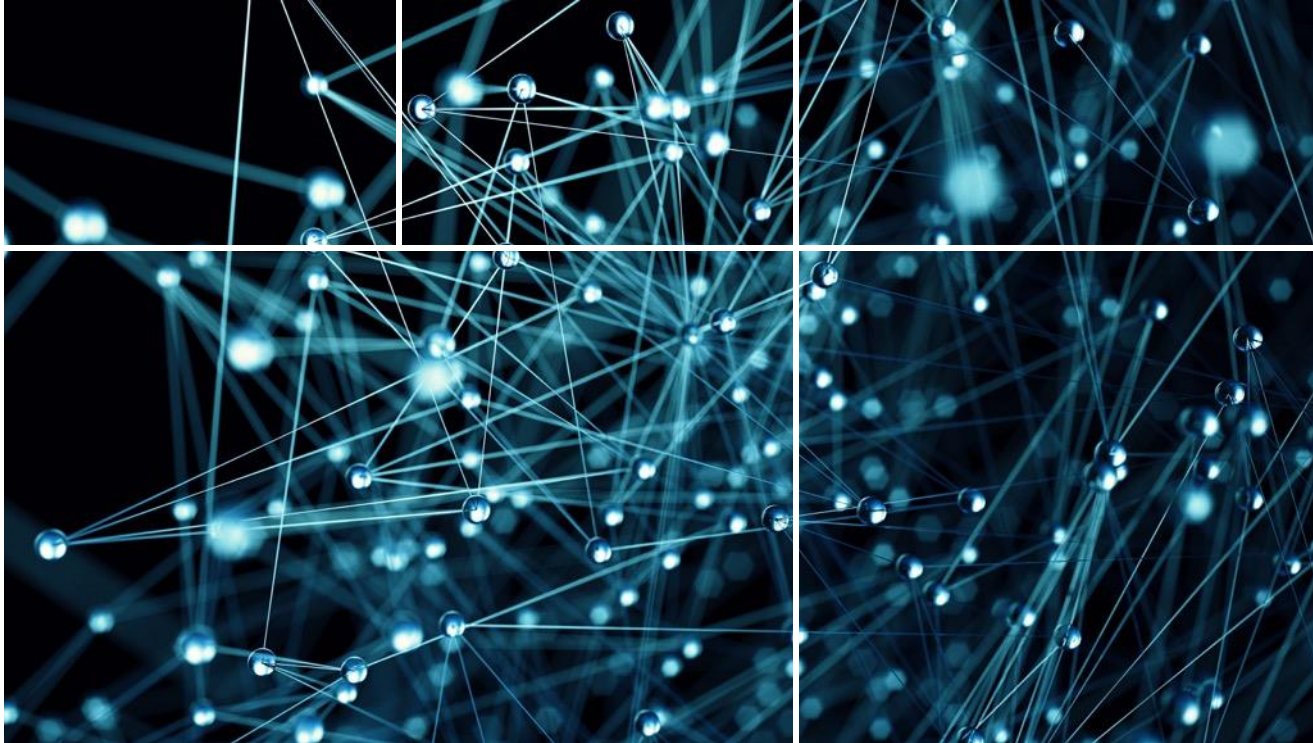


7th March 2023 – CCSHFC 2023



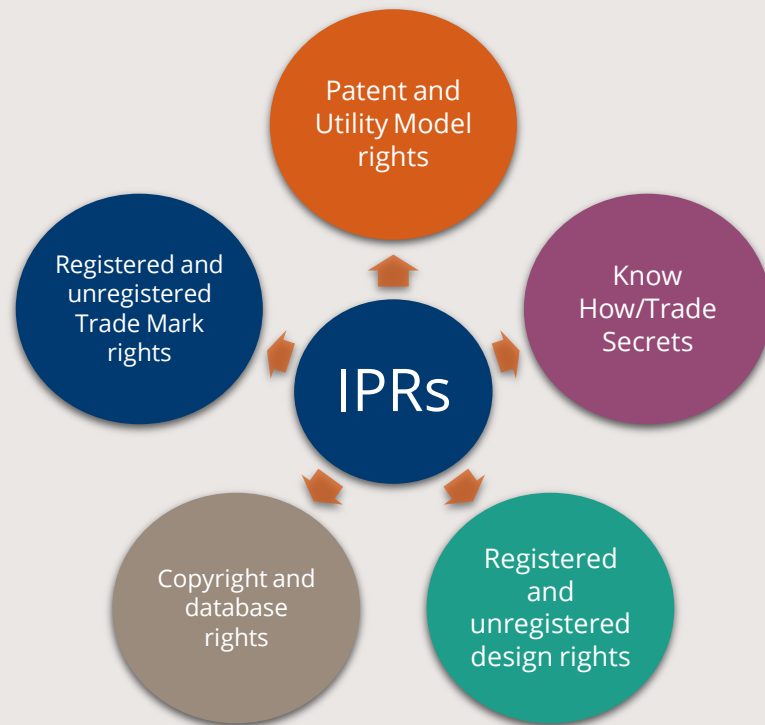
Patent Filing Trends in Hydrogen Fuel Cells for Transportation

Dr John-Paul
Rooney

Withers & Rogers



IP Wheel



Patent filing trends

2022 WIPO Report Covering:

- Key technologies
- Application of these to transportation
- Outlook for the future

Patent Landscape Report

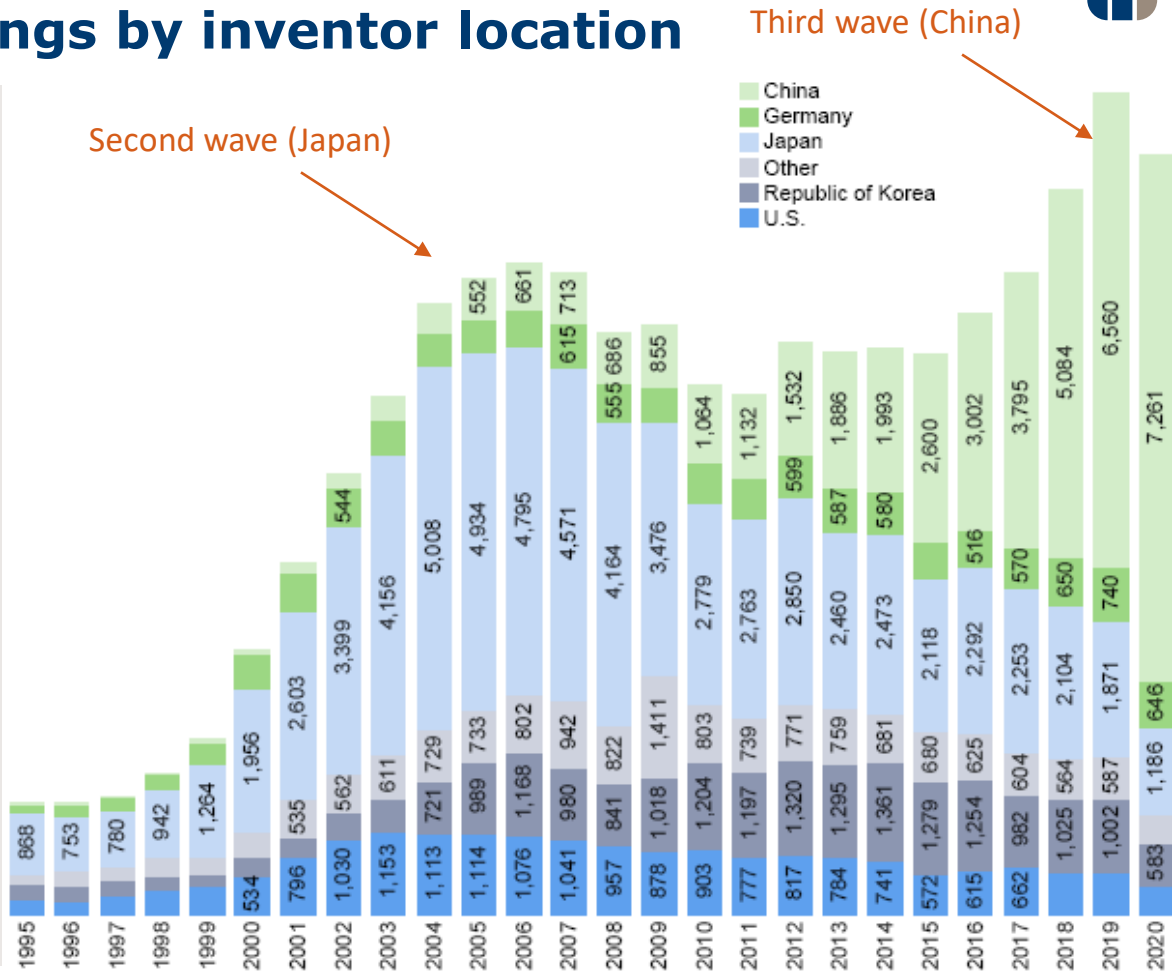
Hydrogen fuel cells in transportation





Number of patent filings by inventor location

- Major contribution by Japanese inventors in first decade of millennium
- Now the major contribution is coming from China, indicating that this is a major powerhouse for HFC innovation





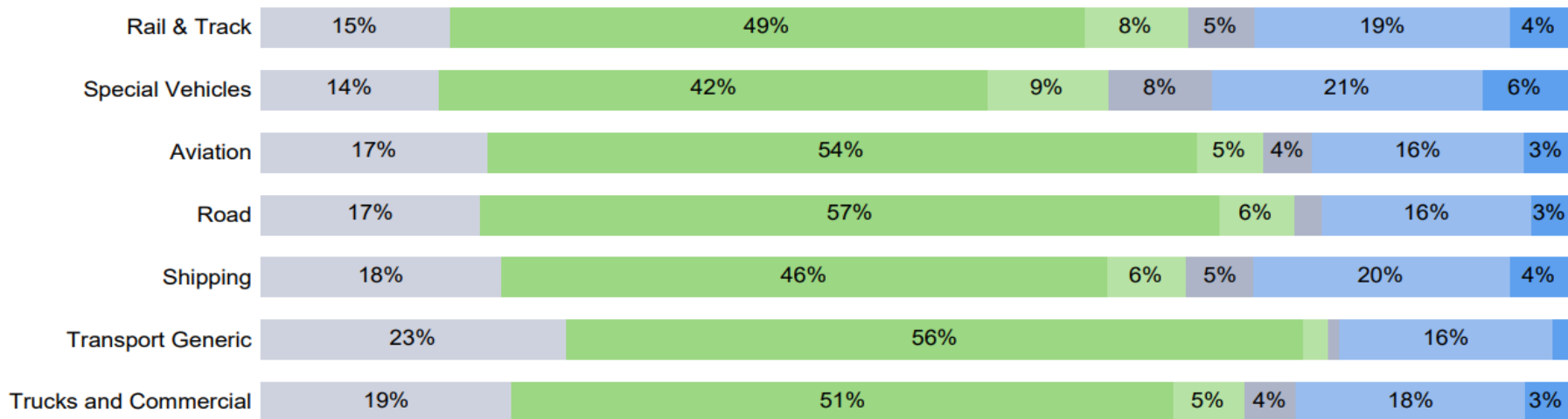
Comparison of filings in the EV and HFC spaces



Source: WIPO, based on patent data Lexis Nexis PatentSight up to March 2022.

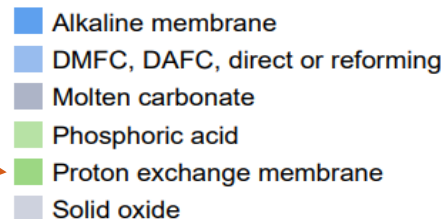
- Roughly 25% of all patent filings in the HFC field are in transport
- BEV patent filings are much higher (ex hybrid)
- Will we see an increase as HFC technology is commercialised more widely?

Technology breakdown by application field



Distribution by application and fuel cell type

PEM technology is clearly dominant, with SOFCs and DMFCs and related technologies also popular

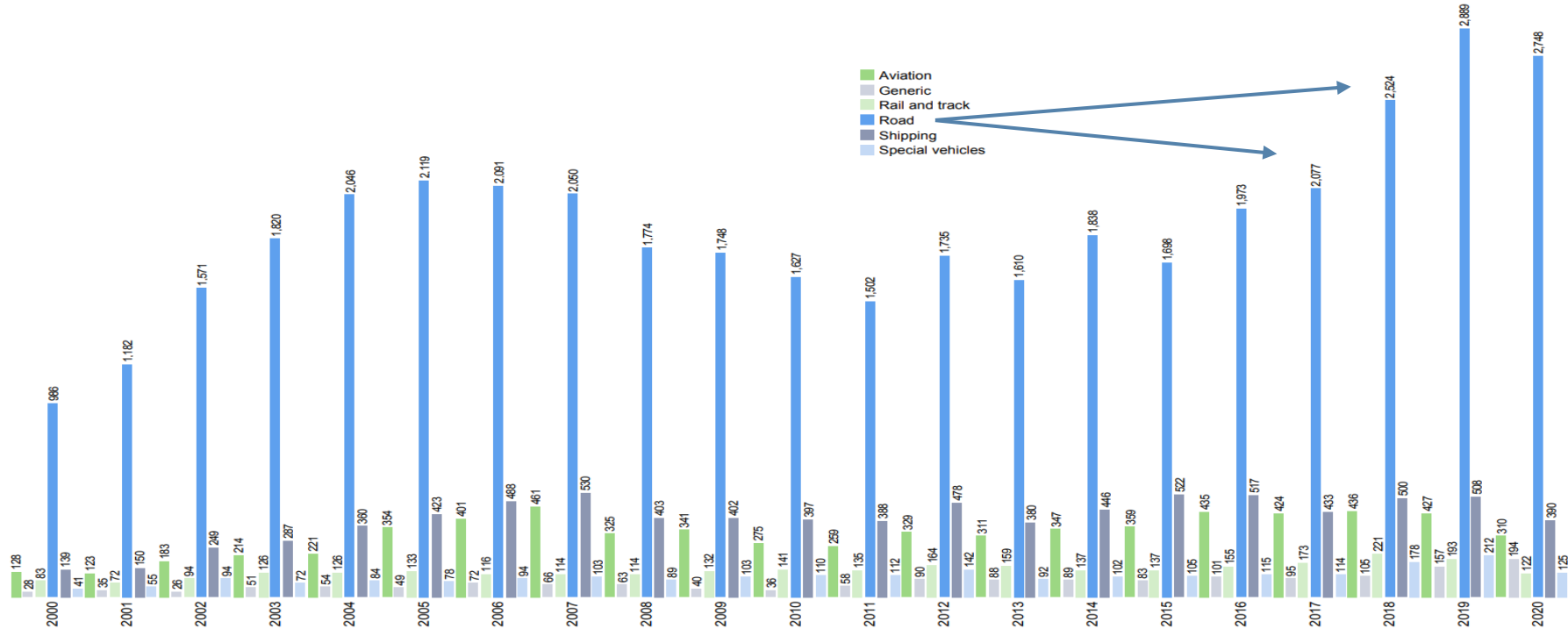


Source: WIPO, based on patent data Lexis Nexis PatentSight up to March 2022.

Note: DMFC is direct methanol fuel cell; DAFC is direct ammonia fuel cell.



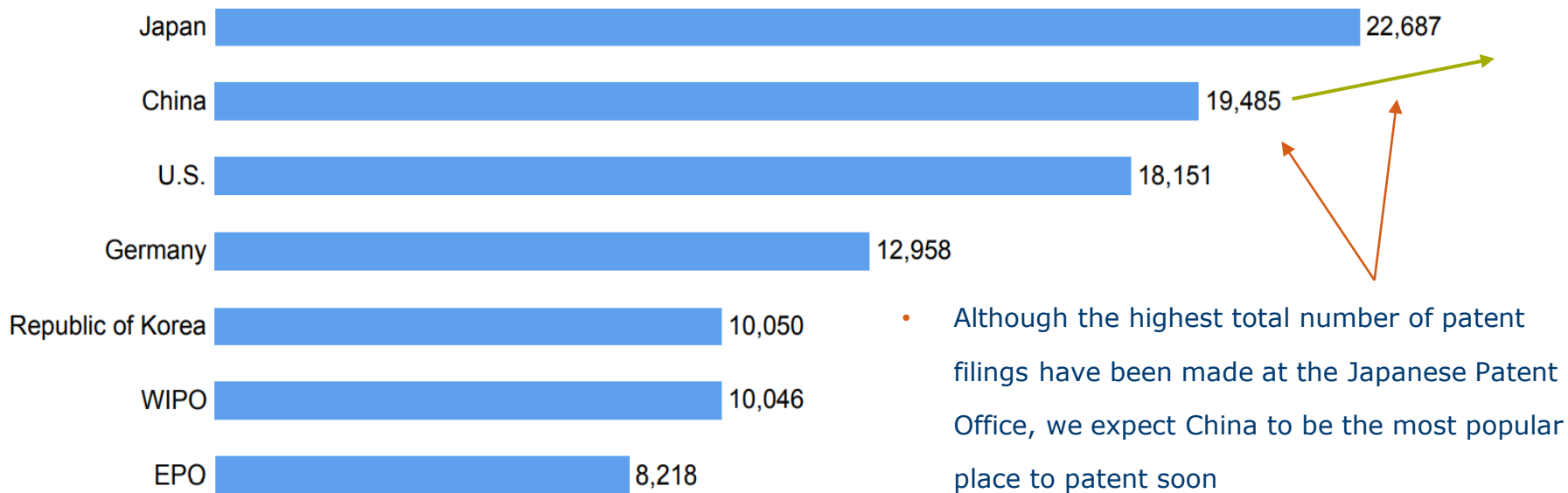
Global patent filings by field of transportation



- Road related patents (cars, trucks, motorcycles) dominate



Filing distribution by patent office



Source: WIPO, based on patent data Lexis Nexis PatentSight up to March 2022.

Note: EPO is the European Patent Office; WIPO is the World Intellectual Property Organization. WIPO represents PCT filings and the EPO EP filings. There is an average 18-month delay between patent filing and publication. 2019 is the last year for which complete data are available.

Key players and the number of HFC road patents

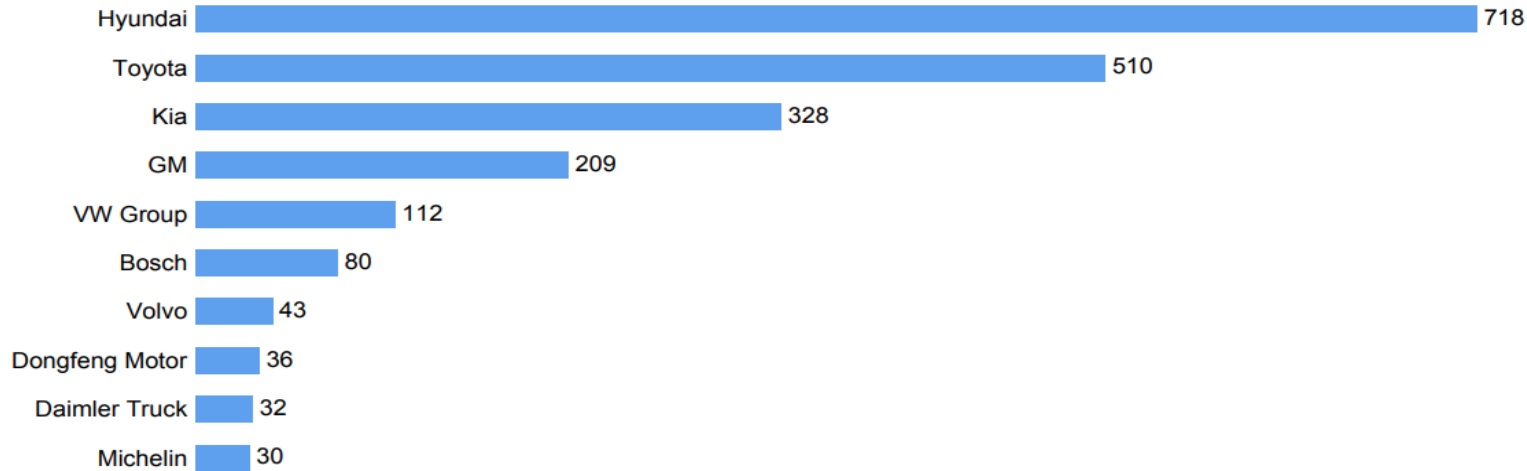
Company	Active patent portfolios	2000	2005	2010	2015	2019	2021	2015	2016	2017	2018	2019
Toyota		132	782	1,919	1,734	2,319	2,720	130	260	265	328	216
Hyundai		29	103	398	821	1,206	1,402	109	161	84	93	113
Honda		52	610	1,217	1,323	1,232	1,191	90	108	58	87	94
GM		37	247	631	815	802	697	22	23	29	17	11
VW Group		16	91	131	206	471	671	64	64	83	122	109
Kia		8	18	65	184	380	576	26	54	76	90	107
Nissan		73	728	617	636	633	540	57	39	24	14	16
IGE Wuhan		0	0	0	0	97	489	0	3	17	35	113
Bosch		53	93	132	241	300	479	25	26	42	56	108
Denso		23	194	221	235	271	301	19	29	43	30	32
Panasonic		59	213	292	293	265	267	16	17	24	19	26
BMW		5	25	51	99	255	250	33	60	64	14	18
Ford		8	56	115	184	243	217	24	24	27	17	11
Volvo		4	12	40	106	176	197	33	21	12	13	14
Daewoo Shipbuilding & Marine Engineering		0	1	8	75	159	189	48	39	23	25	15
Daimler Truck		0	3	18	87	161	182	32	21	10	13	12
LG Chem		1	10	59	119	175	175	15	20	12	7	0
Airbus Group		4	23	83	158	138	156	5	6	6	10	21
FAW Group		0	0	0	58	81	153	0	0	4	8	56
State Grid Corp		0	11	69	108	129	144	5	6	5	12	11

Source: WIPO, based on patent data Lexis Nexis PatentSight up to March 2022.

Note: To analyze the activity of companies we measure the number of active patents in the respective year (cumulative active patent portfolio, left) as well as the filing activity of these players by counting how many patents were first filed in the respective years (counting all patents, inactive and active, right).



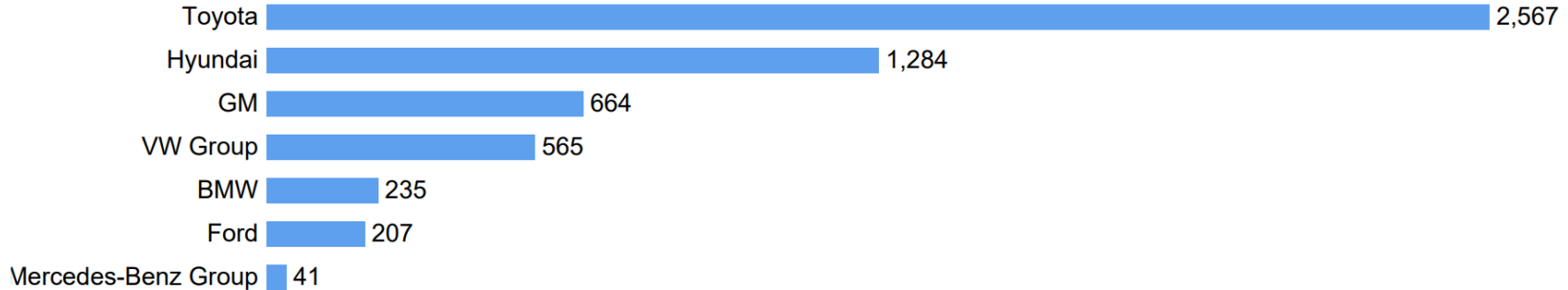
Key players in the truck and commercial vehicles sector



Source: WIPO, based on patent data from Lexis Nexis PatentSight up to March 2022.

- Sector dominated by vehicle manufacturers
- Hyundai leads the patent filings, although Toyota follow closely, in line with their very broad interest in alternative energy sources

Key players in the automotive sector

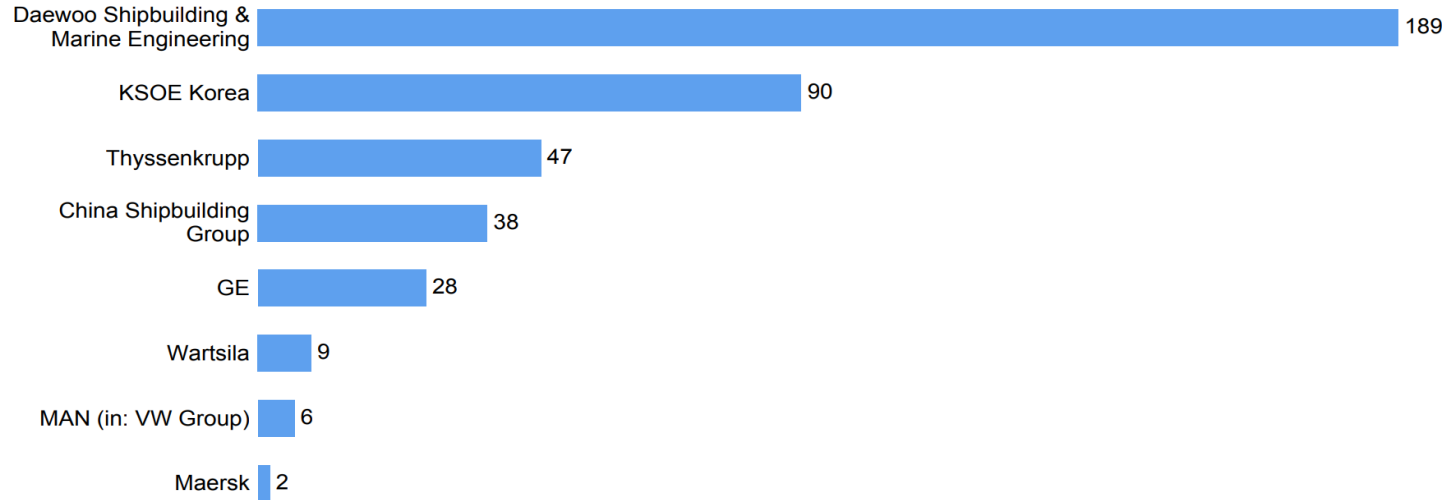


Source: WIPO, based on patent data from Lexis Nexis PatentSight up to March 2022.

- Given their wide-ranging interest in alternative fuels, it is not surprising that Toyota lead the way in patent filings in the automotive space
- As with commercial vehicles, Hyundai are also filing heavily to applications in the automotive sector



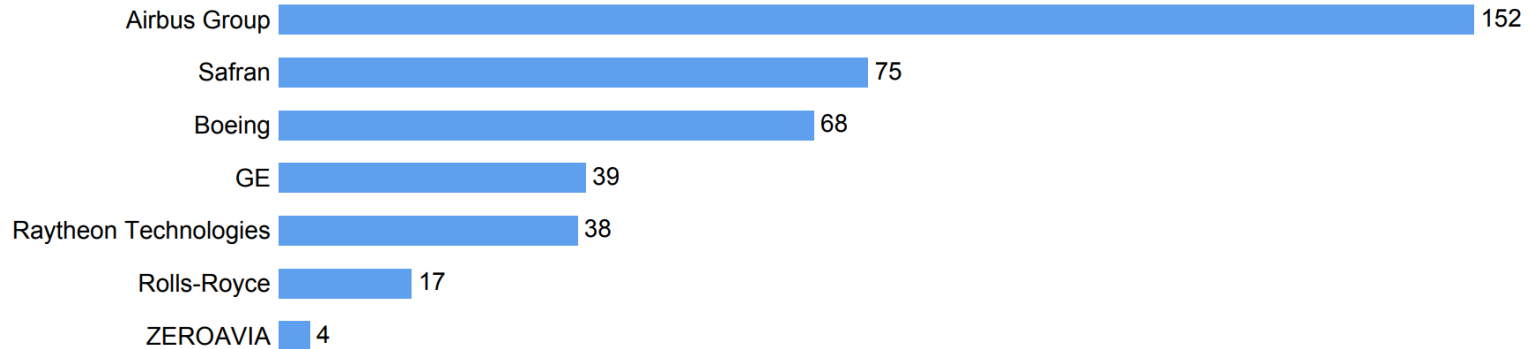
Key players in the shipping and marine vehicles sector



Source: WIPO, based on patent data from Lexis Nexis PatentSight up to March 2022.

- This sector is dominated by manufacturers from the Republic of Korea, the Chinese dominance isn't evident here

Key players in the aviation sector

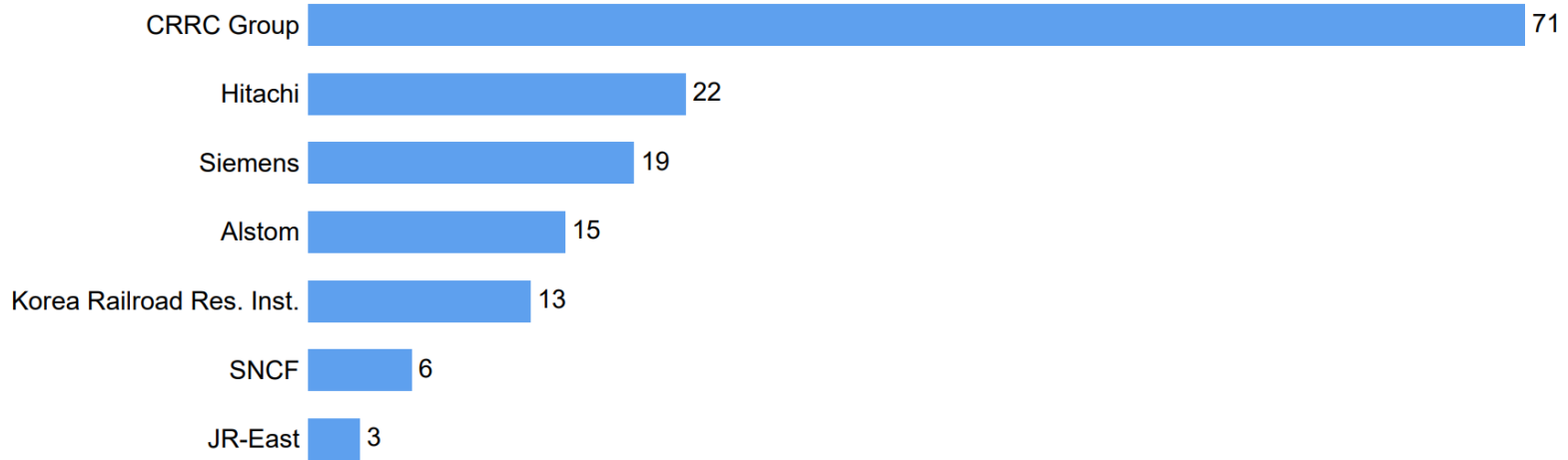


Source: WIPO, based on patent data from Lexis Nexis PatentSight up to March 2022.

- The leader, Airbus, has almost twice as many filings as the second largest player, Safran
- Airbus have outlined a plan to develop novel hydrogen concepts and are committed to this technology



Key players in the rail sector



Source: WIPO, based on patent data from Lexis Nexis PatentSight up to March 2022.

- Chinese players are growing their portfolios, lead by CRRC group
- Alstom are growing their portfolio rapidly, with other filers largely stable in terms of filing numbers



Conclusions

Dominated by SE Asian players in Japan, South Korea and now China

- PEM technology is the leading technology
- Most filings are to road applications
- Dominated by the car manufacturers
- Patent filings for HFC are significantly below BEV patent filings - at the moment?



Any questions?



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