easier to reduce, as the department has direct control over them. Did you remember to turn off the lights when you're the last person leaving the Design Rooms? Good job, you've just contributed to reducing ChemEng's Scope 2 emissions! According to Dr. Cooper, **estimates for these two scopes are actually available on a college-wide level**, which is good news for the Sustainability Committee. **The trick is being able to isolate what percentage of those college emissions belong to the Chemical Engineering Department and where exactly they're coming from.**

The real challenge comes with being able to estimate Scope 3 emissions. These are both difficult to quantify (due to the lack of data surrounding the full supply chain process) and difficult to reduce, since the department itself has no direct control over these emissions. All it can do is decide: **to buy or not to buy?**

One of the examples that Dr. Cooper gave was laptops. The department buys a lot of laptops and PCs every year. In my first year in 2019, every fresher who wanted a department issued laptop could get one. The carbon footprint of a single laptop over the four years of our degree is almost 425 kg of CO_2 [1]. 150 freshers, 150 laptops, 425 kg CO_2 per laptop... it starts to add up. And that's just one example.

Katya Longinova, 4th year UG

This challenge is part of what the Sustainability Committee wants to tackle.

"We might be aiming towards creating a framework on how to go about estimating a department's carbon footprint because this is the first time a department at Imperial would be trying to estimate their carbon footprint, as far as we're aware," Dr. Cooper said.

Thus far, there have only been college-wide levels to estimate a carbon footprint. **If the Sustainability Committee is successful in their mission, this framework could likely be shared across the college and other departments to help them paint an accurate picture of their own carbon footprint as well.**

The long-term goal, Dr. Cooper stressed, was **to maintain constant communication and transparency with various stakeholders in ChemEng's carbon footprint** and **to ensure that quality data was being communicated and collected**. This would in turn provide an accurate measure of success.

The **Committee** is young with **a lot of promise and potential to make real sustainable change in the department**. It's an exciting prospect to see global sustainability efforts reflected right here in our own department and it will be heartening to see how much the committee's studies and actions can improve the department's carbon footprint. **We will all eagerly await progress reports and potentially even opportunities for students to get involved and contribute to fighting the climate crisis on the university scale.**

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Circular economy

An interview with Prof. Jason Hallett

By Wei Jen Chin, 1st year UG

Take, make, dispose. This is the motto of a **linear economy**, and unfortunately, this is currently the way most parts of the world function. I believe we have heard the negatives of such an economy often enough: **the devastation humanity has brought on the environment**, from the depletion of natural resources to the increasing waste. **This is where the concept of a circular economy becomes so significant!**

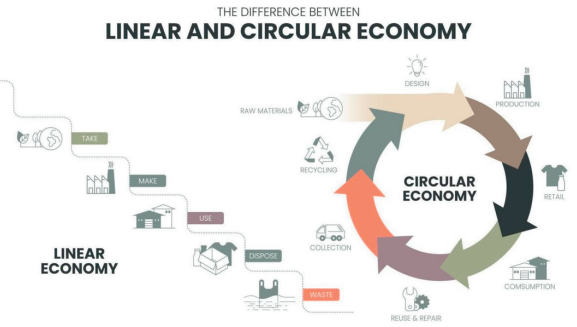
Sustainability is vital to society itself, but **what role do we chemical engineers play in this?** Chemical engineers are **responsible for all kinds of processes on a very large scale**. As such, minor improvements towards sustainability will lessen the damage to the environment.

Systems thinking, one of the many skills we develop, is **crucial in analysing a process as a whole**. Aluminium cans are a perfect example of a product being recycled into the same thing, as the metal is indestructible and can be restored – ignoring any losses in the system. Unfortunately, very few products are entirely circular in this manner. For example, PET plastic bottles, the most commonly used type of plastic bottles, are 100% recyclable [1]. However, they are recycled into textiles, which have a global average recycling rate of only 15% [2]. This means that plastic bottles are actually downcycled, where most of their components end up in landfills after many iterations. We can employ systems thinking to **work towards upcycling on the back end, hence a better outcome overall**.

Linear vs. Circular

Moreover, a cheap feedstock frees up more monetary resources to develop energy-efficient processes, which produce sustainable products that are just as cost-effective as existing ones. **Essentially, it's about thinking of different ways of doing things and identifying the intersection between economics and environmental protection.**

If you're interested in building a career in this field, there's nowhere else to start except from zero. In our course, we are only taught the fundamentals, particularly the tools to assess the sustainability of a process. **Sustainability is application-driven and highly dependent on the product**; there is no such thing as a silver bullet. The best way is to get out there and learn the specifics from research or industry. Lucky for you readers, **Professor Jason Hallett – our resident circular economy expert** whose work contributes greatly to this field – **offered his insights** to give us a glimpse of what a circular economy means.



Linear Economy vs Circular Economy [3]

What is a circular economy? The Ellen MacArthur Foundation defines a circular economy by **three principles**: **1)** eliminating waste and pollution, **2)** circulating materials and products, and **3)** regenerating nature [4]. In an ideal world, we would cause no harm to the environment while maintaining a thriving economy. Unfortunately, processes are not always 100% efficient. There **will always be losses** in any system – by-products and wastes that are toxic or useless. We can **try to minimise losses as much as possible, but the real positive impact comes when we derive value from these materials**. The circular economy concept builds on what already exists in the environment. It is constantly evolving, and as exemplified by Prof. Hallett's research, **something considered waste yesterday can become a valuable product tomorrow**.

The essence of **Prof. Hallett's** work is **figuring out ways to extract useful components from low-value waste and how to make high-demand products from more sustainable resources**. One of the main methods involves designing solvents to accomplish

these selective extractions. Tackling issues one at a time, Prof. Hallett's research [5] has led to **six spin-out companies** – three of which we will delve into:

LIXEA

1. Lixea [6]
Recycling waste wood into biofuels

The Wood Recyclers' Association has reported that 4.5 million tonnes of waste wood was collected in the UK in 2021 [7]. Decades ago, wood was treated with heavy metals – such as chromium, copper and arsenic (CCA) – to protect the wood from decay and insect damage. Fast forward to the present, the **contaminated waste wood is illegal to incinerate**, and the **cost of disposing** of CCA-treated wood is £250 per tonne [8].

Lixea redirects waste wood from landfills to the lab. There, the **extraction process** occurs: an ionic liquid salt binds the metals, enabling the removal of metals by electric deposition and **making clean polymer fractions to allow the retrieval of pure cellulose**. It is important to note that components are only extracted if their monetary worth or value can justify the cost of the purification steps.

Copper currently has market value and can therefore be sold. However, arsenic is no longer in demand as the US Environmental Protection Agency banned its use as a wood preservative in 2003 [9]. **This legacy waste, generated by past decisions and mistakes, has nowhere else to go but the landfill**. Nevertheless, this process **reduces the overall waste, leaving 100% mass recovery of wood and some valuable heavy metals**.

NANOMOX

2. Nanomox [10]
Making sunscreen from steel waste

This is another excellent example of **waste transformed into valuable feedstock**. There is a high demand for iron in the steel industry, but the manufacturing process often results in **iron slag with traces of zinc alloys**, which can no longer be reduced. Enter Nanomox. They use an aqueous ionic liquid system to **oxidise zinc to zinc oxide and extract the metal compound as small particles**. Zinc oxide can be used in a variety of applications, including batteries and tyres.

Nanomox **uses it to produce sunscreen** as it is less toxic than other heavy metals and a good UV blocker. Another reason is that the compound's particle morphology (i.e. size and shape) is a significant property of sunscreen. Since it is possible to control the morphology, zinc oxide is more effective in sunscreen than in other applications. **The remaining pure iron is then sold back to the steel industry. Hydrogen is a by-product of this reaction, which is also desirable in the market** due to its versatility and renewability as an energy source.

DYE
RECYCLE

3. DyeRecycle [11]
Recycling dyes from textiles

We were taught that recycling is one of the "three Rs" that helps our planet, but **recycling isn't always good – it depends on how it is conducted**. In the case of textiles, **clothes are ground to separate cotton fibres; however, the dye in the material can gum up the grinder**. This leads to a more inefficient method, where the clothes are bleached first to destroy the dyes – ironically, dyes themselves are more expensive than cotton – damaging all the cotton fibres, only to re-dye it eventually. Consequently, the dyeing industry produces 20% of the world's wastewater [12]. It doesn't have to be this complicated though. Fortunately, **DyeRecycle developed a method to remove the dyes, recycle the cotton, and then reuse the dyes.**

Historically, products were designed with the sole priority of functionality and aesthetics while disregarding a modular design, thus rendering it **impossible to replace or recycle parts of the product**. In this context, dyes and textiles were combined to make clothes without consideration of how to recycle the dyes or recover both separately. DyeRecycle's simple solution **essentially solves a problem created by these past mistakes**.

These three companies have developed innovative solutions that **re-imagine how to deal with waste from various industries and generate economic desirability** from them by making the materials more valuable. Of course, there is much more research and development, or even businesses driving the circular economy movement. **Sustainability isn't simply about the work we do; it is also about how we do things.**

Building a circular economy requires us to acknowledge that **we live in an economic-driven society**. First and foremost, we can (and definitely should!) take advantage of this by **developing more efficient processes that inherently make more money**. Another aspect is waste, a negative economic barrier due to the cost of treating or disposing of it. As seen in the three examples above, we must shift our perspective as to what 'waste' is and discover new and exciting ways to reap its benefits. **Remember, things only have no demand until we find a use for them.** The last piece is **recycling**: it **has a value curve dependent on energy and money**, where the last few percent of goods are usually not worth the exponential cost.

The circular economy is about **recovering everything accessible and valuable enough within the framework of the linear economy**.

As future chemical engineers (or rather, consultants and finance bros), we should aim to close the loop of the linear economy, little by little, in hopes of creating a more sustainable world.

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A Career in

Sustainability

Part I.

As an Imperial student, **spare time is even more of a luxury than the sports cars** you often see driving down Prince Consort Road. This means that the prospect of allocating attention towards what you are going to do when you graduate presents a thermodynamically unfavourable state of affairs, to say the least. **In an ideal world** (undoubtedly one where steady state is assumed), you would have the **time to reflect on your lecture notes** and then **search for a way to utilise the things** that resonate with you most **in real-world applications**. Chemical engineers, in particular, will know that the world is indeed highly non-ideal, which also includes the hard reality that your student debt won't pay back itself. Unfortunately, this leads to taking the path of least resistance: sticking to what everyone else seems to be doing and applying to all the usual suspects in the graduate recruitment world. Of course, there is a reason that these companies are found in the "top 100 graduate employers" list, but

***Dean Posthuma** is a 2021 graduate who has been working in **Photanol** for the past two years*

there are so many more possibilities for a ChemEng graduate to provide significant value. I was in your position a couple of years ago – also having to **wrestle with choosing to either spend time exploring what possibilities are out there and risk falling behind my peers or remaining loyal to Panopto**.

With the benefit of hindsight, I would say many of the influences that steered me to where I am now were the result of **a willingness to explore** in this way. The fact that it was also a more productive way for me to feel less guilty about procrastinating can be neglected for now!

The issue of **climate change** is something you and I have been subjected to in some form our whole lives, and even if it has only remained in the background, it has always been there. If chemical engineering is the production of the materials and energy foundational to the way we live our lives, my rationale was that **if things must change to avert climate destruction, chemical engineers should have a good idea of how to do this.** When it came to finding companies to apply to, I went for the obvious options that also appeared to care about sustainability until I eventually realised that it is easy to be misled by these convincing sustainability claims. It felt like this was just a way for those companies to ensure that they remain appealing to the best graduates, fair enough. So I broadened my search by exploring any company I came across which I thought might be relevant to ChemEng – ranging everywhere from water treatment to chemical companies, waste management to industry-specific consultancies and so on.

LinkedIn was an incredibly valuable tool for this, and at one point, I even made a spreadsheet to keep track of what I had found. It is helpful to remember that even if a company doesn't advertise internships or graduate roles, **speculative applications can be very effective**. There is a very real difficulty in finding a job because industry experience is required, but you can't gain experience until a company hires you – a frustrating catch-22 situation. This can really put you off from trying, but all you need to do is

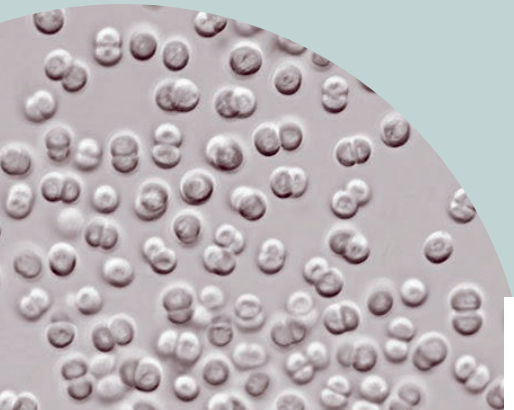
get your foot in the door, and things will become easier. During all of this, I was also very aware that as a student of Imperial, it was statistically much more likely I would work in finance or consulting, or begin a PhD, leaving a far lower probability of going into industry. I won't ever know how much is down to luck or my own efforts, but I now find myself working at a company centred around a sustainable approach within the chemical industry.

Although my career has barely started, the perspective I have gained so far might be valuable and worth sharing.

First of all, the term 'sustainability' is thrown around more and more arbitrarily as it grows in public discourse – generally a good thing. However, it also means the definition, implicit in its use, changes to suit the needs of anyone that wishes to appear virtuous or innovative. Students of Imperial are intelligent enough to decide **how to define sustainability**, but what I want to highlight is that **it shouldn't be limited to tweaking an existing process or business model into a more 'green' version**. Nor should we imply that there is a separate 'sustainability industry' set completely apart from the rest of the industry, potentially leading to the idea that working in sustainability essentially means working at a company with green credentials without considering whether they are actually effective in tackling underlying problems relevant to the overall industry.

For example, a company that converts sugarcane into bioethanol could be called sustainable because plants are used as feedstock rather than fossil sources; this neglects **the degradation of arable land** and the **deforestation** involved.

A company that develops better membrane fabrication may not be seen as particularly sustainable but, in actual fact, could make it **feasible** for process plants to implement technology leading to **huge energy savings**.

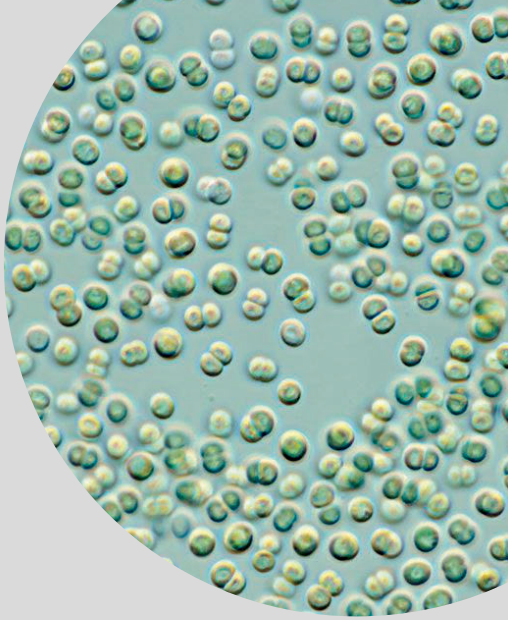


Photanol is a biotech start-up developing a technology platform to **engineer strains of cyanobacteria** for the production of **commodity chemicals** that traditionally come from **fossil sources**. The metabolic pathways inside the cell, including crucially the consumption of CO2 through **photosynthesis**, are modified so that carbon flux is directed towards a specific target compound. As a result, the vast majority of work in Photanol is within the realm of **biology**.

My role as one of the few chemical engineers is to develop a conceptual design for **downstream separation processing (DSP)** of the desired compound, which is produced inside the photobioreactors (PBRs) designed to capture solar energy utilised for the conversion of CO2. This involves investigating and screening existing and developing technologies that could be implemented into a DSP configuration and comparing to alternative configurations via **techno-economic evaluation**, **preliminary optimisation** with process modelling, and experimental validation of the separation process.

The sometimes daunting scope of this role is a consequence of the **start-up environment**: heavily R&D focused, continual change to project constraints & requirements, and generally **resource-limited.** This presents **an exciting opportunity for problem-solving** and to develop a wide range of expertise first-hand; however, the **learning curve is steep**, which can be difficult since there likely won't be an established provision of training or guidance like there would be in a typical graduate program.

I always find it strange that there is no discussion around the fact that there appears to be a lack of start-up culture in the chemical industry. I have my own hypothesis about innovation in the industry: because chemical plants are so massive and expensive, there is **a higher risk in trying something new**. Therefore, innovation basically only amounts to incremental efficiency improvements but never involves the development of an entirely new approach. But why are chemical plants so massive in the first place? Answer: **economies of scale**, a recurring theme you will engage with throughout many aspects of ChemEng.



Whilst a massive scale is economical, it comes at the cost of **adaptability**. This theory also explains why a start-up is **unfavourable** in this industry. The high infrastructural requirement creates a barrier to entry because a lot of money is needed before the demonstration of feasibility and development of a process is possible. As a result, **funding** is much more of a challenge. This tendency for centralisation is what I personally believe to be a primary problem preventing the transition towards a truly sustainable paradigm of chemical manufacturing.

For this reason, **small companies are crucial for innovation**; however, as I mentioned earlier, they are also more likely to be affected by resource limitations. For example, the software you will be familiar with from studying ChemEng (e.g. Aspen) is prohibitively expensive for these companies. This means it is very valuable to be able to program a model in freely available software such as Python or Julia. The ability to code is now fairly common, but not in combination with the understanding of how to formulate the system of equations required for modelling purposes in the context of a chemical engineering problem. This illustrates an important point: **the power of combining an understanding of different fields** – a really key way in which innovation is manifested.

It may be less glamorous than new scientific discoveries or technological breakthroughs, but it is much more pragmatic and necessary for progress to be made. The perspective I gained from my work is that the **combination of the immense potential of biology with the needs of the chemical industry is the way forward**. Still, nuance must be applied for this strategy to be effective. One possibility is to replace fossil feedstock with biomass in the production of bio-crude oil, which is then processed within a so-called biorefinery. This is a very heavily researched concept but is essentially the same old approach which relies upon extreme operating conditions (such as high temperature). This leads to high consumption of energy and favours the centralisation mentioned earlier.

Utilisation of the enzymatic chemical conversions enabled by gene editing of bacteria, adopted by Photanol, is another possibility. A process based on this can operate under mild operating conditions. In addition, **enzymatic conversion has high selectivity**; therefore, only a simplified separation system is required. This could potentially facilitate a more decentralised model, as well as **decrease energy consumption massively**. Exploiting photosynthesis to harness solar energy would be incredible, but it requires an adjustment of the framework that is taken for granted in the industry now. In this example, the transient nature of sunlight over the course of a day means that you can no longer assume steady state, which despite being a bit of a meme (including my miserable attempt above), would have severe implications at all levels of the way the industry functions.

So, in summary, **sustainability is not a box-ticking exercise** but rather about the **ability to think critically** about the problems inherent in the current industry paradigm and how new technology enables processes to be designed differently, addressing problems at the root.

Relating to this, a personal anecdote I think of is my interview with Paul Fennel as part of my application to Imperial. In my application, I declared that as a chemical engineer, I would endeavour to improve the way things are made for the sake of sustainability. Paul challenged me by asking why I thought (as someone who knew nothing about the industry at that point) that this hadn't already been done by the exceedingly capable people in our industry. I ponder about this a lot because it reminds me that **we won't achieve much by expecting to just do existing things better** – there is an imperative for a radically different approach.

* All views expressed here are those held by Dean/Me, not by Photanol.

Part II.

A CAREER IN SUSTAINABILITY

***Maria Zagorulko** is a 2021 graduate who has been working in **Naked Energy** for more than a year*

Maria Zagorulko graduated from the 4-year Meng Chemical Engineering course in 2021 and is now a **Senior Development and Operations Engineer** at **Naked Energy** (a **solar thermal start-up**). In this interview, we dive into Maria's passion in **renewable energy**!

What sparked your interest in sustainability?

"At school, I fell in love with chemistry - my teacher was a real inspiration, and I knew that I wanted to find a way to incorporate chemistry into my future career. When I went to university, **I studied chemical engineering and quickly realised there wasn't much chemistry involved!** Despite that, the degree was extremely interesting, and I quickly fell in love with engineering.

For my **final year project**, I was presented with the task to design **a silicon solar cell production plant.** It was a group activity in which we had to look at economic feasibility, technical execution and safety considerations in an enormous amount of detail. **It really tested the limits of our understanding**, and provided us with **a fantastic degree of experience - an incredibly rewarding project that got me interested in renewable energy!**"

Is a career in sustainability mainly purpose-driven? Is it as meaningful and fulfilling as the common perception presumes?

"The perception is accurate! **Sustainability is one of the most rewarding industries you can work in**. If you want to solve some of the world's biggest problems, the climate crisis presents a **huge opportunity for you to get involved and there's something for everyone**. The focus on energy transition has led to a myriad of new career paths opening. With the energy transition in full swing there's never been a better time for people to pursue a career in sustainability. Seeing our Virtu technology being installed on numerous sites, where it will **decarbonise heat for years to come, is the most incredible fulfilment you can get!**"

How did you plan your career path in sustainability? How did you narrow it down to Naked Energy?

"While studying, I started thinking about how I could make **a real impact** and help to solve urgent problems. I've always been a maximalist so I was asking myself, **how can I help to solve the big problems and make the world a better place?**

I really care about the environment so **renewable energy** felt like a natural fit for me. It **brought together my love for chemistry and sustainability**. Through my studies in chemical engineering, I learned about **sustainable energy technologies and policy requirements**, so that equipped me well for a career in the clean energy sector.

I knew very little about the solar energy industry prior to joining Naked Energy as an intern in 2019, but **working in a start-up is an amazing learning curve.** I was quickly engrossed in solar thermal and I was exposed to a broad spectrum of activities that continuously switched up my day-to-day. I thrived on that variety and I believe **a lot of people would be drawn to sustainability if they knew how much they could learn**.

A brief overview of Naked Energy and Maria's work

What does the company do?

"Naked Energy is leading the global innovation in **solar thermal and solar PVT**. It's an incredibly exciting company to work for. Our whole team is guided by a founding ethos that the **decarbonisation of heat is a crucial piece of the energy transition puzzle**. Without it, we simply can't achieve the world's net zero goals.

We're developing cutting-edge tech that can generate electricity and heat water three to **four times more efficiently than traditional solar PV panels**. The VirtuHOT collector, which generates solar heat, recently received the **gold standard TÜV international certification**.

The VirtuPVT model converts into both heat and electricity, and our modular design eliminates self-shading entirely, allowing people to pay back their initial cost **six years quicker** than the commonly seen PV panels."

As a Senior Development & Operations Engineer, what does a normal day look like?

"My 'normal day' varies a lot from week to week. One day I'll be focusing on data analysis and creating performance reports for our installations across the world, the next my focus shifts to logistics and inspecting our supply chain. I've also had the great privilege of helping set up our UK manufacturing hub in Essex. I'm now **leading in developing a plan to help Naked Energy achieve B Corp status**.

If I had any expectations of working in engineering, Naked Energy has absolutely exceeded them. **I get to work across the country, and with all different levels of seniority** - something I didn't expect from a solar thermal start-up!"

Could you share a scenario where you had to apply technical knowledge & skills you've gained from the Imperial ChemEng course?

"It might come as a surprise, but **I learnt a lot of technical skills at Imperial that I use at work** - there are countless examples! Corrosive chemistry, techno-economic analysis, fluid and thermal transfer - it's all principles to solving the problems we face every day. "

Any advice for students who are keen to go into sustainability?

"If you're considering a career in sustainability, I would definitely recommend **starting with an internship at a start-up**. You get first-hand insights into how the industry works and how you can help your company grow. During my internship at Naked Energy, **my drive and ambition was appreciated**, and **I could see my own potential in the business**.

It is rewarding to see the company growing around you and when your role in that growth is apparent. You can look back and see clear progression - both for the company and yourself.

I'm now entering my first year managing other people, and it's comforting to know that I'm trusted and knowledgeable enough to do that."

Were there any challenges that you had to face and how did you overcome them?

"As a new starter at Naked Energy, I was quite nervous to present my ideas and talk in our team meetings. **The fear of being wrong hindered me from speaking up and being a proactive member of the team.**

Only after months of guidance by my fantastic colleagues did I start to come out of my shell. They showed me that **there's no silly questions or bad ideas**. Once I realised this, I started to immerse myself in discussions and bring my ideas to the table - a massive personal milestone!"

What are your personal opinions and outlook on the transition to renewable energy?

"**The energy transition has to be a global effort.** Every country must acknowledge that we need to switch to clean energy, and it needs to be driven at a much faster pace. Current efforts are sadly not sufficient in delivering the improvements we need. There needs to be an international push from governments and big corporations to **implement tangible changes in good time**."

PIPELINE PHOTO Competition Winners

Nicholas Gerard
Undergraduate
Sustainability

Thirsty Fly
A fly carrying a droplet of water – which I think is unusual because the fly knows it needs water for later. If the fly can think about sustainability, then so can we.

Rohail Hamza
Postgraduate
Sustainability

Bees are key to the sustainability of this planet! The health of our natural ecosystems is fundamentally linked to the health of our bees. Bees contribute to biodiversity by pollinating flowering trees and plants. Also, beekeeping may support reforestation activities which can result in poverty reduction and sustainable regional development.

PIPELINE PHOTO Competition Winners

Matilda Dugdale
Undergraduate
Life & Engineering

The everyday engineering used to put these pitons in place to make the path. Shows how simple engineering solutions can help humanity both literally and metaphorically climb new mountains.

Jiaxian Luo
Postgraduate
Life & Engineering

Taken in the Hyde park after the snow in last December.

FRANK MORTON

Feb 20th @ Birmingham

WRAP UP

2nd Place Overall!

1st Place Tshirt!

Tshirt designed by 2nd year UG Joella Diong!

FOR THE LOVE OF... FOOD

Vegan Edition

CRISPY BANG BANG TOFU, PEANUT AND CHILLI STIR-FRY NOODLES

TAKEN FROM RECIPE BOOK DIRTY VEGAN
BY MATT PRITCHARD
RECOMMENDED BY ISABELLE BEDDOWS

Main Ingredients:

- 120g udon noodles
- 3 tbsp cornflour
- Pinch of salt
- 200g firm tofu, cut into small cubes
- 2 tbsp vegetable oil
- 2cm piece fresh ginger, finely grated
- 1 garlic clove, finely chopped
- 1 red chilli, deseeded and finely chopped
- Kernels from 1 small sweetcorn cob (or handful of canned kernels)
- 1 carrot, cut into fine ribbons
- 1 courgette, cut into fine ribbons
- 100g mange tout or green beans, thinly sliced
- Small handful of coriander, chopped
- ½ lime, cut into wedges, to garnish

Peanut Sauce Ingredients:

- 2 tbsp peanut butter
- 2 tbsp soy sauce or tamari
- 1 tbsp toasted sesame oil
- Juice of ½ lime

1. Cook the noodles in a saucepan of boiling water according to the packet instructions. Cool immediately in cold running water and drain well.

2. To make the sauce, whisk together the ingredients in a small bowl. Add a dash of hot water if it seems too thick. Set aside.

3. Put the cornflour and salt in a shallow bowl and mix together. Add the diced tofu and give it a couple of turns to coat it in the cornflour. Remove and shake away excess flour.

4. Heat the oil in a wok or large frying pan. Add the coated tofu and stir fry over a high heat for 3-4 minutes, until the cubes are coloured well on all sides. Remove the cubes from the wok and set aside.

5. Return the wok to the heat, add the ginger, garlic, chilli, and sweetcorn. Stir-fry for 1 minute then add the carrot, courgette and mange tout and stir fry for another 2 minutes. Take the wok off the heat.

6. Add the tofu, noodles, peanut sauce, and coriander to the wok and toss everything to warm through. Serve with lime wedges for squeezing.

KOREAN PAN-FRIED TOFU

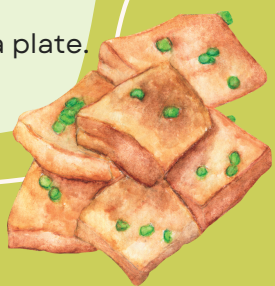
BY EYLUL AKGOK

A SIMPLE, YET DELICIOUS MEAL PERFECTLY PAIRED WITH SHORT GRAIN WHITE RICE!

Main Ingredients:

- 300g firm or extra firm tofu
- 2 tbsp gochujang (Korean red chili paste)
- 2 tbsp sesame oil
- 1-2 tbsp vegetable oil
- 1 tsp sesame seeds
- 2 tbsp soy sauce
- 1 tbsp sugar
- 2 minced/crushed garlic cloves
- 1 chopped spring onion

1. To prepare the sauce, mix your gochujang, sesame oil, sesame seeds, soy sauce, sugar, crushed garlic, and chopped spring onion together inside a bowl. Of course, these measurements can be altered to your own taste!
2. Slice your tofu into even, small, and flat pieces.
3. Pat the pieces dry with a paper towel.
4. Add a little bit of vegetable oil to your pan and heat.
5. Add your tofu into the pan, and fry both sides on medium to low heat for around 7 minutes (or until golden).
6. Once your tofu is nice and golden, transfer it onto a plate.
7. Add the prepared sauce over your tofu. Enjoy!



Note: The handbag in this photo is made of vegan leather.

As if it's your last

By Gots Narongchartsopon, 2nd year UG

Pipes and valves, I eat for lunch
Ice spice says that I'm a munch
Gots seeks sustainable solutions
To reduce waste and start a revolution

Every year I buy New Jeans
But I make sure that they are green
I always use razors more than TWICE
Because once does not suffice

Some process diagrams have recycles
And transporting to uni I tend to cycle
To create a better world for generations to come
To make a difference and leave a lasting outcome

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