Perfecting the Sustainability Script

Explore how to secure a seat at the future energy table.

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Kline & Company

Kline

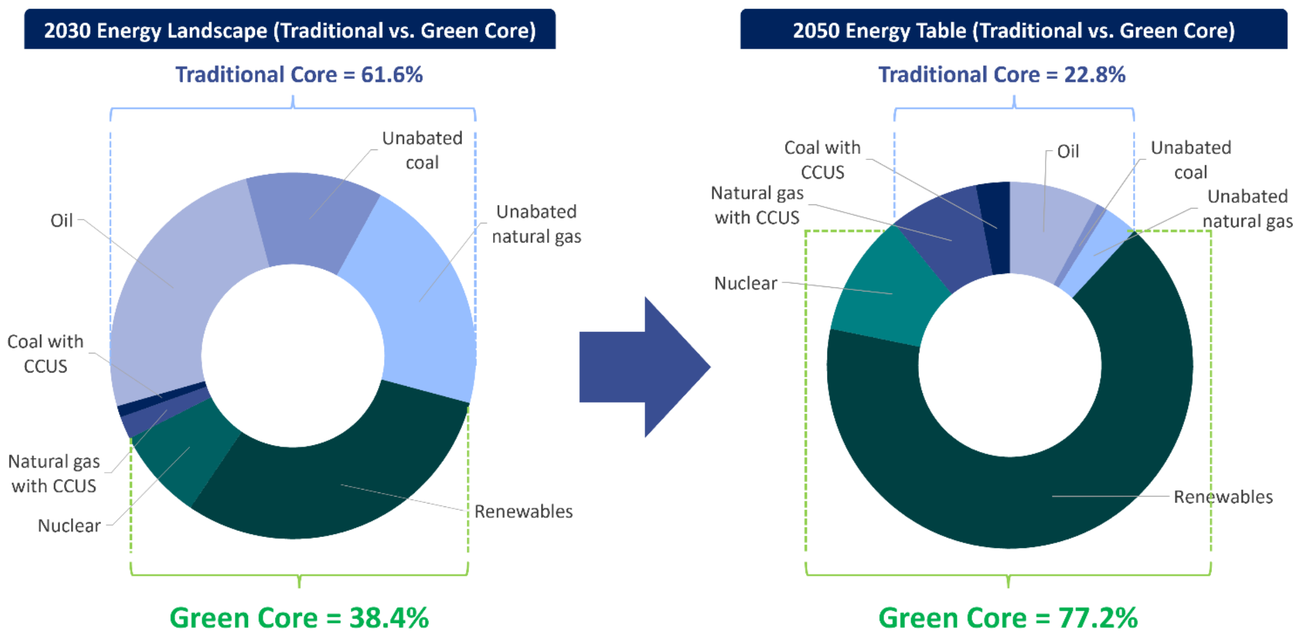
The 2050 Energy Table: Setting the Stage

In the ever-evolving energy landscape, 2050 will see a transformed future. One characterized by innovation, sustainability, and a departure from conventional practices. Fossil-based assets, traditionally the bedrock of energy companies, are poised to become increasingly scarce over time.

However, translating this vision into action is a formidable challenge, not only from an industry perspective but also from the imperative of ensuring that substitutes for conventional energy are both abundantly available and financially viable.

Nevertheless, it is undeniable that as the global narrative shifts toward greener and cleaner energy, the conventional foundation of major oil and gas companies, which we call the 'Traditional Core,' is steadily weakening. In parallel, we see the emergence of a new 'Green Core,' which is gradually eroding the dominance of the traditional core (Figure 1.0), thereby shaping the landscape for the 2050 energy scenario.

Figure 1.0: The 2050 Energy Table: Traditional Core Vs. Green Core



Source: IEA[i], Kline Analysis

What is particularly intriguing is that the transformed landscape of 2050 will incorporate not one or two but several cleaner pathways to produce and reinject cleaner forms of energy back into the energy system. Some of the existing pathways are biofuels, carbon capture and storage, carbon utilization, e-fuels, new microbial pathways, waste-to-energy, and electrification.

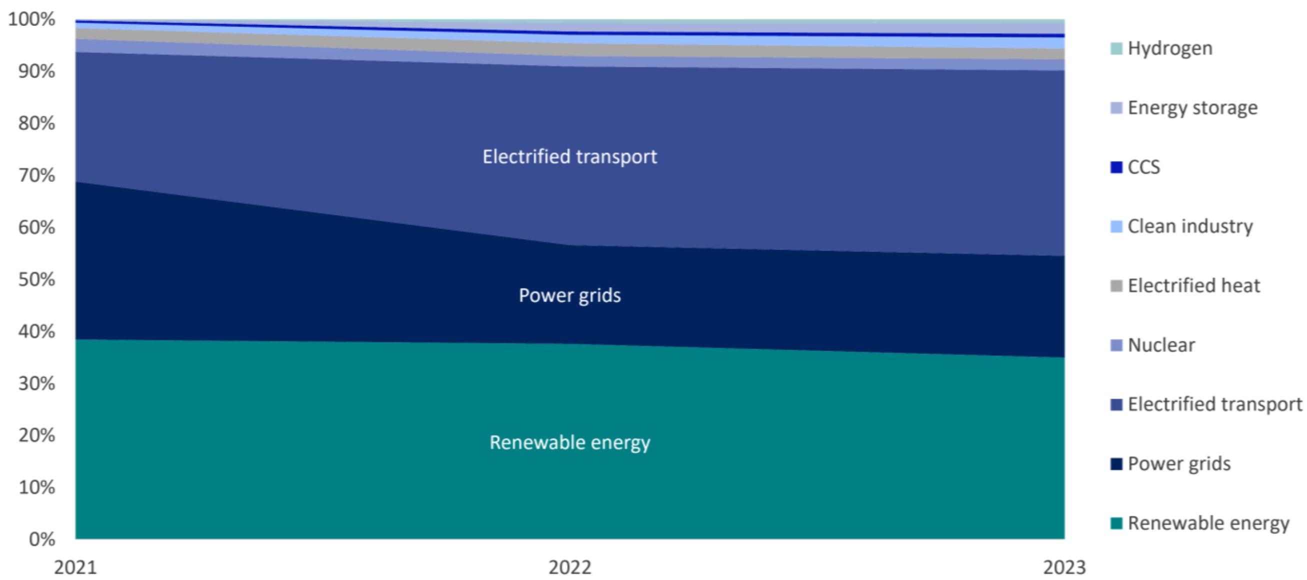
Who is in the driver's seat today?

As the clean energy space expands rapidly, a diverse range of participants are taking their place on the stage. From utility providers and energy companies to private companies, start-ups, and unconventional participants, several forward-thinking companies are venturing into this uncharted territory, embracing the vast potential that the future holds.

So, who are today's players, and which technologies are they investing in? Upon analyzing the cumulative investment across various technologies within the clean energy space, it becomes evident that renewable energy claims the lion's share. However, there have been recent shifts in this investment landscape (Figure 2.0). In 2023, the electrification of the transport sector—encompassing electric cars, buses, two- and three-wheelers, commercial vehicles, and associated infrastructure—attracted more investment than renewable energy. The investment in electrified transport reached a remarkable $634 billion, surpassing the $623 billion invested in renewable energy, which includes the construction of wind, solar, geothermal power plants, and biofuel production facilities, among other components.

The power grid, a pivotal facilitator of the energy transition, ranked as the third-largest contributor at $310 billion. Noteworthy is the substantial growth observed in emerging sectors, wherein hydrogen experienced a threefold increase in investment year-on-year, carbon capture and storage nearly doubled, and energy storage witnessed a 76% rise.

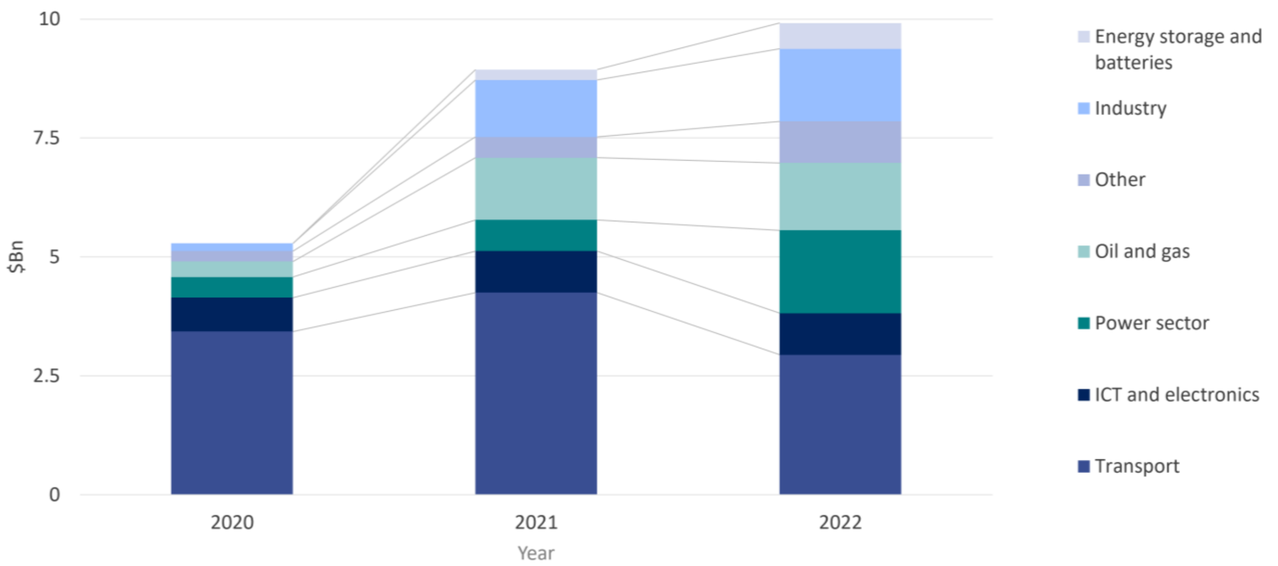
Figure 2.0 Global Investments in Energy Transition by Type (%), 2023



So, who's participating in the future energy business? In terms of players, several venture capitalists (VCs) are investing heavily in clean energy start-ups, which attracted the highest amount of attention in 2022, compared to any other sectors. Most notably, start-ups in CO2 capture, energy efficiency, nuclear energy, and renewables nearly doubled or more than doubled their 2021 level of funding, which was already much higher than the average for the preceding decade.

Besides VCs, this space attracted corporate investments from players in transportation, power, oil and gas, and information and communication technology (ICT), among others (Figure 3.0).

Figure 3.0 Corporate VC Investments in Clean Energy Start-Ups, 2022



Between 2020 and 2022, oil and gas companies invested $2 billion, primarily in carbon capture utilization storage (CCUS), energy efficiency, and renewable energy developers. However, this investment is not enough and represents a significantly small portion of the total investments made in the clean energy space. The lack of action by energy business leaders today is a matter of concern. In 2022, oil and gas companies accounted for only 1% of the total investment in the clean energy space, with four companies contributing 60% of that. When considering the industry as a whole, only 2.5% of the total capital spending was allocated to clean energy investments. This data suggests that most clean energy investments come from outside the energy industry, with several new participants investing in the future energy landscape.

Upon a closer examination of the above trends, it becomes clear that there isn't a singular green solution that unlocks the vast decarbonization puzzle. The product life cycles of various clean energy technologies vary, with scalability achieved by some and challenges faced by others. Business leaders need timely market insights to ensure that they are responding to the changing market dynamics at the right time and at the right pace.

> "Clean energy progress will **continue with or without oil and gas producers**. However, the journey to net-zero emissions will be more costly, and harder to navigate, if the sector is not on board."
>
> - IEA Executive Director, Fatih Birol

Taking a broader perspective, it is apparent that everyone is welcome to join the 2050 energy table and its corresponding value chains. However, the key question remains: Who is truly capitalizing on this opportunity?

Are You on the Right Sustainability Pathway?

Are You on the Right Sustainability Pathway?

The hard truth is that the road to sustainability is not set in stone. Every other day, new technologies emerge, while some older ones gain economic traction, and others wane. Business leaders and governments across the value chain need to work hand-in-hand to ensure that the new technologies are introduced at the right time, with the right route to the market plan in place. There are several green solutions available today, but the question is—which is the right one (that has scalable potential), and for which use case?

Let's look at two use cases of emerging clean energy technologies to demonstrate this.

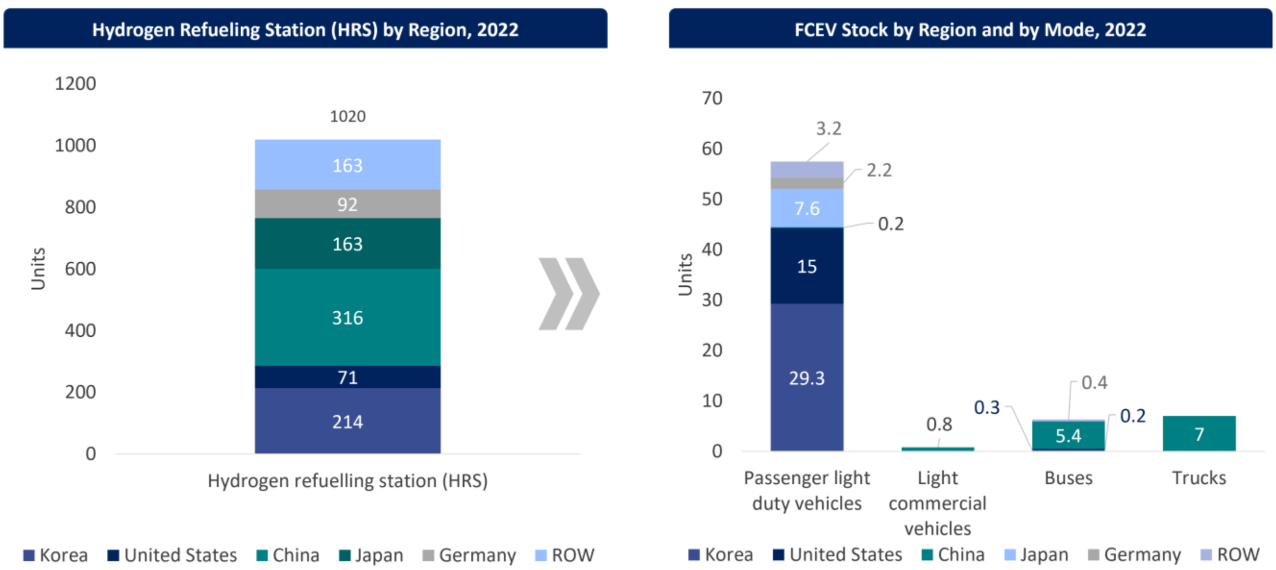
Hydrogen Fuel Cell Vehicles: Ready to Take Off or Not?

In recent times, the global automotive industry has been undergoing a notable shift toward more sustainable and environment-friendly options in contrast to traditional gasoline-powered vehicles. One such alternative gaining momentum is hydrogen fuel cell vehicles, which produce only water vapor as a byproduct.

As the world embraces electric transportation, the prevalence of battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs) has surged. However, fuel cell electric vehicles (FCEVs) have also emerged as an attractive substitute for BEVs. With the global hydrogen market anticipated to experience substantial growth in the upcoming years, the role of hydrogen in the net-zero movement has become increasingly significant. The question remains whether FCEVs will stand the test of time.

As per IEA data, there were approximately 72,000 FCEVs globally in 2022, a 40% increase from 2021 stock. About 80% of the FCEVs are cars, 10% are trucks, and almost 10% are buses. In the same year, sales of electric cars exceeded 10 million (BEVs and PHEVs combined) in the world (Figure 4.0), stock up to 26 million.[iiiii]

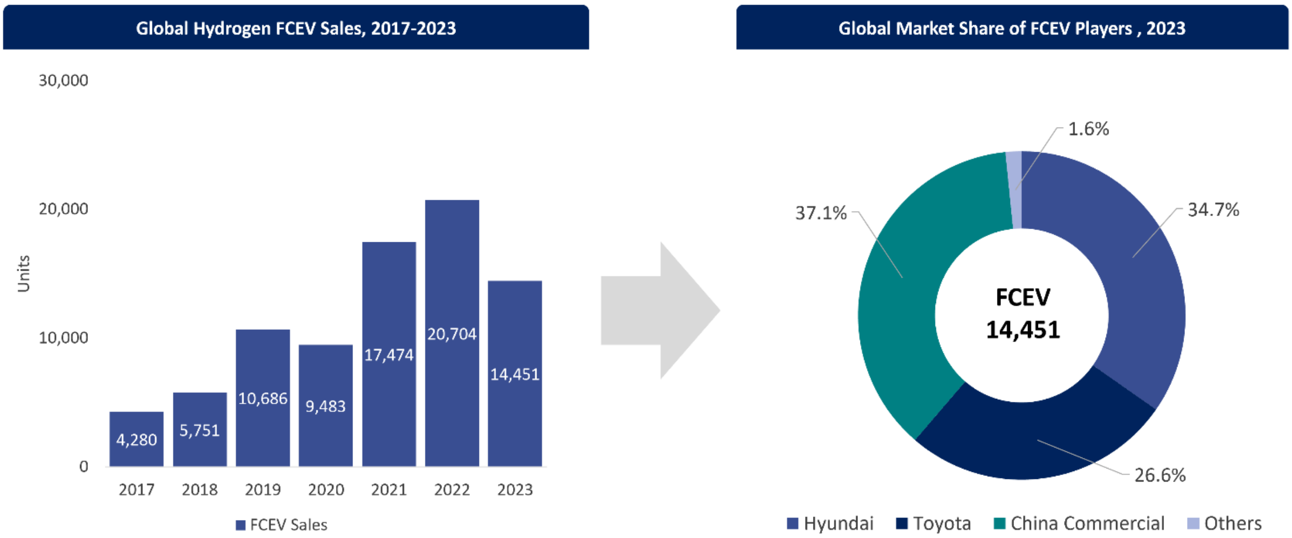
Figure 4.0 FCEV Stock by Country and by Mode, 2022



The global hydrogen car market (FCEV) faced challenges, particularly in 2023, with a notable 30% decrease compared to the previous year. Worldwide, registration of FCEV vehicles dropped from 20,704 units in 2022 to 14,451 units in 2023. Hyundai Motor Company, a key player in the industry, experienced a significant sales decline, primarily attributed to a 42% drop in the sales of its flagship hydrogen car, the Nexo, which sold 4,709 units in 2023 compared to 11,179 units in 2022 (Figure 5.0).

In contrast, Toyota observed a 3.9% increase in sales, driven by the strong performance of Mirai. Despite the challenges, Chinese hydrogen car sales are on the rise, and China has secured the top position for the first time. It is noteworthy, however, that Chinese manufacturers predominantly focus on the commercial vehicle market.

Figure 5.0 Global FCEV market landscape2023[iv]

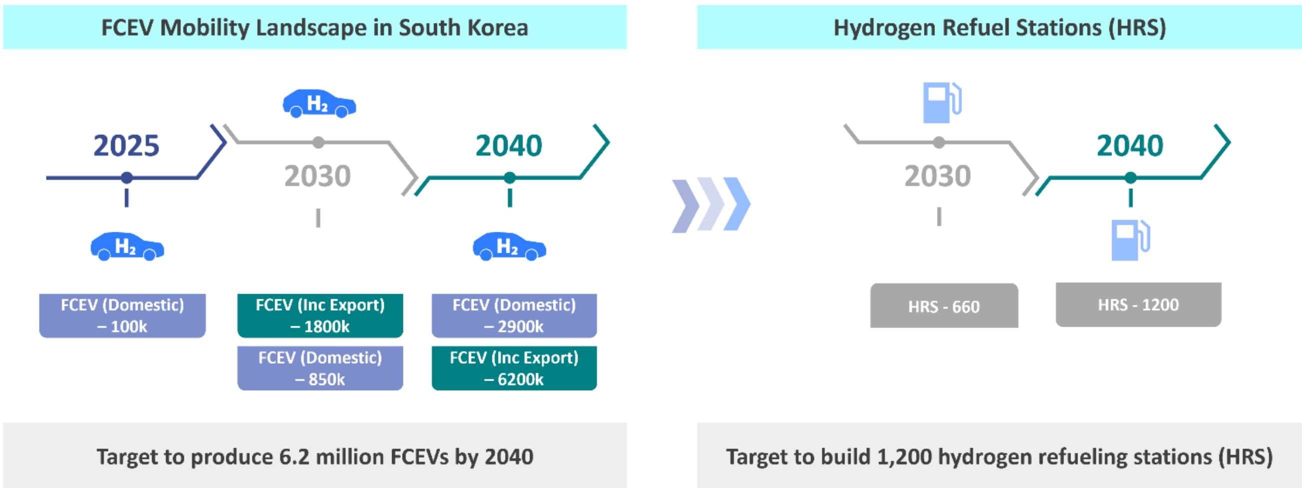


Examining the Business Case for FCEV in South Korea

Case Example: Examining the Business Case for Fuel Cell Electric Vehicles (FCEV) in South Korea

In 2019, South Korea announced one of the world's most ambitious national hydrogen strategies, the Hydrogen Economy Roadmap, to revolutionize the country's energy system, reduce its heavy reliance on imported fossil fuels, and create growth opportunities through hydrogen (Figure 6.0)[v]. As a part of the roadmap, the country set production targets of 15GW of fuel cell power generation, 6.2 million FCEV, and 1,200 refueling stations by 2040.

Figure 6.0 South Korea's Hydrogen Economy Roadmap, 2019



Later, this roadmap was revised in 2022 with new targets and additional government measures, such as:

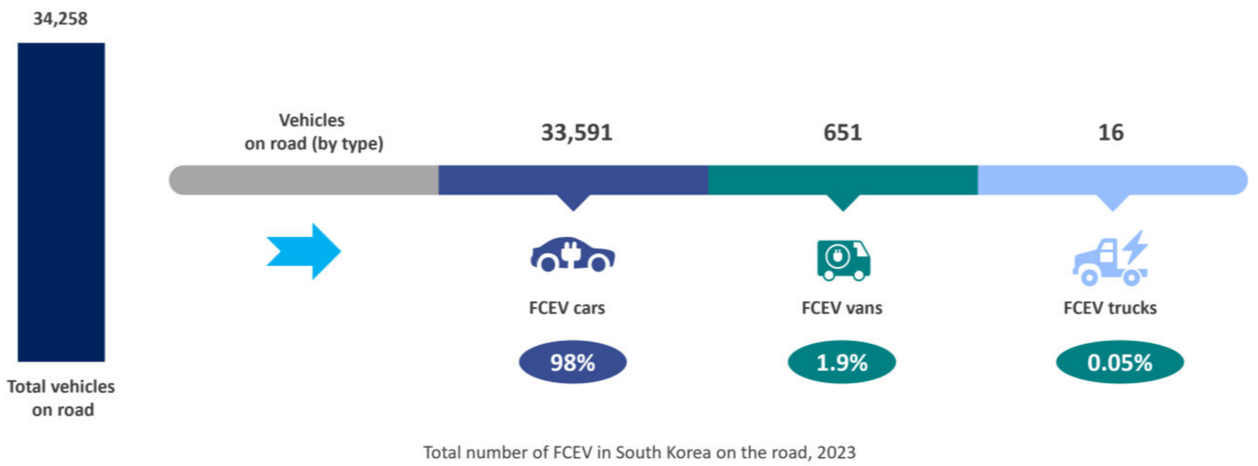
- Securing advanced technologies to nurture 600 hydrogen-focused companies by 2030
- Producing 30,000 hydrogen-powered commercial vehicles by 2030
- Building 70 liquid hydrogen fueling stations by 2030
- Clean hydrogen to account for 7.1% of the nation's energy mix by 2036

Also, in a strategic move to boost FCEV sales, the South Korean government announced a substantial enhancement to its hydrogen vehicle subsidy program in early 2023. This upgrade significantly expanded the number of supported FCEVs, with 95% of them being passenger cars, potentially leading to a 50% reduction in their purchase price.

Under the new initiatives, the acquisition of a new passenger car qualifies for government support amounting to 22.5 million won ($18,000), and some regions offer additional local subsidies. Notably, cities such as Busan and Incheon are providing supplementary funds of up to 33.5 million won ($27,500), potentially resulting in substantial reductions and effectively halving the price of hydrogen cars in these areas.

However, these initiatives did not prove effective. Contrary to expectations, South Korea experienced a substantial decline in the number of registered cars in 2023. The registrations of FCEVs plummeted by 54% compared to 2022, with a mere 4,635 hydrogen-powered cars, vans, and trucks added to the country's fleet last year. With only 34,258 FCEVs on the road in 2023 (Figure 7.0), the ambitious target of 6.2 million set by South Korea's roadmap for 2040 appears to be a distant goal.

Figure 7.0 Total Fuel Cell Vehicles on Road in South Korea in 2023 by Type (Units)



Where did South Korea take a wrong turn in the FCEV journey?

In the pursuit of a hydrogen-powered future, South Korea encountered unexpected hurdles on its journey toward sustainable transportation. The initial optimism surrounding the country's push for hydrogen vehicles has faced a harsh reality check, raising critical questions about the viability of this eco-friendly technology.

South Korea's struggle stems from two challenges—a lack of sufficient hydrogen charging infrastructure, and the escalating costs associated with hydrogen refueling.[vi] While the nation successfully incentivized the development and adoption of hydrogen cars, it overlooked the crucial aspect of aligning incentives with hydrogen infrastructure.[vii]

Despite successfully nurturing a market for FCEVs through substantial government subsidies, the oversight on supporting infrastructure has become glaringly apparent. Filling stations, or charging stations as they are referred to in South Korea, are grappling with operational issues, leading to long wait times and service disruptions. Users reported waiting times of up to two hours for refueling, underscoring a critical need for robust and reliable hydrogen infrastructure.[viii]

Compounding these challenges, the recent decision by Hynet, a government- and Hyundai-backed entity, to increase hydrogen prices has further fueled dissatisfaction among FCEV owners. This setback shows the delicate balance required to sustain an emerging market, where price hikes can swiftly erode consumer confidence.[ix]

Furthermore, FCEVs find themselves in an uphill battle against their battery-electric counterparts, which have gained a competitive edge through economies of scale. The shift in market dynamics has posed a huge challenge for FCEVs to assert their presence and compete effectively.

Adding to the complexity, Seoul's recent decision to slash the budget for hydrogen car subsidies by approximately 43% signals a re-evaluation of priorities. This reduction is likely a response to the lackluster uptake of FCEVs, emphasizing the government's reluctance to pour additional funds into expensive infrastructure and green hydrogen production without tangible market demand.[x]

South Korea's experience mirrors a global trend, as evidenced by a parallel situation unfolding in California. There, FCEV owners grapple with both price fluctuations and supply disruptions, with nearly half of hydrogen-filling stations going offline due to unforeseen challenges in the hydrogen supply chain.

Kline's Opinion: Key Learnings From This Case

In the evolving landscape of sustainable mobility, South Korea's journey highlights the intricate interplay between government incentives, infrastructure development, and consumer adoption. As nations navigate the path toward a hydrogen economy, South Korea's experience serves as a thought-provoking case study, offering valuable insights into the holistic approach needed for the successful integration of fuel cell technology into the fabric of modern transportation.

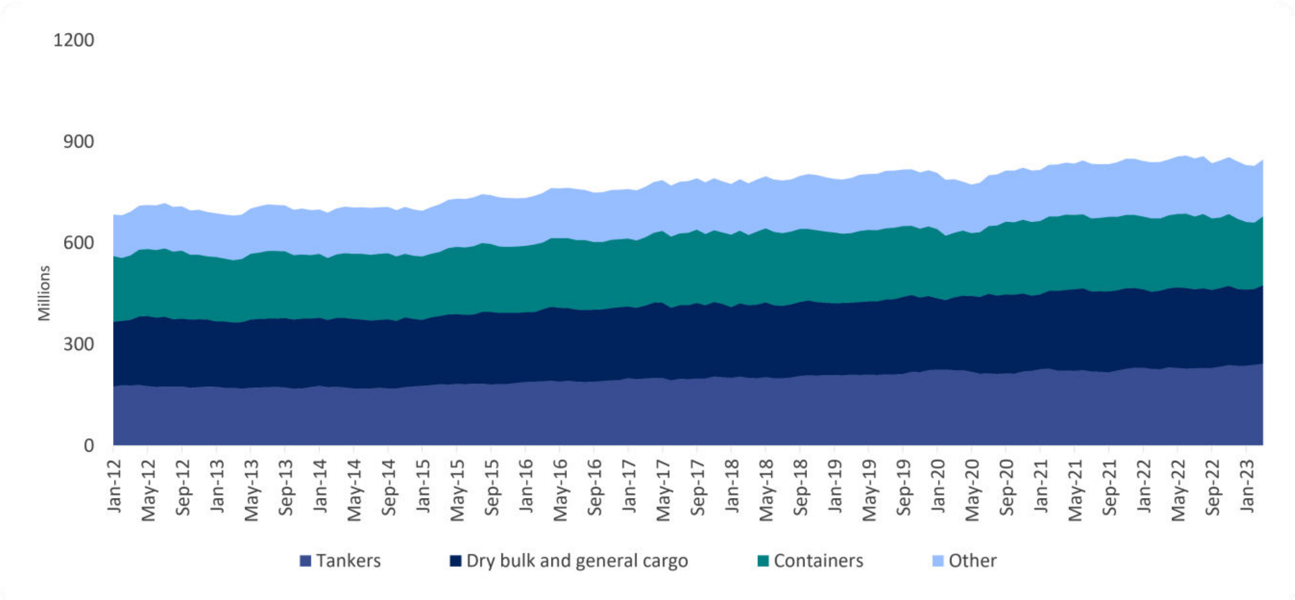
Maritime Industry: Expectation Vs. Reality in Alternative Fuel Adoption

Uncharted Waters for the Maritime Industry: Expectation Vs. Reality in Alternative Fuel Adoption

The shipping industry is a vital player, handling about 80% of the world's merchandise trade and contributing around 3% to the global greenhouse gas (GHG) emissions. Over the past decade, emissions from the sector have surged by 20%, a trend that the world simply cannot afford (Figure 8.0). Decarbonizing the global fleet by 2050 is estimated to cost between $8 billion to $28 billion annually, with an additional $28 billion to $90 billion needed each year for the necessary carbon-neutral fuel infrastructure.[xi] Such a substantial financial commitment could increase shipping costs, thereby impacting the global economy.

A 2023 UNCTAD simulation underscores the potential economic ramifications. Hypothetical increases in maritime logistics of 10%, 30%, and 50% could result in reductions in the global GDP by 0.01%, 0.04%, and 0.08%, respectively. To put this into perspective, a 0.08% drop in the global GDP, valued at $104 trillion in 2022, would equate to approximately $80 billion in losses to the global economy.[xii]

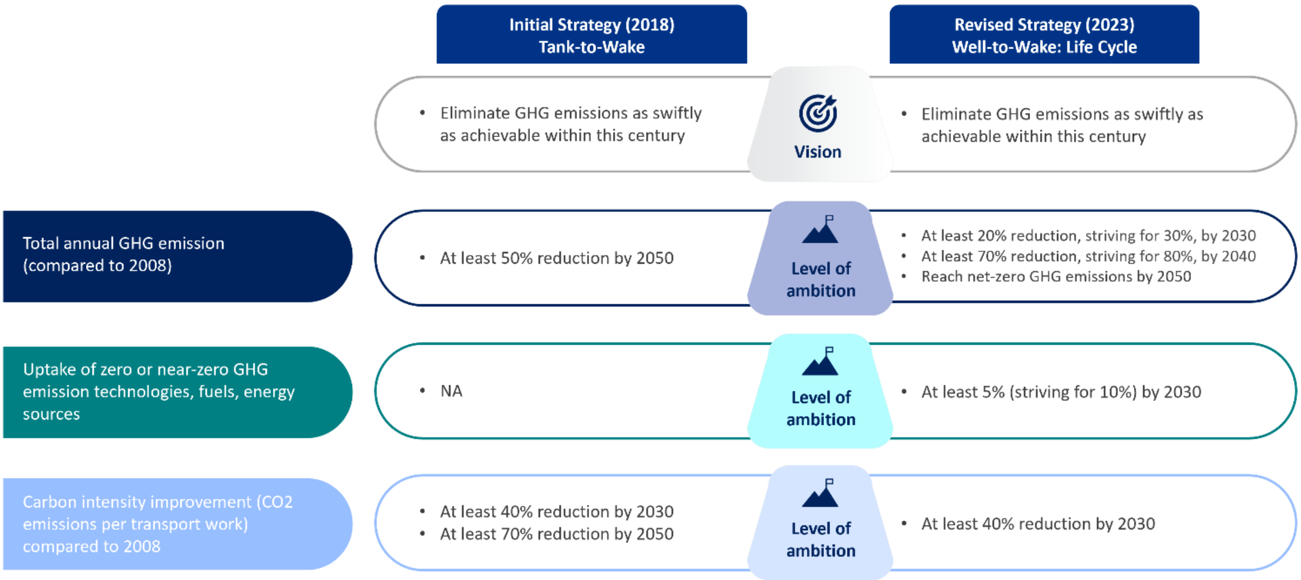
Figure 8.0 Carbon Dioxide Emissions by Main Vessel Type, Tons, 2012–2023[xiii]



In the pursuit of a more sustainable future, the maritime sector is at the forefront of efforts to decarbonize. However, this journey toward cleaner and greener shipping is proving to be a complex voyage, where expectations often clash with the reality of implementation challenges.

One significant hurdle involves breaking away from fossil fuels. Today, the shipping industry is responsible for a staggering 80% of trade worldwide and relies heavily on an annual consumption exceeding 300 million metric tonnes of heavy petroleum fuel oils.[xiv] This colossal consumption comes at a considerable environmental cost, with the industry being a major contributor to CO_2 emissions. Recognizing the urgent need for change, the International Maritime Organization (IMO) has set an ambitious target to halve the sector's carbon emissions by 2050, measured against 2008 levels (Figure 9).

Figure 9.0 2023 IMO (International Maritime Organization) ***GHG Strategy***



While much of the shipping sector is committed to decarbonizing, the alternative fuels needed to power much of the industry's fleets are still being tested for availability and affordability, a question that was relevant in Case in Point: 1 as well. Too many uncertainties exist for companies across the maritime value chain. It is imperative to demystify these uncertainties and move forward with actions that will make a difference.

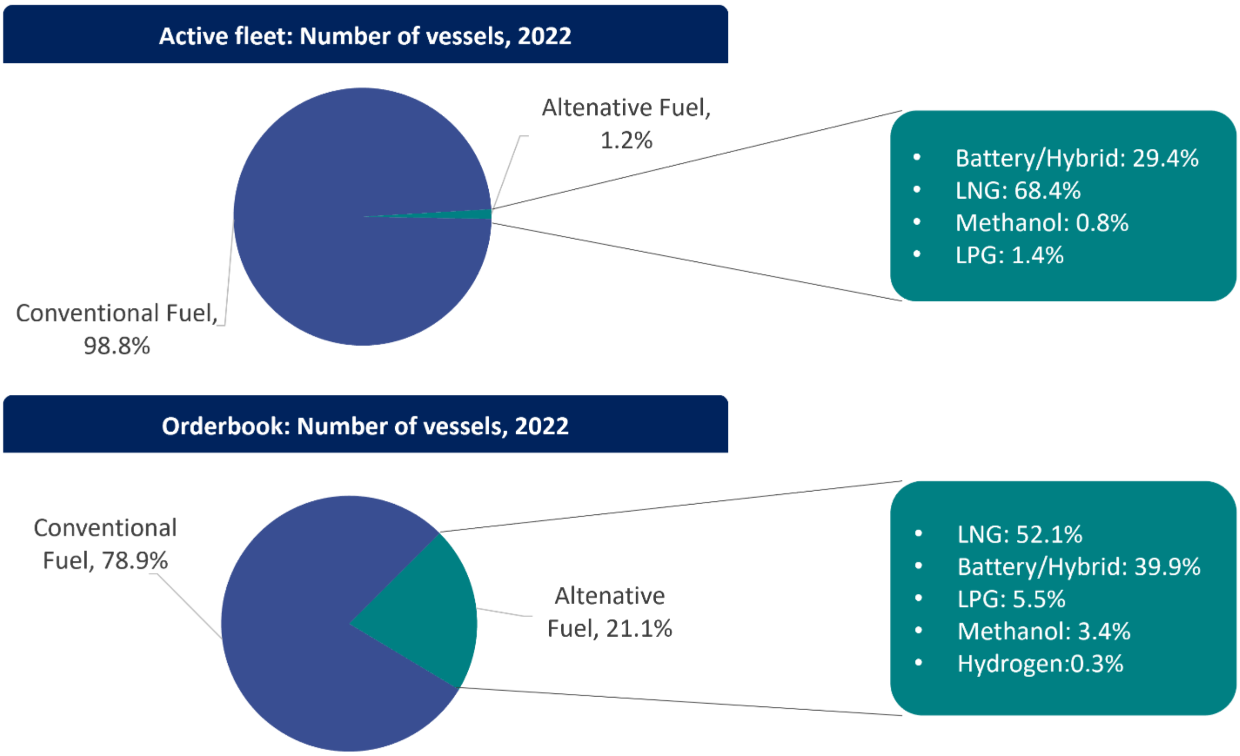
How is the industry reacting to these targets?

Today, the collective interest of both industry participants and governmental bodies in transitioning to alternative fuels is evident. Yet, the landscape demands meticulous consideration of various factors. Factors such as technological readiness, scalability, and regulatory certainty are crucial in supporting the demand for alternative fuels and vessels.

Moreover, the strategic emphasis on creating a business case holds paramount importance. This phase not only substantiates the viability of alternative fuels but also plays a vital role, particularly in light of the current average age of the vessel fleet ranging from 25 to 30 years.

If we look at the fuel consumption in 2022, the majority of fuels (~98%) consumed were conventional fuels, with a meager 1.2% being alternative fuels consisting of liquified natural gas (LNG), and to a lesser extent, battery/hybrid, liquified petroleum gas (LPG), and methanol (Figure 10).[xv]

Figure 10.0 Alternative Fuel Uptake in World Active Fleet and Orderbook, Number of Vessels, 2022



Examining the Alternative Fuel Landscape

a. Biofuels

Biofuel is currently one of the easiest options available for vessel operators to lower emissions with existing infrastructure. According to the Global Centre for Maritime Decarbonisation, biofuel can cut net carbon emissions by 20% (for a typical 30% biofuel and 70% MGO blend). These formulations are readily available in many major ports, and their popularity is increasing among operators and charterers who are eager to immediately address emissions.

Fuel costs play a crucial role in managing the cost structure of each shipowner. The typical approach adopted by vessel owners is to procure sufficient fuel required to meet customer demands, comply with regulations, or achieve company carbon reduction targets. However, when making any such switch, price is always the main point of discussion.

In terms of blends, the range used in the market today typically falls between B20 and B50, but they are also available as 100% biofuel. The choice of this blend often depends on the incentive structure. For example, the Dutch government has an extensive incentive structure, leading to the widespread use of B30 and B50 blends. In Singapore, the commonly used blend is B24.

The preference for this particular fuel is experiencing notable growth. Singapore itself is a case in point as the globe's largest bunker hub, where sales of bio-blended marine fuel witnessed an impressive threefold increase, exceeding 500,000 tons in 2023.[xvi]

b. LNG

LNG is among the top list of non-traditional fuels currently used in commercial ships, including some large container vessels. The number of LNG-fueled ships has climbed up over the past decade. According to DNV, as of December 2023, there are 469 LNG-fueled ships—excluding LNG carriers—in operation, with a further 537 on order. LNG's global bunkering infrastructure is also showing promising signs of development.[xvii]

A better sustainable alternative, in the form of Bio-LNG/BPG, is gaining ground in the landscape of alternative fuel options. Today, bio-LNG production has already carved a well-established path, with global biomethane production reaching 30 Mtpa and being compatible to be used in the existing infrastructure.

LNG outperforms other alternative marine fuels in terms of volumetric energy density, nearly double that of ammonia and methanol and four times that of liquid hydrogen. The higher energy density enables efficient fuel storage, leaving more space for revenue-generating cargo, which is a crucial consideration in vessel design (Figure 11).

One notable drawback associated with LNG is that it primarily constitutes methane, which possesses a significantly higher global warming potential than CO2—estimated to be 86 times higher according to some analyses.[xviii] Consequently, even minor gas leaks during production, refueling, or usage could lead to a proportional increase in GHG emissions.

Other challenges include the substantial capital investment required to adopt LNG-compatible engines and fuel tanks, and the establishment of new infrastructure for bunkering or refueling ships while in port. However, recent data from Clarksons suggests that LNG bunkering infrastructure continues to expand with ~188 ports offering LNG bunkering services and a further 82 bunkering locations being under active implementing discussions.[xix]

Figure 11: Comparison of Different Alternative Shipping Fuels

Energy Source	Fossil (Without CCS)			Bio	Renewable			
Fuel	**LNG**	**Methanol**	**LPG**	**HVO (Advanced Biodiesel)**	**Ammonia**	**Hydrogen**	**Electric**	**Liquified Biogas (LBG) Compressed Biogas (CBG)**
Energy Density	• LNG has roughly one-third of the volumetric energy density as diesel.	• Methanol have even lower volumetric energy density—40–50% of LNG.	• LPG has 40% lower volumetric energy density than diesel.	• Biodiesel is the only fuel that is close to matching the energy density of diesel.	• Hydrogen and ammonia have even lower volumetric energy density—40–50 % of LNG.		• Low energy density means that fully electric systems are only feasible for a very limited number of vessel types and sizes with short sailing distance.	• CBG:7.2 GJ/m3 • LBG:21.2 GJ/m3 • Methane and LBG have similar energy densities, making them more viable as fuels for long-distance transport in ships.
Technology Maturity		• It is highly mature technology.	• It has moderate-to-low level maturity.	• It is highly mature technology.	• Moderate to low level - For the use of ammonia in fuel cells to become commercially viable on a large scale, the technology must mature	• Moderate-to-low level: Fuel cells will be the primary converter for use with hydrogen when the technology is sufficiently mature.	• Battery electric is highly matured.	• Low: It is attributed to the lack of infrastructure required for LBG refueling
Cost of Fuel	• From LNG terminals to the receiving ship, the costs typically range between 40–120 USD/m3, which is the equivalent of approx. 15-40 USD/MWh shaft output.	• LNG, methanol, and LPG are competitive in terms of energy costs.	• Transport costs for LPG is slightly lower than those for LNG due to the slightly higher energy density. • Price of LPG carriers are typically also somewhat lower than comparable LNG carriers	• HVO is significantly more expensive.	• The cost is highly dependent on the electrolyzer load factors (number of running hours per year) and the cost of electricity. • Lower energy content of ammonia is translating to 20–70 USD/MWh.	• The cost is highly dependent on the electrolyzer load factors and the cost of electricity. • Liquid hydrogen is approximately 30% more expensive than compressed hydrogen.	• NA	• Utilizing LNG infrastructure for bunkering in ports can result in a more cost-effective implementation. • Vessels employing LNG can easily transition to liquefied biogas (LBG) as a drop-in fuel.
Capital Cost (Converter and Storage)	• Storage cost is around 4–7 USD/kg LNG equivalent.			• There is no additional investment cost reported when running on advanced HVO.	• Ammonia is transported by multi-cargo gas carriers, which can also transport LPG. Hence, equipment and costs for transporting ammonia can be estimated from the cost of LPG.	• Fuels cells are currently many times more expensive than the internal combustion engines.	• It costs equivalent to 18,500 USD/kg LNG. • Storage tanks cost is 8–20 USD/kg.	
Commercial Readiness	Commercial availability of promising alternative fuels will depend on the level and speed of which environmental regulations are implemented. For alternative marine fuels, which are far more expensive, the adoption rate will be minor/at piloting stage until regulations or incentive schemes makes them more competitive and incentive schemes are developed.							

c. Methanol

Methanol is currently manufactured using natural gas feedstock and remains in liquid form under ambient pressure. In comparison to various alternative fuels, its temperature makes storage and handling simpler. The capital investment for a new build or retrofit utilizing methanol is lower due to the absence of the need for pressurization or expensive cryogenic fuel tanks and systems. However, it is essential to note that fuel tanks occupy approximately 2.5 times more space than oil tanks, and in some cases, cofferdams are necessary for protective measures.

Methanol has the potential to be entirely sourced from renewable means, as it can be generated from various sources such as biomass or electrolysis and powered by renewable energy. This positions it as a compelling candidate for a sustainable future where shipping relies entirely on renewable fuels.

A.P. Moller – Maersk (Maersk), a prominent shipping and maritime logistics company, is intensifying its commitment to methanol utilization in its fleet. In 2021, Maersk made a groundbreaking move by placing an order for the world's first methanol-powered container ship, aligning with its policy of exclusively procuring new build vessels capable of operating on green fuels. For this, Maersk has engaged Hyundai Heavy Industries to construct 18 green methanol-powered ships.[xx] This includes the initial order for eight 16,000 TEU ships in August 2021, with an additional four sister ships exercised later and a subsequent order for six 17,000 TEU ships in November 2022. The anticipated delivery for these vessels is scheduled for 2024 and 2025. Remarkably, just two years following the initiation of the first methanol-powered ship order, the global order book has surpassed 100 methanol-enabled vessels, as reported by Maersk.[xxi]

d. Ammonia

Ammonia emerges as another viable zero-carbon fuel alternative under consideration. Ammonia is more attractive as it has zero carbon content and is touted as a far more sustainable option when produced from renewable sources. Although green ammonia is anticipated to offer the most cost-effective operation with zero or near-zero GHG emissions on a well-to-wake basis, significant barriers such as safety concerns and limited availability must be addressed before its widespread adoption.

Ammonia can be used as the energy source for fuel cells, or it can be part of the fuel source for an internal combustion engine. Notably, "green" ammonia presents a dual potential for achieving zero-emission shipping in both the well-to-wake and tank-to-wake phases. Challenges persist in terms of scalability in production, availability, novel engine technology designs, safety considerations, and supply chain concerns.

Recently, CMB.TECH has made headlines by placing an order for the world's first ammonia-powered container vessel, named Yara Eyde. This groundbreaking vessel, owned by Delphis (the container division of CMB.TECH) and operated by NCL Oslofjord (a collaboration between North Sea Container Line and Yara Clean Ammonia), marks a significant step toward sustainable shipping practices.[xxii]

e. Hydrogen

Among the alternative fuels discussed earlier, industry leaders in the maritime sector hold the optimistic view that green hydrogen-derived fuels could be the final piece of the puzzle in solving the industry's decarbonization problems. Many perceive hydrogen, specifically produced through renewable means (which is known as green hydrogen), as a potential near-zero carbon solution on a well-to-wake basis.

The shipping industry presently has limited experience using hydrogen as a fuel and important technologies (e.g. the engine), and the infrastructure needed to support this development remains under development.

Among the potential roadblocks, working with hydrogen's low energy density by volume could be a challenge. To put things in perspective, a kilogram of hydrogen as a gas at room temperature at sea level takes up the same volume as 11,900 liters of or 3,144 US gallons of gasoline. Hence, it needs to be compressed to 700 or 800 times the pressure of the atmosphere at sea level before it is useful.[xxiii] Other challenges include the need for infrastructure development to support production and distribution.

Kline's Opinion: Key Learning

At present, there is no clear frontrunner in determining the optimal fuel for decarbonizing the maritime sector. The ultimate champion will be the fuel that effectively meets all three benchmarks of availability, affordability, and a comprehensive sustainability profile.

"Everyone is welcome to join the 2050 Energy table. But the question remains: Who is actually seizing the opportunity and has secured for themselves a seat at the future energy table? The hard truth is that the road to sustainability is not set in stone; it's still developing and changing every day. Being a frontrunner is not easy, and not participating is not an option. In their sustainability journey, business leaders constantly need insights that help them unlock commercial value in their investments. And, Kline's Green Value Compass is here to aid in that journey."

- ***Ruella Menezes, Director, Kline Energy***

The Green Value Compass

Secure Your Seat with Kline's Green Value Compass

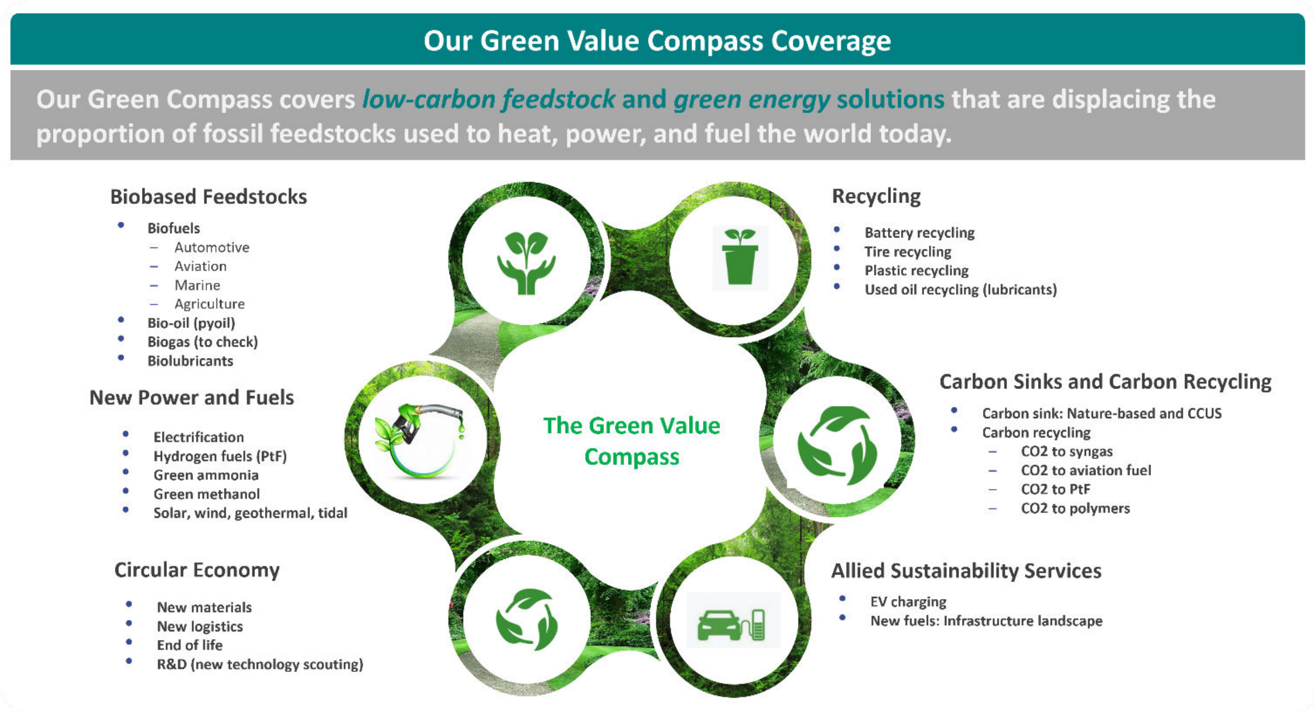
The two case studies discussed above confirm our understanding that the road to sustainability is not set in stone. The landscape is evolving fast and today's challenges may not be the challenges of tomorrow. However, to secure a position in the future landscape, investments must be strategically deployed. This requires business leaders to make bold yet well-informed investment decisions. Companies that successfully navigate this transition are poised to establish themselves at the forefront of the future energy paradigm.

However, the process is not as straightforward as it may appear. With numerous technologies, pathways and markets available, and unexplored terrains to tap into, it is crucial to pivot decisively and astutely. And addressing these two fundamental questions will be critical:

- Which technologies and markets will endure?
- Which technologies will ensure long-term economic viability?

Kline's Green Value Compass (GVC) is a unique offering that enables clients to unlock and safeguard commercial value throughout their sustainability journey. It serves as a crucial tool to manage the uncertainties and evaluate the trade-offs of this new energy landscape.

In the ever-evolving clean energy space, new technologies are continuously emerging, while others gain or lose economic traction. Leaders in this dynamic landscape face the challenge of making informed decisions to secure investments and create a resilient pathway for the future of their business.



Kline's GVC uses comprehensive business intelligence to equip clients with the necessary insights, turning risky and uncertain opportunities into secure investment decisions. With real-time market insights and our industry expertise, the GVC delivers forward-looking, data-driven strategies and insights. By doing so, it adds a sense of certainty to our clients' future endeavors, enabling them to shape a successful and sustainable business trajectory.

Meet Our Energy Practice Leaders

Yana Wilkinson
Vice President and Practice Head, Energy

Annie Jarquin
Vice President Energy

Milind Phadke
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Ruella is Director at Kline & Company's Energy practice and brings with her more than 14 years of experience in strategy and consulting. With a primary focus on sustainability, her expertise lies in uncovering emerging sustainability markets, formulating market entry strategies, evaluating project feasibility, conducting business planning, and performing competitive assessments. Prior to Kline, Ruella spent nearly a decade working at Accenture, where she assisted clients in the Energy and Chemicals sector, with various strategy and consulting assignments aligned with business growth, sustainability, and digitalization.

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