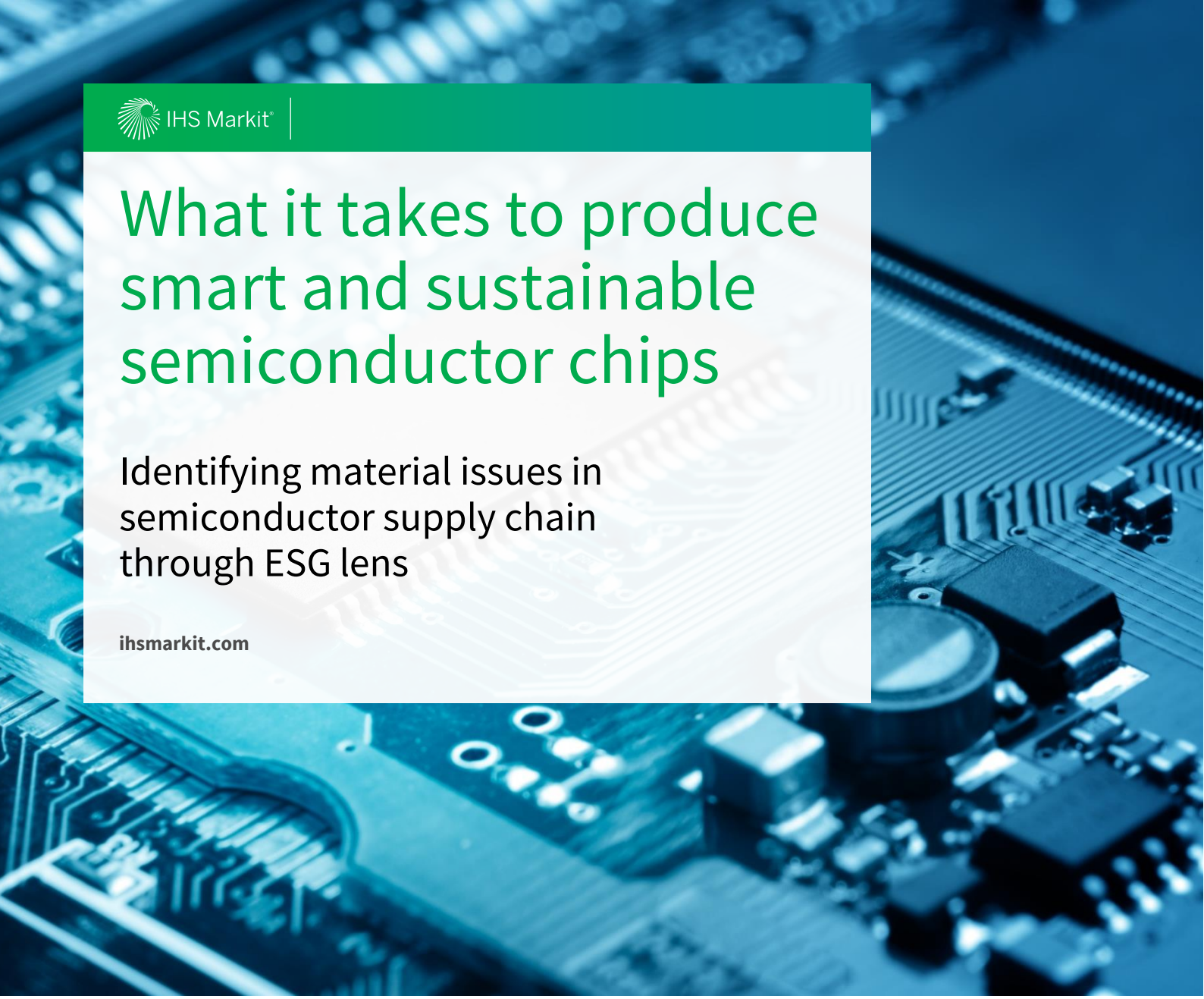

IHS Markit®

What it takes to produce smart and sustainable semiconductor chips

Identifying material issues in semiconductor supply chain through ESG lens

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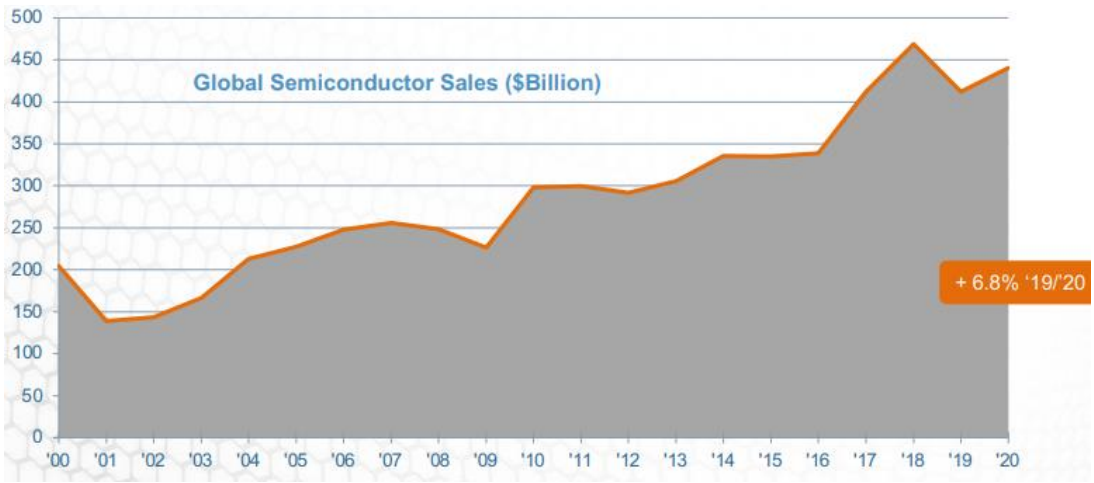
Why is the Semiconductor industry a ‘hot potato’ these days?

Think about how your working environment changed after the pandemic started. You created your own office setup at home, started to use video chats for multiple client meetings which made your Wi-Fi connection more important than ever. The long-distance calls and work-from-home trend made you search for lighter and faster mobile devices. This transition brought about by COVID-19 increased your demand for better connectivity. Semiconductors, crucial for telecommunication and embedded in nearly all types of electric devices are in stark demand. In parallel to the connectivity demands in our homes, in the world at large, 5G, IoT and quantum computing technology are developing fast. The conundrum is - they also require semiconductors.

According to the World Semiconductor Trade Statistics (WSTS), Worldwide semiconductor sales increased from $204.4 billion in 2000 to $440.4 billion in 2020, a compound annual growth rate of 3.91% per year. According to WSTS Fall 2020 Semiconductor Industry Forecast, worldwide semiconductor industry sales are forecasted to reach $469 billion in 2021 and $496 billion in 2022, predicted to show continuous growth.

Figure 1: Global Semiconductor Sales reported from WSTS (US$ bn)



Source: World Semiconductor Trade Statistics (WSTS) and SIA Estimates

Challenges for market players in semiconductor industry

Global semiconductor shortage crisis

Despite the increasing demand in recent years, the complexity of manufacturing process, rising shipping cost due to pandemic, and shortage of 200mm fabs[1] have resulted in global shortage of semiconductors. The biggest problem is that this shortage cannot be resolved immediately due to the nature of the semiconductor industry. Some vendors increased their capacity, building new plants in new regions but supply increase cannot be executed in only few months. Even if the producers put together new plants, it will take longer than 1.5 years for the supply to increase. Moreover, other accidents such as winter storm in February in Texas[2] and a fire in Japan impacted some big chip suppliers.

CNBC recently reported that the CEO of Marvell Technology stated, "The semiconductor chip shortage that is hamstringing the production of products ranging from cars and computers to appliances and toothbrushes will extend into 2022 and potentially beyond."[3] One of the biggest challenges the market players are facing currently is how to manage their supply capacity without sacrificing their product quality.

Going deeper into the major players in semiconductor market

There are three broad categories of semiconductor players in the market. A semiconductor foundry is a manufacturer that owns fabrication plant operations. A pure foundry manufacturer does not produce its own designs. When a foundry manufactures its own designs, it is called an Integrated Device Manufacturer ("IDM"). When a semiconductor company only designs chips and outsources all manufacturing, it is called a fabless company. Figure 2 summarizes top key players in the semiconductor industry, most of them are IDMs.

[1] https://semiengineering.com/demand-picks-up-for-200mm/

[2] https://www.bbc.com/news/technology-56114503

[3] https://www.cnbc.com/2021/10/03/semiconductor-chip-shortage-could-extend-through-2022-marvell-ceo.html

Figure 2: Global Semiconductor business – top 10 by revenue (US$ Billion)

Rank	Company	2020 revenue in USD Billion	Headquarter location	Type
1	Samsung Electronics	208.5[1]	Seoul, South Korea	IDM
2	Intel	71.9	Santa Clara, California, USA	IDM
3	SK Hynix	35.3	Icheon, South Korea	IDM
4	TSMC	35.0	Hsinchu, Taiwan	Foundry
5	Micron Technology	30.9	Boise, Idaho, USA	IDM
6	Qualcomm	24.3	San Diego, California, USA	Fabless
7	Broadcom	20.9	San Jose, California, USA	Fabless
8	Texas Instruments	14.4	Dallas, Texas, USA	IDM
9	Toshiba	12.3	Tokyo, Japan	IDM
10	Nvidia	11.7	Santa Clara, California, USA	Fabless

Source: Company reports

[1] Samsung Electronics revenue is notably high compared to peers because it operates both semiconductor production and other electronic appliances.

Due to differences in business models, the environmental, social and governance ("ESG") concerns faced by these different types of companies vary. E&S issues are greatly influenced by the factory's geographic location. Unexpected natural disasters and industrial accidents can slow down production capacity, also impacting company reputation and possibly deteriorating E&S risk. In addition to traditional environmental issue such as water management and greenhouse gas emission ("GHG") management plan, clean technology and human capital development have been a rising focus in the industry. Compared to E&S issues, governance concerns are more specific to market regulations and practices. In general, the quantum and structure of executive remuneration packages, and share ownership of executives, remain hotly debated issues amongst investors. Therefore, issuers in the semiconductor industry should be able to understand their investors' voting behaviors prior to their Shareholder Meetings to better manage governance issues.

It is noticeable that the ESG issues are becoming more intertwined over the years. Shareholder proposals on Say-on-climate are rising, implying environmental issues are coming to the board's table more frequently. Investors and proxy advisory firms are updating voting guidelines on E&S issues specifically. Corporates are therefore in need of proactive engagement with market participants and managing their nonfinancial risks.

Innovation - when information security rises to the top of the material ESG risk list

For the three types of semiconductor companies, innovation remains the key to success. In January 2021, **Qualcomm** held its own virtual automotive summit – Automotive Redefined[4], positioning the company as an automotive technology supplier, following its success as chip designers with mobile devices. **TSMC**, the world's most dominant foundry recently announced its plan to invest US$ 100 billion over the next three years to meet chip demands.

Information security, data privacy and cyber-attacks are the top ESG issues for institutional investors. The UK government's intervention in US-based Nvidia's proposed $40 billion acquisition of chip designer for the UK-based Arm on national security grounds, showed how much is at stake when it comes to technological innovation and the protection of intellectual property.

[4] https://www.qualcomm.com/company/events/automotive-redefined-technology-showcase

Material ESG issues and how companies are managing them

The semiconductor supply chain is comparatively long and more complicated than other electronic components production matrices. Semiconductor device fabrication involves a multiple-step sequence of physical and chemical processes such as photolithography, film deposition, etching, diffusion and implantation, cleaning, and planarization.[5] This complex manufacturing process often involves diverse stakeholders for each step of the production. The duty of the semiconductor company to engage closely with their employees, subcontractors, factories, and regulatory institutions on ESG issues are therefore an involved activity.

IHS Markit looked into global market players in the semiconductor industry including Samsung Electronics, SK Hynix, TSMC, Broadcom, and others. We identified the most important material issues they addressed in their 2020 and 2021 Sustainability Reports, and how they are making their value chains sustainable regarding each issue.

1. Making a Safe and Healthy Environment for Workers

In foundries and IDMs, where sourcing and manufacturing are involved, material ESG concerns become more complicated as they involve many chemicals that contribute to global warming. If waste disposal is not adequately managed, some chemicals may cause occupational health and safety issues. Fabless players are also not free from supply chain management responsibilities. They are exposed to supply chain risks of a different nature. As noted in the 2020 Annual report of (form 10-K), **Broadcom** acknowledged that "social and environmental responsibility regulations, policies and provisions, as well as customer demand, may make supply chain more complex".

SK Hynix has an advanced safety and health program, 'SHE Management', for employees which promotes safe and risk-free worksites, a people-oriented health system, and sustainable environmental systems. Moreover, in 2021 Sustainability Report, they explained how they managed to ensure safety for employers during the pandemic. This included emergency report channel using Kakaotalk (messenger app) and forming a collaborative network with specialized medical institution.

2. Using Water Resource Efficiently

Globally, water management industry growth is dependent on regulatory drivers. Industrial development requires high-quality process water, and as a result of this, to mitigate the competition for drinking water for global citizens and also the effects of water scarcity, there is an uptick in water improvement projects.[6] Water management is a challenging area for semiconductor suppliers as production requires significant volumes of water for production. In addition to this, some processing lines require ultrapure water, which can challenge the capacity of supplier water recycling programs.

TSMC provides a good example through the design of its well-structured water resource management program which includes an efficient water recycling system and relevant

[5] *Electronic Chemicals-Semiconductors, Silicon, and IC Process Chemicals*, Specialty Chemicals Update Program, IHS Markit

[6] *Water Management*, Specialty Chemicals Update Program, IHS Markit

disclosure published through the website and sustainability report. The company has clear quantitative goals such as reducing water consumption unit, increasing replacement rate of regenerated water, and reducing water pollution composite indicator. These targets are both short-term and long-term to enable investors to assess the company's ESG integration level in water management.

Regards to water recycling, TSMC states "The key to successful water resources allocation is detailed classification and comprehensive water reclamation mechanisms. TSMC categorizes wastewater according to purity so that the cleanest water is given priority to be purified and recycled for use in the manufacturing process, and the second cleanest water is treated in water recycling facilities then supplied for use by water consuming units other than production equipment."

3. Reducing Carbon Footprint

SK Hynix demonstrates the integration of company sustainability goals into business strategy. The company's efforts are particularly notable for the management of environmental issues. It has sustainability guidelines that consist of a 'Declaration of Sustainability Management', a central environment policy and additional focused policies for specific ESG issues. In SK Hynix 2020 Sustainability Report, the company explained in detail, their approach to environmental issues including its greenhouse gas (GHG) emissions goal. It plans to reduce GHG emissions by 40% by 2022. Efforts in environmental issues are not limited to the parent company. As mentioned previously, the semiconductor supply chain consists of a diverse group of stakeholders, and therefore engagement with these other market players is recognized as being instrumental to achieve overall company ESG goals. SK Hynix explains that it committed to support GHG reduction projects in Least Developed Countries and also the creation of an 'ECO Alliance' which aims to promote an eco-friendly semiconductor ecosystem based on cooperation between SK Hynix and its suppliers. To align with best practice and gain competitive advantage amongst its peer group, SK Hynix has the opportunity to focus more on investing in cleantech opportunities to magnify their positive performance in environmental matters.

4. Investing for Human Capital

Samsung Electronics is one of the few companies that still runs a graduate training program which covers marketing, sales, business management, product management, customer experience, technical, paralegal and people. It is a two-year development program that helps graduates to transition from student to professional life. These programs are available in the company's home market, South Korea, and also in key business centers, such as the US and the UK. Samsung also runs a MBA leadership program for high potential candidates.[7] At a time when many global firms have postponed their graduate schemes, this human capital management program is likely to attract high-quality candidates who are likely to develop a strong loyalty bond with the employer.

TSMC has a special Academia Cooperation with Semiconductor Program to attract talent. They have set up numerical target goal for 2021 and 2030 to recruit more talented graduates. According to TSMC, "TSMC's strategy of talent attraction and

[7] https://news.samsung.com/us/samsungs-mba-leadership-development-program-ldp/

retention, industry-academia cooperation is mainly structured through the Semiconductor Program on device/integration, process/module, and equipment engineering."

5. A More Transparent Corporate Governance

Corporate governance is a broad term, which constitutes Board structure, pay plan for executives, company disclosure policy, compliance system and more. Of all, remuneration is a key corporate governance issue which demands ongoing attention. The recent shortage of supply into the semiconductor market might affect how investors will view companies' incentive payments for executives. Increased pay is not the issue. But disclosing transparent information to investors and being able to explain clear rationale for pay increase is key. Considering multiple big market players are based in U.S., say-on-pay can become center of attention in the next AGM season. Shareholders will closely monitor if the pay plan is sustainable for the long term, and if there is a risk of shareholder value decrease.

Toshiba explains how they calculate their performance-linked compensation in their recently published Sustainability Report. They breakdown incentive into short-term and long-term compensation. For short-term, their standard criteria are operating income and operating cash flow. For long-term, they use TSR (total shareholder return). This can be a good information disclosure practice. Shareholders are curious to know what standards the company use to calculate incentive especially when there is a performance target.

Meanwhile, Board structure, especially on independency, professionalism, and diversity is a hot topic these days. Proxy advisors such as ISS and Glass Lewis have emphasized independency criteria for Board election for years, but they have also broadened their view to gender diversity. Globally, there are legislative changes where corporates are required to include female directors on Board. This change is also a point which companies can seek for competitive edge compared to peers. Some corporates are placing one woman on Board because it is mandatory by law. However, the market will require more information onwards. The company's perspective on diversity will gain more spotlight in corporate governance.

Implications on semiconductor market

Through IHS Markit's BD Corporate Platform, we identified the top 15 holders investing in the global semiconductor market. The 'BIG 3' asset owners (Vanguard, BlackRock, State Street) were the largest holders. Considering they invest mainly in index funds their investor portfolio turnovers are comparatively very low. This re-emphasizes the importance of institutional investors' stewardship activities and the necessity of monitoring ESG issues and engaging with corporates in long-term horizon.

Meanwhile, investors with the largest proportion of portfolio invested in semiconductor industry was National Development Fund of The Executive Yuan (89.04%) which is a venture capital, followed by Invesco Capital Management (10.19%) and Capital International Investors (9.39%). Identifying major shareholder base, their dominant investment style, and top priority ESG topics would be helpful for companies to efficiently engage with their biggest holders and to understand what their requirements are on ESG issues.

Figure 3: Top15 Institutional Investors (by holding) in global semiconductor market

Institution Name	Count Of Securities in Semicon	% Portfolio (semicon)	Dominant Style	Equity Assets Under Management (USD, mm)	FI Assets Under Management (USD, mm)	Reported Total Assets (USD, mm)
The Vanguard Group, Inc.	389	4.68	Index	4,806,387	2,109,088	8,717,830
BlackRock Fund Advisors	350	4.59	Index	3,016,990	645,684	3,761,391
State Street Global Advisors (SSgA)	483	4.41	Index	1,984,204	300,972	2,488,994
Fidelity Management & Research Company, LLC	150	6.11	Growth	1,403,375	950,637	2,822,666
Capital World Investors (U.S.)	29	8.39	Value	894,796	8,456	916,218
T. Rowe Price Associates, Inc.	84	4.14	Growth	1,151,579	226,893	1,772,562
Norges Bank Investment Management (Norway)	292	5.02	Value	938,395	91	938,657
Capital International Investors	26	9.39	Growth	443,990	153	444,168
Geode Capital Management, LLC	270	4.87	Index	843,601	5,142	848,940
BlackRock Investment Management (U.K.), LTD	195	5.05	Growth	776,689	138,787	1,007,856
Capital Research Global Investors (U.S.)	42	6.25	GARP	589,854	3,089	596,711
National Development Fund of The Executive Yuan	3	89.04	Venture Capital	40,414	0	40,414
Invesco Capital Management, LLC	184	10.19	Index	342,889	42,095	392,389
J.P. Morgan Investment Management, Inc.	124	5.90	Growth	471,295	157,602	764,558
Wellington Management Company, LLP	130	3.67	Value	663,861	245,366	913,867

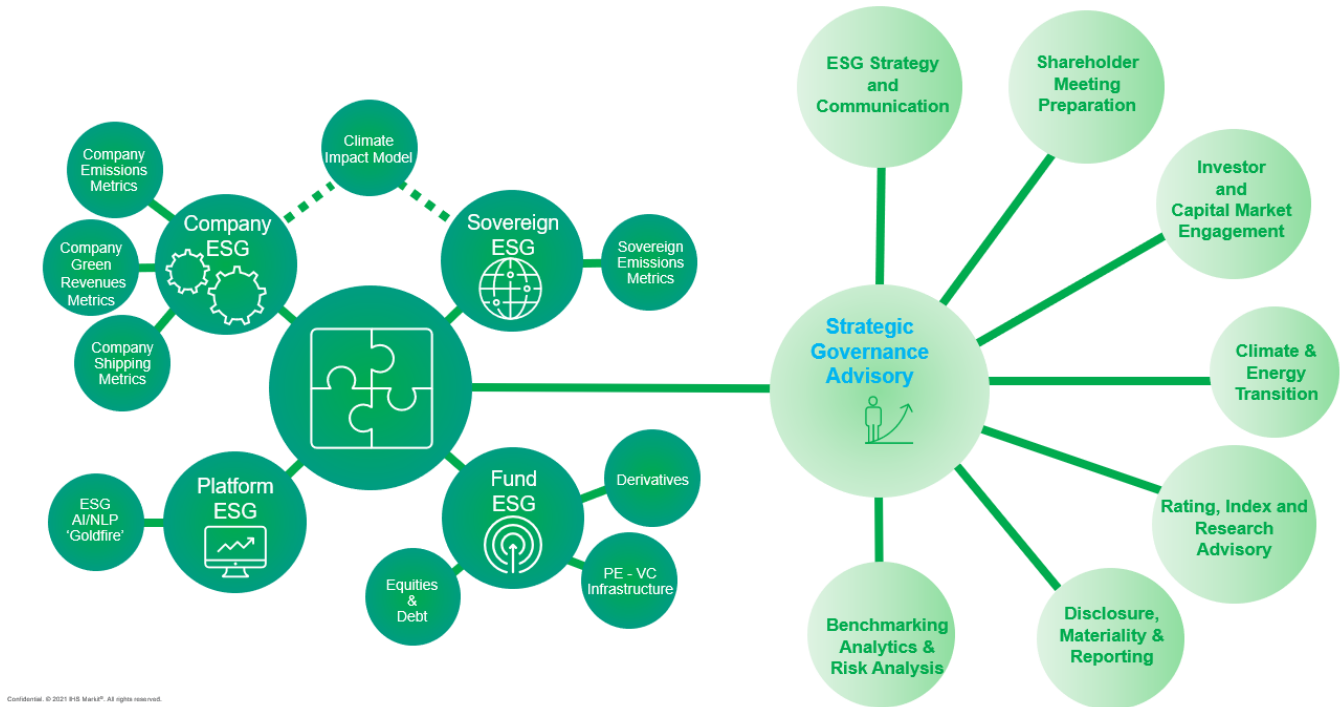
As of October 2021, from IHS Markit's internal data platform

How IHS Markit can add value…

Our advisory program helps companies position themselves to benefit from the growing ESG-linked capital pool and proactively prepare for the regulatory, reporting and industry trends that are relevant to each business. Our global team advises at board and management level as well as with investor relations, communications, and sustainability teams.

Our team will tailor the solutions so that companies can:

- Analysis of investors' ESG DNA
- Target existing and potential ESG-focused investors
- Advise, plan, and facilitate investor engagement on ESG issues
- Assess capital market sentiment
- Understand the influence of a particular ESG rating and disclosure framework
- Implement a climate transition program in line with carbon neutral scenario



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Yura is a Senior Governance Analyst in our ESG and Corporate Governance advisory group, with a focus on APAC and Korean issuers. Her focus is on ESG and corporate governance research as well as proxy solicitation and shareholder meeting (AGM) preparation. Prior to joining IHS Markit, she worked as ESG analyst in Korea Corporate Governance Service (KCGS) based in Seoul, specializing in responsible investment analysis and proxy advisory for institutional investors. Yura has also experience in giving lectures at KOFIA on ESG topic such as 'Foreign ESG investment trend'. She graduated from Korea University Business School.
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