



The Shipping Challenge: “Carry More, Emit Less”

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Dr Grahaeme Henderson is responsible for Shell's international shipping and maritime activities, including ships, barges, drilling units, floating production facilities and related operations. His work spans Shell's entire business from exploration and drilling, through design, construction and operations.

Grahaeme's global team also manages Shell's oil tanker, LPG and LNG vessel portfolio which has significantly expanded following Shell's recent combination with BG. Shell's combined fleet of managed and chartered vessels includes over 70 LNG carriers, comprising some of the most technically advanced on the oceans today. This is the largest LNG fleet in the world, making up over 16% of the global tonnage

Grahaeme is strongly focused on safety and the environment, improving the efficiency of shipping and maritime operations, and driving technology and innovation, including Floating LNG and LNG as a maritime fuel.

Grahaeme has been a member of the Shell Trading Executive Committee and a Director of Shell International Trading and Shipping Company since April 2011. He is active in a variety of shipping industry bodies: he is Chairman of the Oil Companies International Marine Forum, President of the UK Chamber of Shipping and Chairman of the UK Shipping Defence Advisory Committee. He is also a member of the World Economic Forum's Global Agenda Council on the Oceans and an Adjunct Professor for Southampton University.

Grahaeme was previously Managing Director of Brunei Shell Petroleum, Royal Dutch Shell's upstream joint venture company in Brunei. His career with Shell has also included assignments in the UK, Nigeria, Syria and The Netherlands.

He has a First Class Honours BSc Degree and a PhD in mathematics of sea waves, and is a Professional Chartered Engineer. He is married with a daughter and twin sons.

The world is facing an "Energy Challenge". Namely, how does the world economically meet the increasing demands for energy, whilst tackling climate change?

In his Distinguished Lecture at Southampton University, Dr Grahaeme Henderson argued that the shipping industry cannot hide from this challenge, and examined how the increasing amount of goods and energy the world demands can be shipped around the globe, whilst lowering the shipping industry's environmental impact.

As well as outlining a series of measures the industry can take in addressing this challenge, Dr Henderson stated that it is critical that the shipping industry does not shy away from the climate change debate and, instead, is seen to be a leader in reducing its own greenhouse gas footprint and emissions that affect air quality.

Dr Henderson argued that Innovation, genuine collaboration and pragmatic policy solutions are all needed if the shipping industry is to reduce its environmental impact at a time when demands for its services are growing more than ever.

- Ladies and gentlemen, good evening. It's a real pleasure and privilege to be here in the impressive surroundings of the Southampton Marine and Maritime Institute. Southampton University is a place that means a great deal to me, firstly on a personal level as I spent 7 very happy years here completing my Undergraduate BSc Degree and PhD, and I also lectured here in Maritime Engineering for a year. Also professionally too, as Shell enjoys a well-established relationship with the University.
- We are working with Professor Ajit Sheno, the Shell chair Professor Dominic Hudson, and students, academic and professional staff, on a number of challenging innovative areas of academic research. We are also able to provide data and operational insights from our own global shipping and maritime operations to the University.
- This evening I will speak for around 30 minutes and then will open the floor to questions. I know that in the audience today there are many experts; some have already helped me in providing information, for which I am most grateful, and I am sure that they will not hesitate to join the debate.
- I will be referring throughout my speech to something called LNG. This is Liquefied Natural Gas, predominantly methane, which forms a liquid when cooled to -162 degrees C...that's cold! In its liquid form it takes up a volume about one six-hundredth of the volume in its gaseous state. This makes LNG relatively easy to store and economic to transport by ships over long distances. A simple process of warming the liquid at its destination turns it back into a gas that can be used to create energy.
- I will begin this lecture by framing the significant challenge facing our industry as I see it. I will then introduce some of the initiatives that Shell is looking at to meet these challenges. Finally, I will explore what more industry can do to drive the changes that I believe are critical for its environmental and economic sustainability into the future. I must stress that I don't - and can't - have all the answers, but my objective this evening is to challenge and pose some questions to help drive the change to make the necessary improvements.
- Before I do this, I would like to give you a very brief overview of Shell's Shipping & Maritime business. My team are involved in all of Shell's global shipping and maritime activities, comprising some 2000 floating assets. These include Shell's ships, barges, drilling rigs, supply boats, floating production units and much more, including the

maritime aspects of the world's first Floating LNG facility Prelude. We also manage Shell's own crude, product and LNG fleet of around 55 ships and 3200 staff on the water. This includes around 40 LNG carriers, which makes Shell one of the largest LNG ship operators globally. We are also one of the world's largest charterers of vessels, and we work closely as partners with the owners and operators of these ships.

- So what is the challenge that the shipping industry faces?
- The world is seeing an unprecedented rise in the demand for energy, goods and products. This is being driven by a rapidly increasing affluent middle class within a global population growing by 200,000 people a day. That's an additional 70 million people each year on our planet or - put another way - the addition of nine times the population of London every year. This trend could lead to the world's population reaching 9.7 billion by 2050, up from some 7 billion in 2011! To highlight this, the world has grown by about 1000 people since I started speaking.
- Shell has long recognised the "Energy Challenge". Namely, how do we economically meet these increased demands for energy, while producing less Greenhouse gases, the most significant being CO₂? International climate experts state that greenhouse gas emissions are rising faster than ever.
- As early as 2040, the cumulative release of CO₂ could exceed 3.7 trillion tonnes. This is likely to lead to an increase in global surface temperature exceeding 2 °C above pre-industrial levels, which is the goal in average global temperature rise that was agreed within the United Nations Framework Convention on Climate Change (UNFCCC). Shell's approach to climate change is based on understanding and addressing this challenge.
- Today, an energy transition is taking place:
- A slow but steady shift from a predominantly carbon-based system towards one of net-zero carbon emissions. This will require continued growth in renewables and improvements in energy efficiency. As we work towards a lower-carbon future, it will be necessary to rely on a variety of energy sources.
- We can see the effects of climate change with its impact on our oceans. The oceans are the world's primary heat sink and are at significant risk. The heating of the oceans could affect sea level, currents and sea life.
- Healthy oceans sustain life; not just the animals and organisms within them, but the hundreds of millions of people who rely on it for food and their livelihoods. Evidence shows that many fish species have moved towards the poles in response to ocean warming, disrupting fisheries around the world. Increased acidity levels are impacting the skeletons and shells of marine animals. With increased water temperature, acidity levels and de-oxygenation, the food chain is being severely impacted at a time when the growing population is ever more reliant on the ocean for food stocks.
- But the damaging impact to the oceans does not stop there. There are even more dramatic possibilities.
- According to the US National Oceanic and Atmospheric Administration, if emissions continue on their current trend, sea levels could continue to rise by as much as 2 metres by the end of this century. That's a huge change. This could have catastrophic results for the estimated 150 million or more people that are currently living on land that could either be submerged or exposed to chronic flooding by 2100.
- With changing weather patterns and rising sea levels, we are also seeing a greater frequency of severe storms,

and flooding of coastal and tributary areas.

- If you were to walk out of London along the river, past the Thames barrier, it's not uncommon to get soggy feet due to storm surges. There is something deeply disconcerting about seeing parts of London underwater, even if it's just the Thames footpath. In fact, last year we saw a record number of closures of the Thames Barrier in an effort to protect London from these surges - well over 50!
- Whilst climate change is one of the most important issues facing the world today, this also sets the context for the challenge that the shipping industry must address. Shipping is fundamental to society. The energy, food and goods that we take for granted every day are vital to power, shape and sustain our lives. So how do we economically ship the increasing amount of goods and energy the world demands, whilst lowering the environmental impact. In essence, how does the shipping industry "carry more, emit less"?
- According to the International Maritime Organisation, the IMO, Shipping currently accounts for 3% of the world's total greenhouse gas emissions and, if unchecked, this is expected to increase significantly by 2050, potentially contributing 17% of global emissions according to a recent EU Policy Paper. There are many variables and scenarios used to make these predictions, but regardless of the debate around the percentage contribution, there is no doubt that the shipping Industry's growing environmental footprint is simply not compatible with mitigating climate change. Most stakeholders now agree that additional measures are needed to reduce shipping's CO₂ emissions.
- Cargo movement by sea has more than doubled since 1990, from four billion to nine billion tonnes. Given the importance of shipping, it is critical that the shipping industry does not shy away from the climate change debate and, instead, is proactive in reducing its own greenhouse gas footprint and emissions that affect air quality.
- According to a study by the University College London Energy Institute, to stay within the two degrees target limit, shipping will need to halve its CO₂ emissions by 2050. Taking into account expectations for increase in trade, this means that ship emissions in 2050 would need to be approximately 2g of CO₂ per cargo tonne per nautical mile as an average across the world fleet. To give you some indication of the challenge, currently the average emissions of the largest dry bulk vessels stand at 5-6g of CO₂ per cargo tonne per nautical mile and the largest wet bulk vessels stands at 6-8g of CO₂ per cargo tonne per nautical mile.
- Given this mammoth task, how can the shipping industry take up this challenge? How can we look our children in their eyes and say that we are delivering them an environment that we can be proud of and a sea teeming with fish?
- The traditional factors that force change in any industry are business drivers, like the need to reduce cost or adapt to changing landscapes, and regulatory drivers – those that force change from the top down.
- At the moment, there are very few business drivers pushing the shipping industry to improve its environmental performance. The low oil price has further reduced financial incentives to reduce fuel use, slowing the drive for efficiency.
- Since 1990, we have seen the industry place emphasis on optimising the capital expenditure for the design and building of ships, rather than environmental performance. This has mainly been driven by a high freight rate.

When freight rates are high, new ships are in high demand from owners and yards tend to build standard designs, which are understandably optimised for efficiency of production through the shipyards rather than efficiency in operation.

- Another "split incentive" we see is between the owner and the charterer. Currently a reason the owner of the vessel may not invest in energy efficient technology is that the charterer pays for the fuel. Even if the owner does invest in the technology on the basis of remaining competitive, the current model is that the charterer seems unwilling to share the benefit of the fuel savings with the owner. Part of the reason for this is the difficulty in actually attributing a reduction in fuel cost to a technology.
- Turning to regulations, are there robust requirements in place to force the industry to reduce greenhouse gas emissions? The primary regulations have been set by the IMO in the form of the Energy Efficiency Design Index, the EEDI, which sets targets for efficiency improvements in the design of new vessels. This global regulation is a first of its kind and a good first step. However, the EEDI is calculated with the vessel in the laden condition and operating at the design speed, which is not representative of the real situation. Crucially, its targets are being all too easily met through existing efficiency measures and speed adjustments. Using the argument put across in a recent Delft University study, it is possible that the EEDI 2015/2020 target effectively brings us back to the 1990 vessel design basis and therefore, we won't have actually achieved any advancement in efficiency!
- So, whilst the IMO should be applauded for taking this lead, a question is whether the EEDI is stringent enough and does it go far enough?
- It's at this point that I want to ask the real question; why should we wait for regulations? Everyone in the shipping industry agrees that "safety is our top priority". I would like to suggest that reducing emissions be its priority too.
- So what is Shell doing with our own shipping operations to meet this challenge? Like others, interestingly we have found that increasing the efficiency of our operations is more than just good business. The more efficient the operation, the safer it is, the more it reduces the environmental impact and the more cost effective it becomes. I must stress that our work in this area is still in progress and we have programmes in place to make further steps changes.
- In 2012, Shell began a programme to make our shipping operations more efficient. This began with a forensic analysis of over 105 activities that makes up a ship's journey from the loading to the discharge of a cargo in order to deliver continuous improvement. We timed every one of the 105 steps, over and over.
- Working together with our masters and ship's crew, ports, technology groups and certification authorities, we minimised durations at berth in terminals, ports and refineries. By reducing loading and discharging time by 13% we have saved around half a day per journey since the programme started, optimising our vessel requirement. It also means that ships burn less fuel in port.
- In transit, we have reduced the fuel consumption of our managed fleet by implementing web-based route optimisation tools based on weather conditions, optimising our propeller and hull cleaning cycles and by applying advanced hull coatings. These measures along with many others, have already led to around a 5% reduction in fuel consumption. In real terms, we have so far saved over 300, 000 tonnes of fuel and reduced our emissions by

over one million tonnes of CO₂.

- Safely challenging and optimising the certified maximum volume of cargo permitted on our LNG carriers also means that the Shell operated fleet can now move an additional 400,000m³ of LNG a year with the same number of ships.
- An area of interest to me is so called "big data"; a term I like in relation to shipping, as we only use "small data" at the moment. The correct use of large quantities of data in real time can ensure that processes run as efficiently as possible. To use a simple example in airline terms, buying a ticket sets off a data process so efficient - from the ticketing, luggage management, aircraft refuelling, passenger loading, flying and monitoring the journey - that almost the only variables are the ones that we cannot control, such as getting to the airport and the weather. This highly efficient process and use of data, is where I would like to see the shipping industry.
- To be really efficient, we need to open up the flow of data enabling us to optimise our operations in real time. "Big data" is an area of particular expertise available in Shell through our partnership with Ferrari.
- A Formula One car is a data machine with millions of data points being collected and real time data adjustments being made in the operational performance of the car. We are working on similar innovative technologies for our ships, harnessing and analysing the large quantities of data, with resulting optimisation of ship's operations in real time.
- We are exploring the impact of large data sets to deliver insights that we do not currently get from the limited data transmitted by ships, an example being the traditional daily noon report that provides 30-50 data points. New DataLoggers placed on a number of trial vessels provide some 30,000 data points per day. This is just a start and by using remote diagnostic technology, I believe the resulting optimisation of ship's operations in real time can add a further 10% to our efficiency savings.
- These are all replicable ways to "carry more, emit less", and we are currently extending this work to our chartered fleet. We are also keen to support the speed of development of the new technologies that we believe show real promise in reducing environmental impact such as air lubrication - a blanket of bubbles under the ship's hull to reduce friction - giving further fuel savings of more than 5%. This is a prime example of collaboration between ship owners, technology providers, charterers and shipyards.
- Improving environmental performance at Shell is not only limited to shipping assets. LNG as a fuel is a new alternative for the shipping industry, which is cleaner than heavy fuel oil in terms of sulphur and nitrogen oxides, and particulates, and can help reduce greenhouse gas emissions. As a result, LNG is the strategic choice for environmental compliance, providing customers with a cost-competitive and technically proven fuel, without compromising performance.
- Examples of Shell's leadership in helping to develop LNG as a fuel for shipping include launching the world's first LNG powered barges that are currently operating on the Rhine called Greenstream and Greenrhine. Shell is also involved in a new, dedicated LNG for transport infrastructure at the Gas Access To Europe (GATE) terminal at the Port of Rotterdam in The Netherlands. As a result, Shell will start to offer LNG fuel to marine and road customers in northwest Europe. In fact, just last week we began construction of a first of its kind high technology bunker vessel

to supply LNG from this terminal to marine customers in the region.

- In America, we have also launched two LNG powered Offshore Supply Vessels for our deep water operations in the Gulf of Mexico. We are continuing to explore options for further LNG powered ships, barges and vessels.
- So what more needs to be done?
- For me, innovation is the most important factor in ensuring that we address the challenges ahead. This is about more than new technology, it's about new ways of doing business. Technology, although very important, will not be enough on its own to address the challenge. A much more collaborative business model is also needed to align agendas to make the shipping industry a truly efficient, joined up operation.
- We need to work with the shipyards to create efficient designs, re-setting the emphasis to operational performance; looking at and valuing the total through-life cost of a vessel. We must remember that the lifespan of an LNG carrier for example is 30 to 40 years, so we must make decisions accordingly.
- The UCL Energy Institute has said that if shipping is to dramatically reduce its CO₂ emissions then it will need to dramatically reduce the speed of ships in transit using optimised vessel designs. As ship speed is driven by existing business conventions, we will need to agree new business models that truly promote efficiency. But to do this, there needs to be a far stronger focus on collaboration and not relying solely on regulation.
- We need to seamlessly work together across the industry, with ship owners, charterers, shipyards and brokers, and with Governments, regulators, universities and classification societies to develop a clear, agreed pathway and develop new ways of working, and speeding up the technological advances that aid us in meeting the challenge.
- We have seen collaboration work in our own industry. One example is in the area of safety where industry has considerably improved its safety performance. This has taught us that when the right framework and governance is put in place and everyone has the same objective, it is possible to make significant inroads into meeting a particular challenge. The shipping industry can replicate the same ways of working to reduce its environmental emissions.
- I believe that the shipping industry can also learn from other industries that use collaboration to meet challenges. In the space industry, more than 80 nations work together to use data from the International Space Station for furthering space activities. Another strong example is the pharmaceutical industry with individual companies collaborating by sharing their own big data across the industry in an effort to cure cancer. If these industries can do it, so can the shipping industry.
- To conclude, my vision is a world where in the next few years the shipping industry will be embracing new technologies, and more importantly will be working collaboratively; delivering significant reductions in Greenhouse gasses and emissions that impact air quality. Shipping will be seen as the efficient, cohesive and high technology industry.
- It will "carry more and emit less", and be held up as a beacon for others to follow in addressing one of the toughest challenges the world has ever faced. Thank you.