



PatSnap Analytical Report

Sustainable Aviation Fuel

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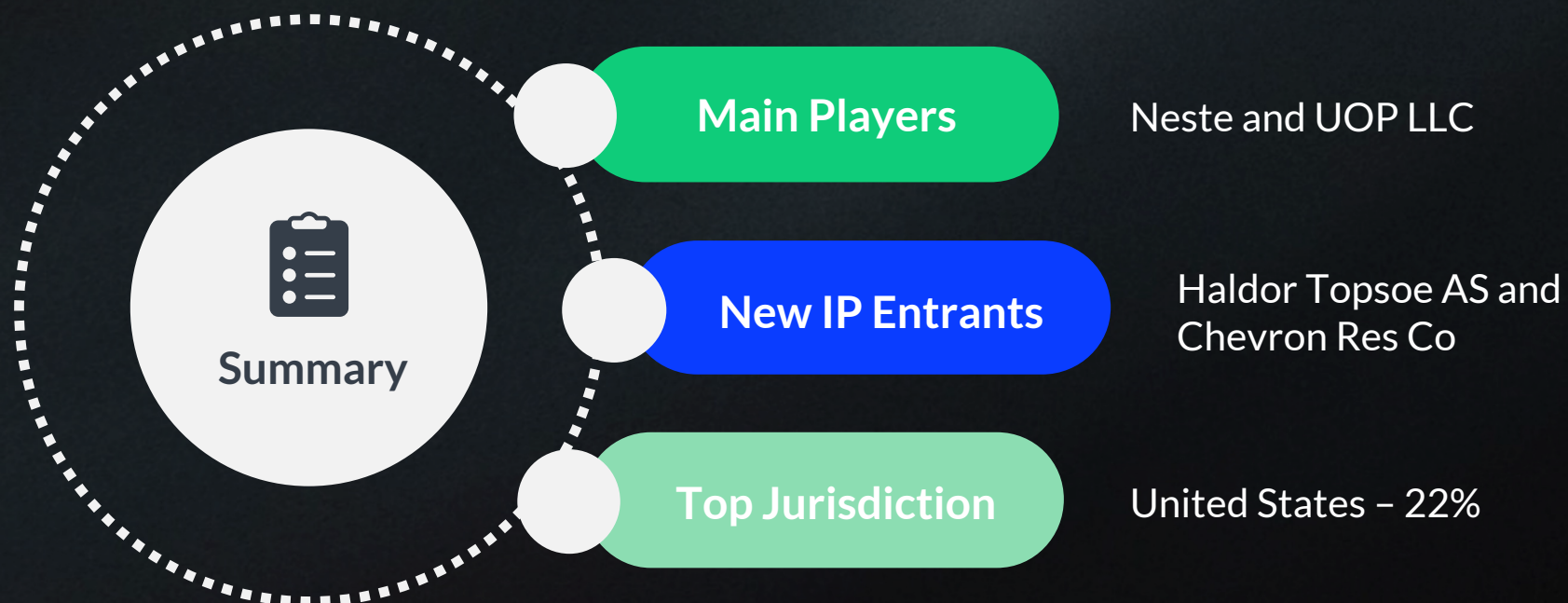
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Application Trends

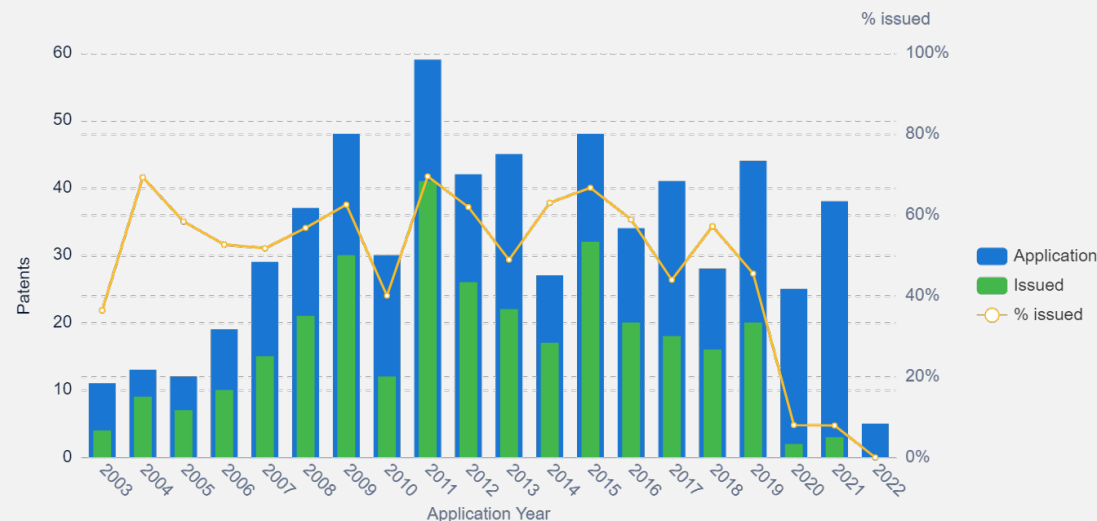


Figure 1

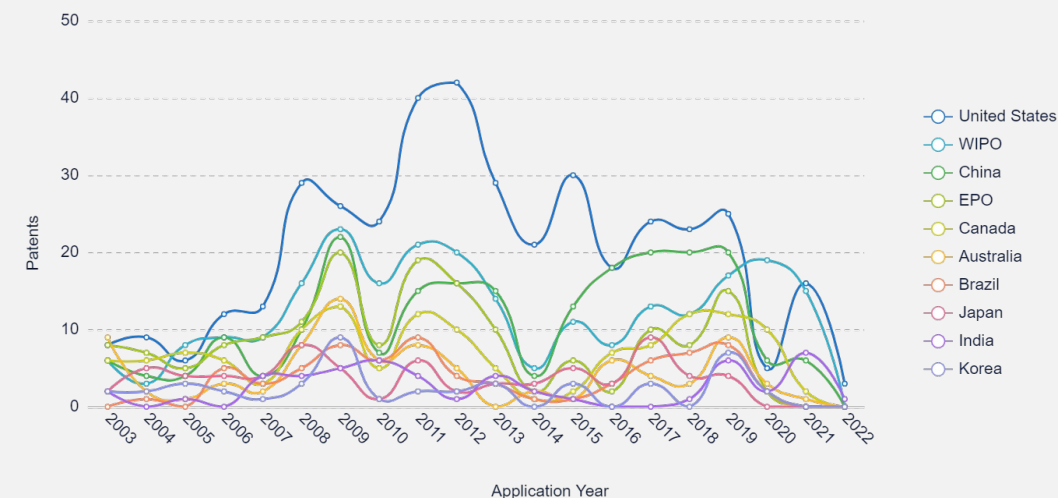
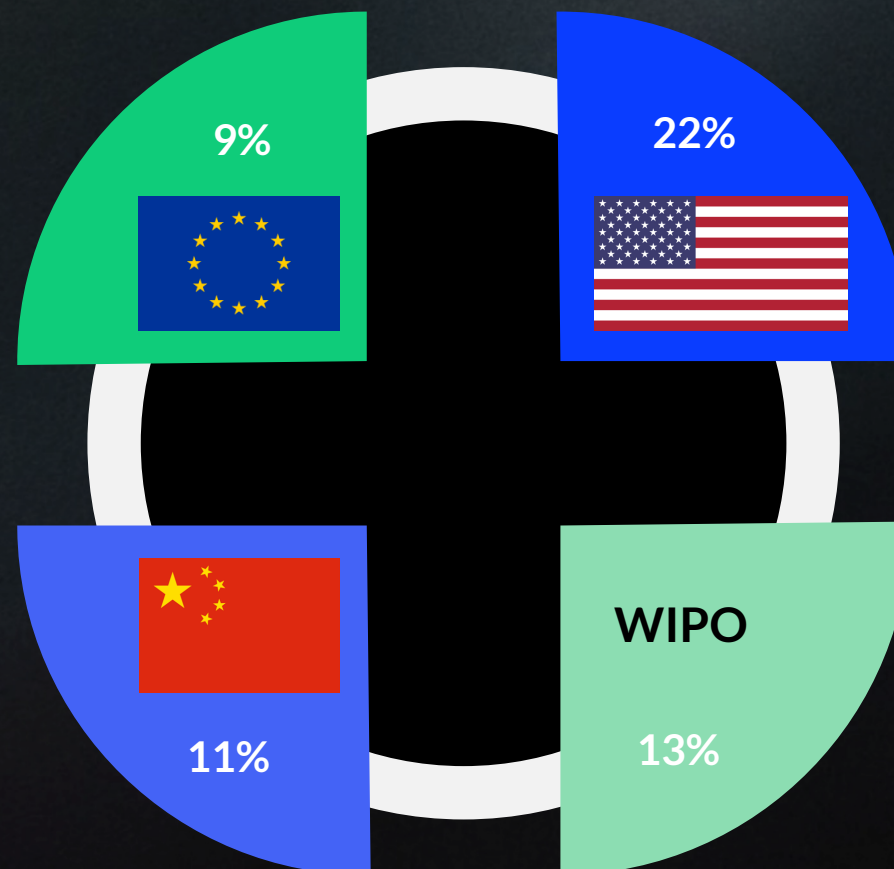


Figure 2

Figure 1 illustrates the annual application trends for technologies related to Sustainable Aviation Fuel (SAF) between 2003 to 2022. **The noticeable decline in issued patents from 2021 to 2022 can be attributed to the delay in granted applications.** The blue bars indicate the number of patent applications, whereas the green bars showcase the number of issue patents. The trend line, in yellow, indicates the grant rate of the applied patents.

Although the number of applications varies between certain years, figure 2 illustrates that from 2006 to 2019 the United States (US) leads, with a peak in 2012 followed by a **3131% decline in 2013. This sharp downtrend continues today.** In contrast, applications in China (CN) increased by **325% from 2014 to 2015. This rise continued** until 2020 when there was a **sharp 70% decline**, which may be attributed to the impact of COVID-19. In fact, in 2020, the WIPO region was the only region of the top 10 to see an increase in the number of applications, although this was a **relatively modest increase of 11% from the previous year.**

○ Jurisdiction Overview



Top Countries and Origin

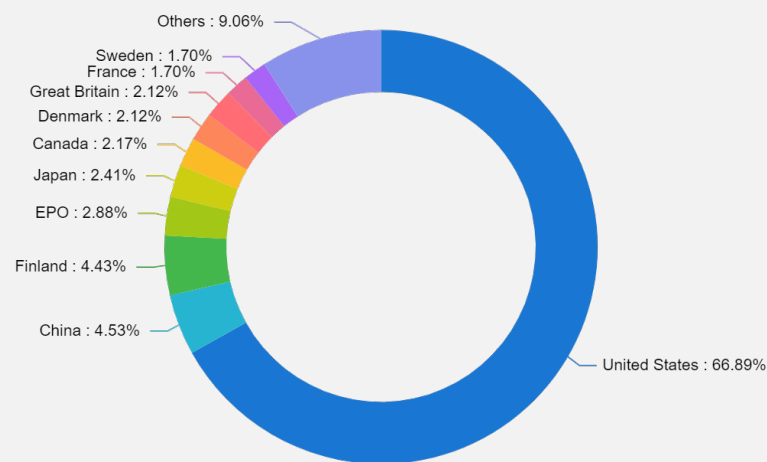


Figure 3a

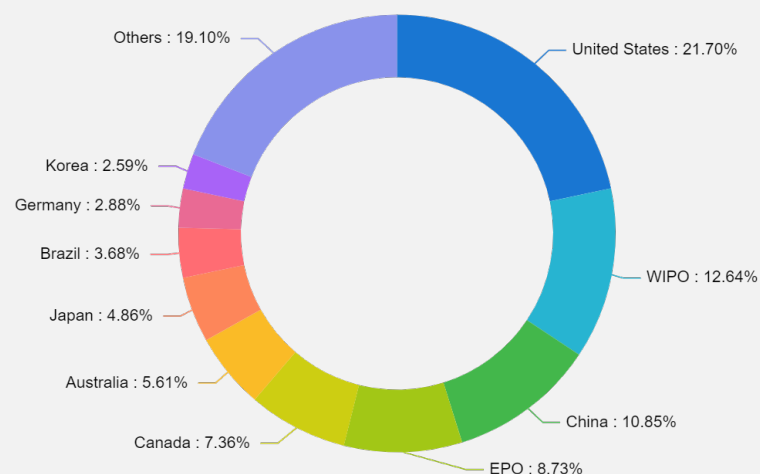


Figure 3b

Figure 3a shows the top countries in which the earliest application originated, and therefore indicates the geographic source of the technology. The chart shows that **well over half of those applications, related to SAF, originated in the US**, inferring that the US may have the strongest innovation capability with regards to the SAF technology area.

Figure 3b shows where patents are being filed geographically, noting the most important target markets for SAF technology. Although most of the applications originate in the US (67%), the number of applications filed in each geographic territory is far more evenly distributed. Only **21.7% of applications relating to the SAF technology space are made in the US** – indicating that significant numbers of those applications originating in the US are actually targeting international markets, such as those in the WIPO territory.

○ New Entrants Overview



TOPSOE

Haldor Topsoe is the world leader in high-performance catalysts and proprietary technology for the chemical and refining industries. This company enables organizations in the chemical and oil & gas industries to get the most out of their processes and products, using the least possible energy and resources. And they are the forefront of developing sustainable technologies.



Chevron Corporation is one of the world's leading integrated energy and technology companies, with subsidiaries that conduct business worldwide under the Chevron, Texaco, and Caltex brands. Chevron explores, produces, and transports crude oil and natural gas; refines, distributes, and markets transportation fuels and other energy products; and develops the energy resources of the future, including biofuels and other renewables.



Valero Energy Corporation (NYSE: VLO) is a Fortune 500 oil and gas refining and retail company based in San Antonio, Texas. The company owns and operates 18 refineries throughout the United States, Canada, and the Caribbean with a combined throughput capacity of approximately 3.3 million barrels per day, making it the largest refiner in North America.

○ New Entrants

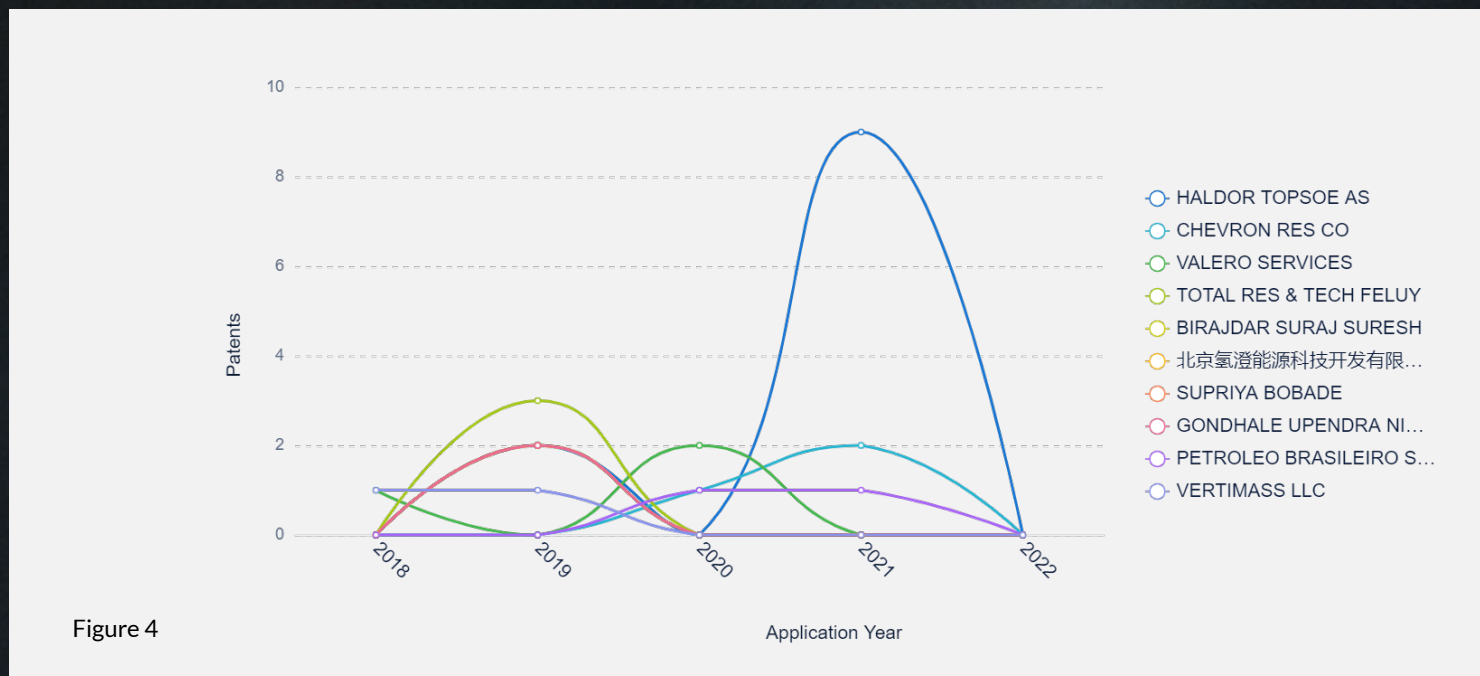


Figure 4 shows the impact of several new entrants in the area, with **Haldor Topsoe AS (DK)** leading with the highest number of filings in 2021. Of the nine applications file in 2021, seven of these are published, and the remaining two fall under the PCT publication category. The company's most valuable 2021 patent, worth \$3,400, is [IN202117018086A](#) (a method for co-production of aviation fuel and diesel). In contrast, the company's most valuable patent in its portfolio is [AU2009218828B2](#) (a method and reactor for the preparation of methanol), which is valued at \$6.4M and was filed in 2009.

Interestingly, of these 10 new entrants, it appears that **only Haldor, Chevron, Valero, and Petroleo continue to file applications in the SAF technology area beyond 2020**. Once the lag in 2022 filings catches up, new data may indicate otherwise for the remaining top 10 new entrants. While **Total Res (BE)** does not appear to have filed in this technology area beyond 2019, the company's most valuable application of that year, [CN223305229A](#) (process for hydrotreating a diesel fuel feedstock with a feedstock of naturally occurring oil(s), hydrotreating unit for the implementation of the said process, and corresponding hydrotreating unit,) is valued at \$33,000 and is currently under examination.

Haldor Topsoe A/S Company Profile



Figure 5



Haldor Topsoe AS is the most active new entrant in our technology area, as shown in figure 4. The company submitted its first application in 2018 and has the **highest number of applications in 2021 with nine applications**. The radar map in figure 5 shows that this assignee seems to be **focusing almost solely in diversifying its portfolio within the technology areas**, with a small focus on technology specialization and internationalization.

Figure 6

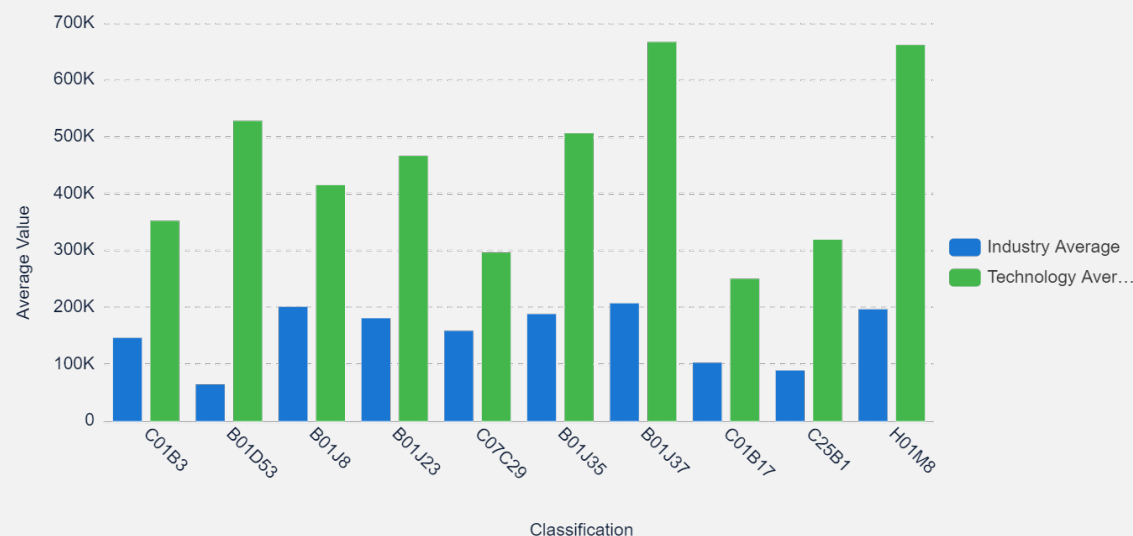


Figure 6 compares the company's average estimated patent value, within its top IPC classes, against each IPC class's industry average patent value. In each IPC class, the company's average estimated patent value **exceeds the industry average patent value by a minimum of 87%**, with Haldor's technology average for specifically the B01D53 (*Separation of gases or vapors; Recovering vapors of volatile solvents from gases; Chemical or biological purification of waste gases*) IPC class exceeding the industry average value by 820%.

Top Companies



Figure 7

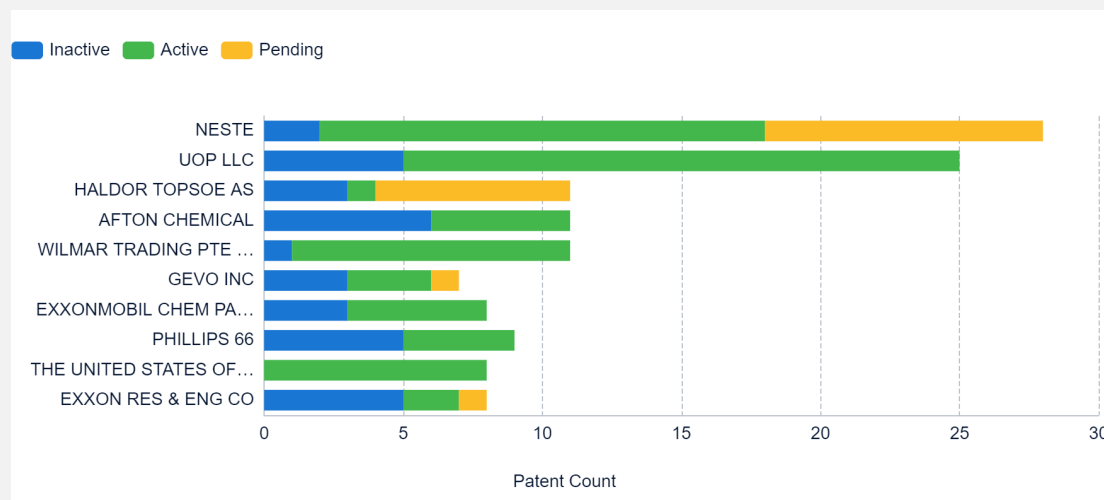


Figure 8

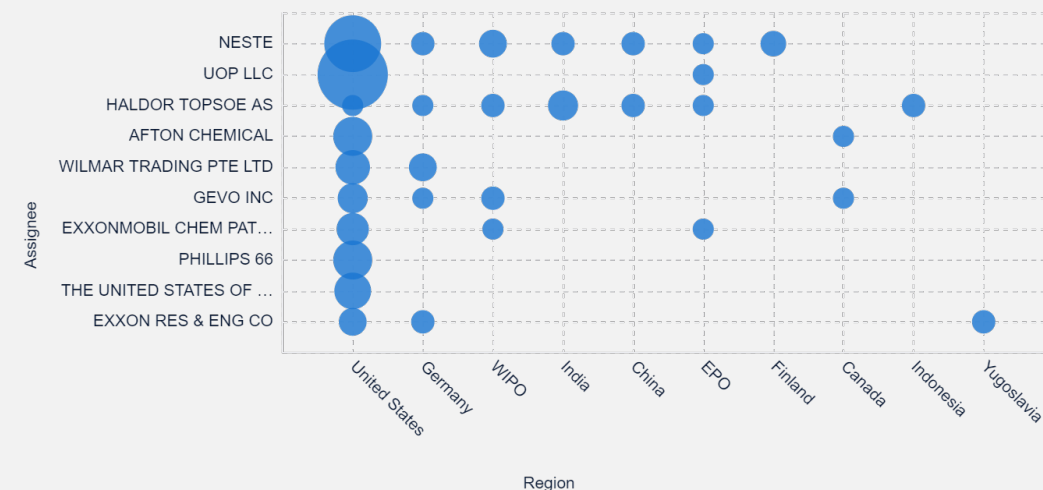


Figure 7 shows the 10 companies with the largest portfolios within the SAF technology field. Of all **Neste's (FI)** 28 active, pending, and inactive publications, **57% are active**. Within the same legal status categories, **80% of UOP's (US)** publications are active. Figure 8 shows that although Neste has applications in multiple regions, with **55% of those applications filed in the US**, UOP has only filed in the US and EPO regions, with **96% of its applications filed in the US**. This highlights the significant differences in target markets for patent protection between both these major players.

Neste's highest valued patent EP2450425A1: A method for lipid extraction from biomass, is valued at **\$6.75M** while **UOP's** highest valued patent is US9476639B2: Hydrocarbon gas processing featuring a compressed reflux stream formed by combining a portion of column residue gas with a distillation vapor stream withdrawn from the side of the column, valued at **\$6.11M**.

○ Key Patents



 Publication Number	 Title	 Estimated Expiration Date	 Valuation	 Cited by Simple Family Count	 Simple Legal Status	 Current Assignee
US6187465B1	Process and system for converting carbonaceous feedstocks into energy without greenhouse gas emissions	05 Nov 2008	N/A	491	Inactive	Raven SR, INC
US20030008183A1	Zero/low emission and co-production energy supply station	23 Jun 2008	N/A	211	Inactive	ZTEK

Technology Classifications

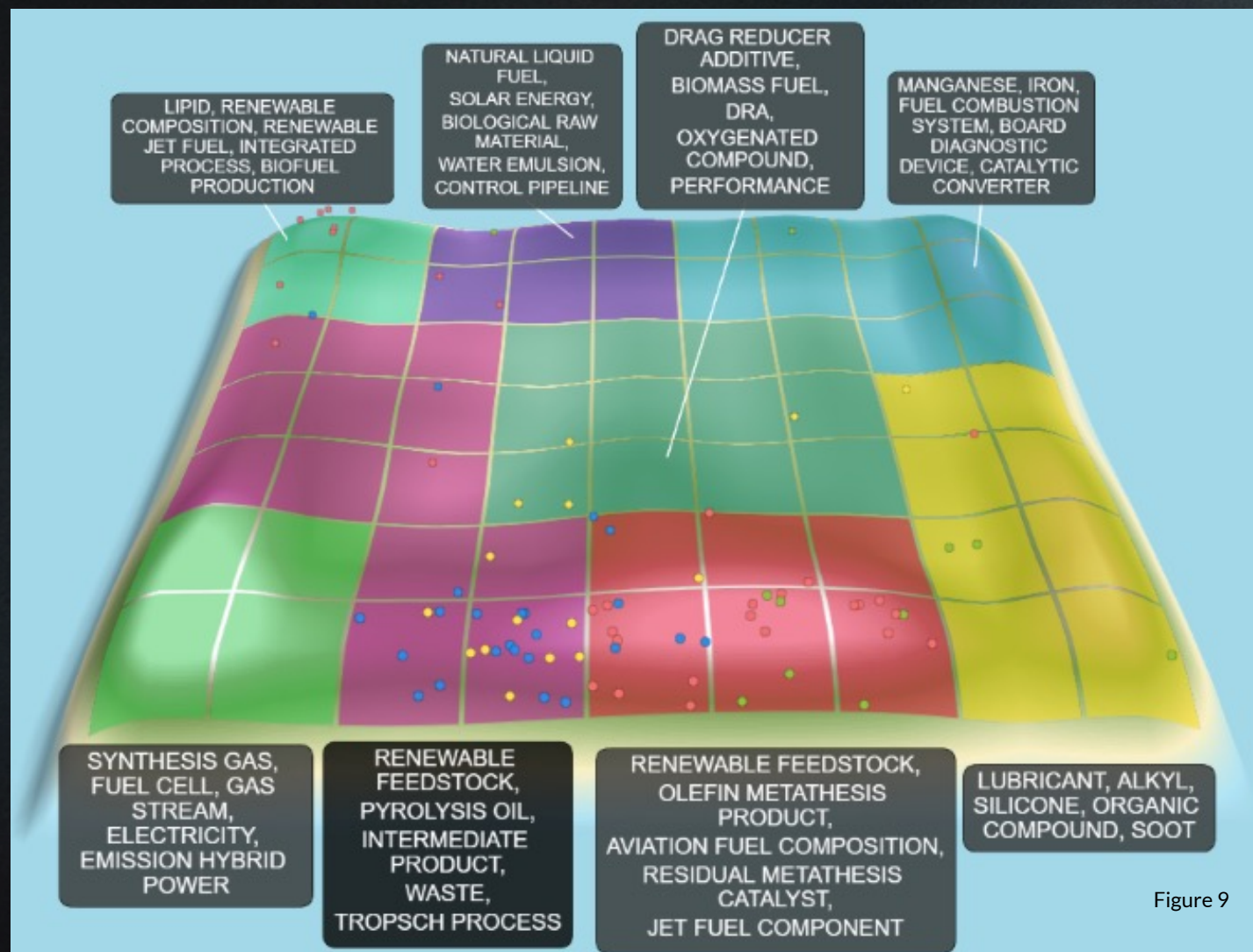


Figure 9

Figure 9 depicts a technology landscape in the SAF technology area made up from patent keywords and classification codes. The red dots depict patents filed under Neste, the yellow dots depict patents filed under Haldor, the blue dots depict patents filed under UOP LLC and, finally, the green dots depict patents filed under Wilmar. From the concentration of filings visible in certain clusters of the landscape, **the major players are primarily innovating in areas such as renewable feedstocks, jet fuel, and biofuel production.**

Of these four companies, **Neste's applications fall into the most clusters, while Wilmar's applications which fall into the fewest.** The average value of a patent within the portfolio of Neste, Haldor, UOP, and Wilmar, is **\$1.21M, \$430,000, \$117,000, and \$987,000, respectively**

Report Overview



Purpose:

Technology Landscape Overview.

Core Platform Query:

TAC_ALL:(((sustain* OR renew* OR natural) \$SEN (fuel OR biofuel* OR blend*)) AND (aviation OR jet OR air* OR aerial* OR Aerospace)) AND (IPC:(C10L1 OR C10G3) OR CPC:(Y02P30 OR C10L1 OR C10G3))

NOTE: the results for the patent graphs are based on one representative per simple family.

○ Connecting the dots so you can innovate better



Founded in 2007, PatSnap is the company behind the world's leading Connected Innovation Intelligence platform. PatSnap is used by more than 10,000 customers in over 50 countries around the world to access market, technology, and competitive intelligence as well as patent insights needed to take products from ideation to commercialization. Customers are innovators across multiple industry sectors, including Biotechnology, Medical devices, Pharmaceuticals, Chemical, Electronics Manufacturing, Automotive, Consumer Goods, Aviation & Aerospace, Education, and Legal Firms.

PatSnap's team of 1000+ employees work from its global headquarters in Singapore, London, and Toronto. To learn more about how PatSnap is improving the way companies innovate, visit www.patsnap.com.

*Please note the information shared in this Powerpoint does not represent a legal opinion from the PatSnap team.