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State of the Gasification Industry: Worldwide Gasification Database 2014 Update

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Abstract:

The GTC Worldwide Gasification Database underwent a major content update in 2013. This paper records the result of the 2014 annual update. Gasification capacity has increase by over 10% despite the closure of a substantial number of oil-based units in China and India for commercial reasons.

In addition to maintenance of the content, the user interface of the online, web-based version has undergone an important change as part of the general overhaul of the GTC website The most visible aspect of this is the map of facilities, which allows direct access to plant datasheets without prior selection by county, technology or feedstock.

Introduction

The GTC Worldwide Gasification Database underwent a major content update last year as part of its regular three-year cycle. The rate of increase in the construction of gasification plants shown last year has increased to an extent that an annual update has been considered worthwhile.

The growth of the gasification industry over the years since the database started can be seen in the numbers of gasification projects and gasifiers shown in Table 1.

Table 1 Numbers of Gasifiers Included in Database Updates.

Update Year	Total Projects	Total Gasifiers	Real-Active Proj./Gasif.	Constr. Proj./Gasif.	Planned Proj./Gasif.	Real-Active GWth	Constr. GWth	Planned MWth
1999	329	754	128/366	n/a	33/48	42.7	n/a	18.2
2001	350	800	131/409	n/a	32/59	43.3	n/a	24.5
2004	391	841	117/385	n/a	38/66	43.0	n/a	25.3
2007	408	891	144/427	n/a	10/34	56.2	n/a	36.5
2010	463	990	192/505	11/17	37/76	70.8	10.9	40.4
2013	747	1741	234/618	61/202	98/550	104.7	63.4	84.0
2014	862	2378	272/686	82/262	133/735	116.6	82.8	109.2

2014 Update of Gasification Database Content

The database now includes a total of 862 projects, consisting of 2378 gasifiers (excluding spares), of which 272 projects with 686 gasifiers are active commercial operating projects. It covers 82 projects with 262 gasifiers under construction and a further 133 projects with 735 gasifiers in the planning phase. The output of operating gasifiers is 116.6 MW_{th} (up from 104.7 last year) with 82,8 and 109,2 MW_{th} in the construction and planning phases respectively. Note that while the output of the 'planned' capacity has been adjusted using probability-of-realization factors, the number of gasifiers has not. The balance of the database consists of plants that have been shut down, non-commercial pilot plants and projects either abandoned or currently in too early a pre-planning phase to justify including in the statistical analysis.

The relatively small increase in actual operating plant capacity is partly caused by recognizing shutdowns of stand-alone (i.e. not integrated in refineries) oil gasifiers in India and China for economic reasons. Plants built when crude cost 30$/bbl was no longer economic, even on marginal costs, when the price is around 100 $/bbl.

The main additions this year remain

- Coal-to-chemical projects in China, in particular substitute natural gas (SNG).
- Biomass and waste plants in Europe and USA. Note that in the analysis these two feedstocks are now shown separately.
- Updating the status of existing entries.

Data Sources and Verification

The information included in the database comes from a multitude of source including journal articles, press releases, internet searches and the like. About two-thirds of the current database goes back to previous versions, so that acknowledgement to previous workers is due. The data has been made available to gasification licensors to verify the accuracy of the data collected. In some cases verification has been performed by contact with the owners.

IEA Task 33 and Other Databases

The work this year included information exchange with the IEA Task 33 database of biomass gasification projects. The Task 33 database is currently also undergoing an update, but there will always be a number of differences between the GTC biomass list and that of Task 33. This is due to a number of differences in philosophy.

- Task 33 places an important focus on pilot and development plants, which are mostly not included in the GTC database, where the focus is in commercial plants.
- Task 33 emphasizes projects based on biomass gasification. This includes downstream processes such bioSNG or bioFT. Where these developments are based on slipstreams from a commercial plant, GTC's strict gasifier-based data will not show these as separate entries, but just record them as a note on the gasifier datasheet.
- GTC has a cut-off at 1MW$_{th}$ even for biomass gasifiers. Such units are however included in the Task 33 database.

New Interface for Online Database

The GTC has put considerable effort into updating its website during 2014. This has included the interface to the databank. Much of this work is 'behind the scenes, but one very visible addition has been the 'Map of Facilities' shown in Figure 1. This allows one to access the datasheet of any individual plant just by clicking on its geographical location.

Figure 1 Map of Facilities

Gasification Database Results

Gasification plants are becoming larger with each generation, and this is visible from Table 2, a list of the thirty largest projects operating or in planning. Although there is some growth in the size of individual gasifiers, most of these mega-plants achieve their capacity with multiple units.

Table 2 Top 30 Commercial Gasification Projects by Size

Gasification Plant/ Owner	Location	Gasification Technology	No. Gasifiers	MWth SG Output	Start-up Year	Feed/Product
Pearl GTL	Qatar	Shell	18 + 0	10936	2011	Natural Gas / FT Liquids
Sinopec Changji SNG Plant	China	Unspecified	20 + 2	10000	2017	Coal / SNG
Sinopec Urumqi SNG Plant	China	Unspecified	20 + 2	10000	2017	Coal / SNG
Yinchuan CTL Plant	China	Siemens	22 + 2	9300	2016	Coal / FT Liquids
Jamnagar Gasification Plant Phase I	India	E-Gas	6 + 2	5000	2015	Petcoke / Electricity-SNG-CO-Acetic acid
CPI Yili SNG Phase II	China	Unspecified	20 + 2	7500	2016	Coal / SNG
Huadian Changji SNG Plant	China	Unspecified	20 + 2	7500	2017	Coal / SNG
Datang Ningxia SNG Plant	China	SEDIN	45 + 3	7125	2015	Lignite / SNG
Sasol Synfuels West	South Africa	Lurgi FBDB	40 + 0	7048	1977	Subbit. coal / FT liquids
Sasol Synfuels East	South Africa	Lurgi FBDB	40 + 0	7048	1982	Subbit. coal / FT liquids
Qinghua Yili SNG Plant Phase II	China	Unspecified	20 + 2	6875	2016	Coal / SNG
CHNG Xinjiang SNG Plant	China	TPRI	7 + 1	6450	2014	Coal / SNG
Jazan IGCC	Saudi Arabia	Shell	16 + 0	4465	2016	Refinery residue / Electricity
Jamnagar Gasification Plant Phase II	India	Unspecified	6 + 0	5336	2017	Petcoke / Electricity-SNG
CCI Mozambique	Mozambique	Lurgi FBDB	40 + 0	5055	2018	Coal / FT Liquids
Yankuang Changji SNG Plant	China	Unspecified	16 + 2	5000	2019	Coal / SNG
Datong SNG Plant	China	Siemens	9 + 1	5000	2017	Coal / SNG
Xuzhou Tacheng SNG Plant	China	Unspecified	16 + 2	5000	2019	Coal / SNG
Xinjiang Guanghui Aletai SNG Plant	China	Unspecified	16 + 2	5000	2019	Coal / SNG
Tebian Changjji SNG Plant	China	Unspecified	16 + 2	5000	2018	Coal / SNG
Kailuan Changji SNG Plant	China	Unspecified	16 + 2	5000	2018	Coal / SNG
ChinaCoal Changji SNG Plant	China	Unspecified	16 + 2	5000	2017	Coal / SNG
Henan Coal Changji SNG Plant	China	Unspecified	16 + 2	5000	2017	Coal / SNG
Guodian Yili SNG Plant	China	Unspecified	16 + 2	5000	2016	Coal / SNG
Lu'an Yili SNG Plant	China	Unspecified	16 + 2	5000	2016	Coal / SNG
Beijing Holding Zhungeer SNG Plant	China	Unspecified	16 + 3	5000	2019	Coal / SNG
CNOOC Ordos SNG Plant	China	Unspecified	16 + 0	5000	2018	Coal / SNG
Xinmeng SNG Plant	China	Unspecified	16 + 0	5000	2018	Coal / SNG
Guodian Xing'an SNG Plant	China	Unspecified	16 + 0	5000	2019	Coal / FT Liquids
Yulin Methanol Plant	China	GE	10 + 4	3383	2015	Coal / Methanol

Although the Pearl and the two Sasol Fischer-Tropsch facilities remain at the top or close to the top of this list, the large number of SNG plants proposed in China is striking. While of course some of the plants in the above list may not in the end be built, probably most of them will, since in the short term they provide the only feasible solution to meet the urgent need for clean domestic fuel in China's cities. Many of the projects in this list are under construction or only in planning, and so may be unfamiliar to many readers. In order to put some of these projects into a more familiar perspective, the top twenty operating plants are listed in Table 3.

Table 3 Top 20 Operating Commercial Gasification projects by size

Gasification Plant/ Owner	Location	Gasification Technology	No. Gasifiers	MWth SG Output	Start-up Year	Feed/Product
Pearl GTL	Qatar	Shell	18 + 0	10936	2011	Natural Gas / FT Liquids
Sasol Synfuels West	South Africa	Lurgi FBDB	40 + 0	7048	1977	Subbit. coal / FT liquids
Sasol Synfuels East	South Africa	Lurgi FBDB	40 + 0	7048	1982	Subbit. coal / FT liquids
Datang Duolun MTP Plant	China	Shell	3 + 0	3373	2011	Lignite / Methanol
Shenhua Ningxia Coal to Polypropylene II	China	SEDIN	14 + 2	2500	2014	Coal / Methanol-PP
Shenhua Ningxia Coal to Polypropylene I	China	Siemens	5 + 0	1912	2011	Coal / Methanol-PP
Great Plains Synfuels Plant	United States	Lurgi FBDB	12 + 2	1900	1984	Lignite / SNG
Shenhua Baotou Coal-to-Olefins Plant	China	GE	5 + 2	1750	2011	Coal / Methanol-Olefins
Hexigten SNG Plant	China	SEDIN	12 + 2	1670	2012	Coal / SNG
Rongxin Inner Mongolia Methanol Plant	China	ECUST	2 + 1	1400	2014	Coal / Methanol
SARLUX IGCC Project	Italy	GE	3 + 0	1271	2000	Visbreaker residue / Electricity
ISAB Energy IGCC Project	Italy	GE	2 + 0	1203	1999	ROSE asphalt / Electricity
Sanwei Neimenggu Methanol Plant	China	GE	4 + 2	1167	2011	Coal / Methanol
Edwardsport IGCC	United States	GE	2 + 0	1150	2012	Coal / Electricity
Tianjin Chemical Plant	China	Shell	2 + 0	1124	2010	Coal /
Henan Jinkai	China	HT-L	4 + 0	1120	2012	Coal / Ammonia
Yunnan Methanol & DME Plant	China	BGL	4 + 1	1120	2011	Coal / Methanol
Bintulu GTL Plant	Malaysia	Shell	6 + 0	1032	1993	Natural gas / FT liquids
Long Lake Integrated Upgrading Project	Canada	Shell	4 + 0	1025	2008	Asphalt / H2
Leuna Methanol Plant	Germany	Shell	6+0	984	1985	Visbr4eaker residue/ Methanol
Shenhua Erdos DCL Hydrogen Plant	China	Shell	2+0	861	2008	Coal / Hydrogen
Fujian Refinery Ethylene Project	China	Shell	2+1	858	2009	Asphalt / Hydrogen and Electricity

Compared with last year, there are two new plants in this list, the second stage of Shenhua's Ningxia Polypropylene facility which came on stream in August, and Rongxin Methanol, which includes ECUST's first 3000 t/d gasifier. The two plants that have dropped out of the list since last year are the Shenhua Ordos DCL Hydrogen Plant and the Fujian Refinery asphalt gasification unit.

Worldwide Gasification Capacity and Growth

Figure 2 presents the growth of operating syngas capacity over time.

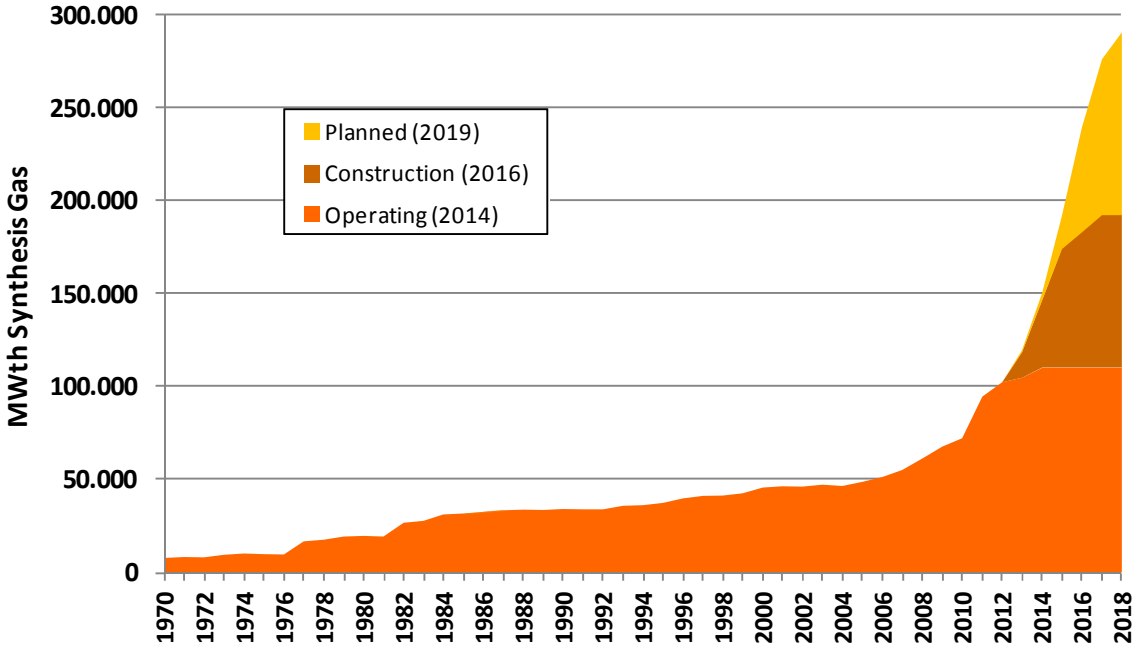

Figure 2 Cumulative Worldwide Gasification Capacity and Growth

Gasification by Location

The regional distribution of gasification plants is shown in Figure 3. Whereas in 2010 there had been a fairly balanced situation between Asia/Australia, Africa/ME and North America, the Asia/Australia capacity either operational or under construction is more than the rest of the world put together. This is mostly in China, though there is significant operating or planned capacity in India, Malaysia, Japan and South Korea. The next countries worldwide by syngas production are South Africa and Qatar with their Fischer-Tropsch units, as shown in Figure **4**.

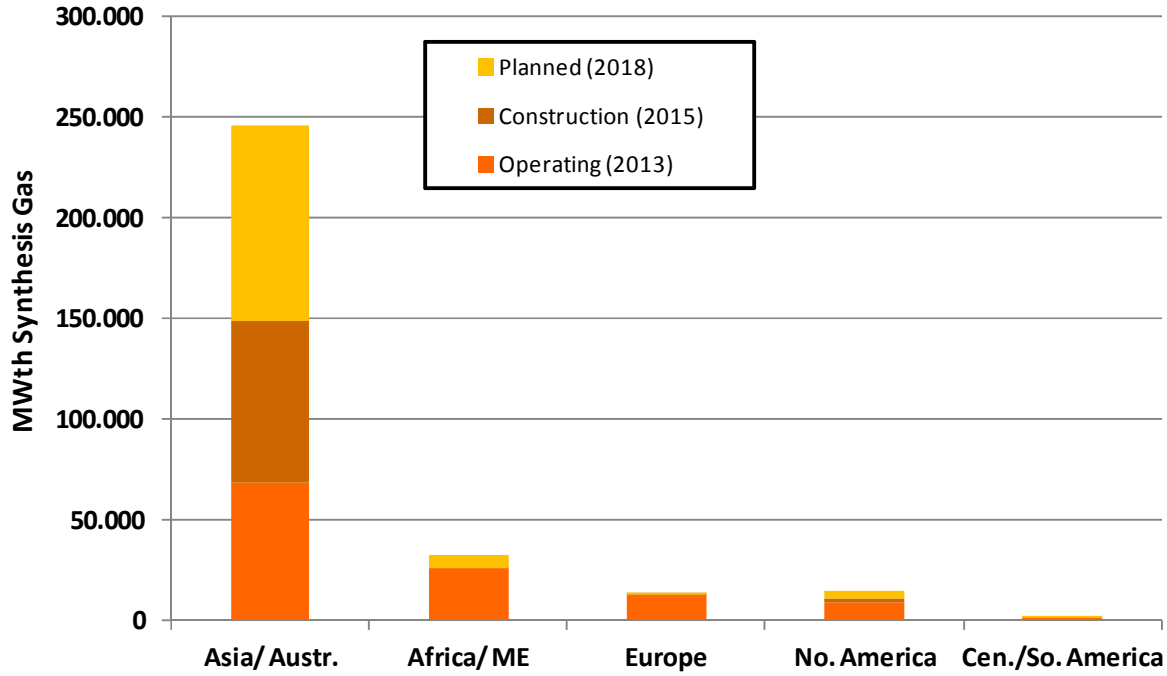

Figure 3 Gasification Capacity by Geographic Region

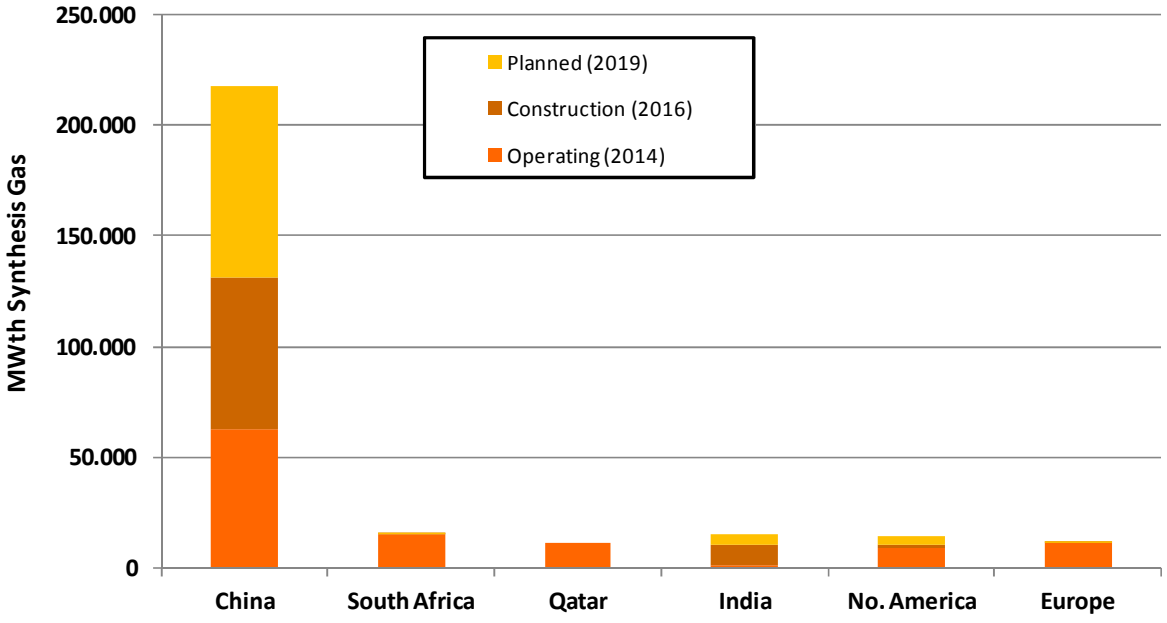

Figure 4 Gasification Capacity in Selected Countries

Gasification by Application

Chemicals production remains the most important application of gasification, particularly if one looks at the current operating capacity shown in Figure 5. The planned SNG plants in China have raised the gaseous fuels category into the second largest category.

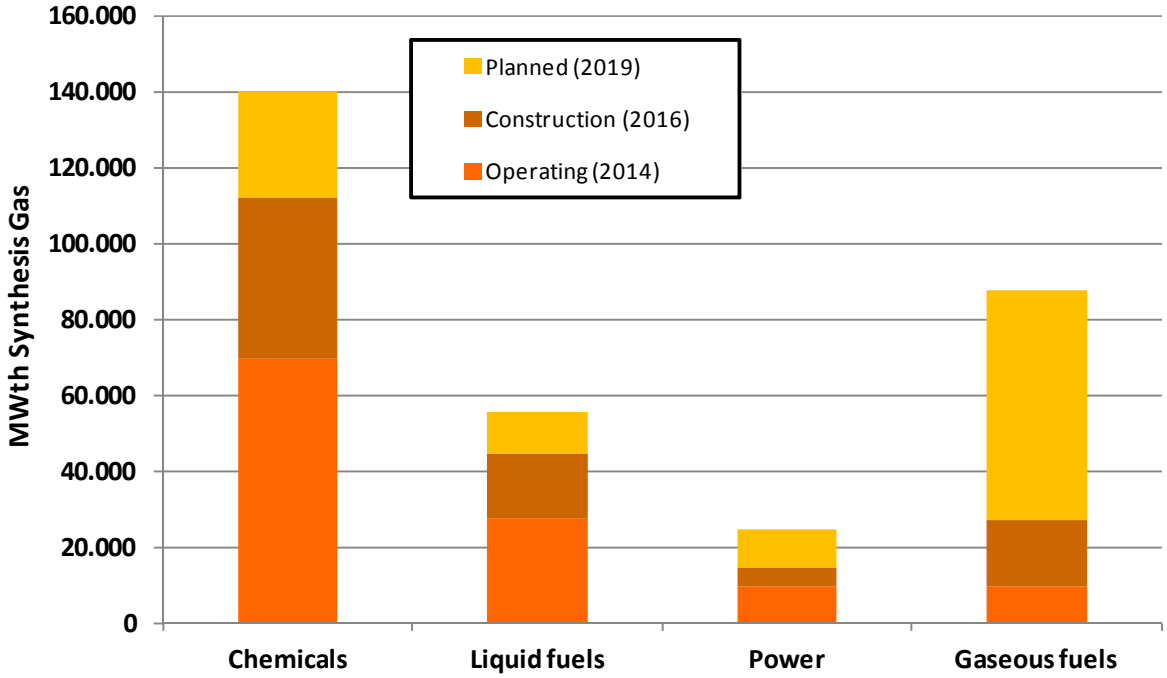

Figure 5 Gasification by Application

Gasification by Primary Feedstock

There had been a time when the use of coal and oil as a gasification feedstock was of the same order of magnitude. However with the price of crude oil at about $100/bbl, it is not surprising that coal has come to dominate the feedstock market. In fact, most oil gasifiers not connected to a refinery have been shut down since the first issue of this database in 1999. In many cases it is simply no longer economic to use oil products as a feedstock for ammonia. Coal is now the dominant feedstock and as shown in

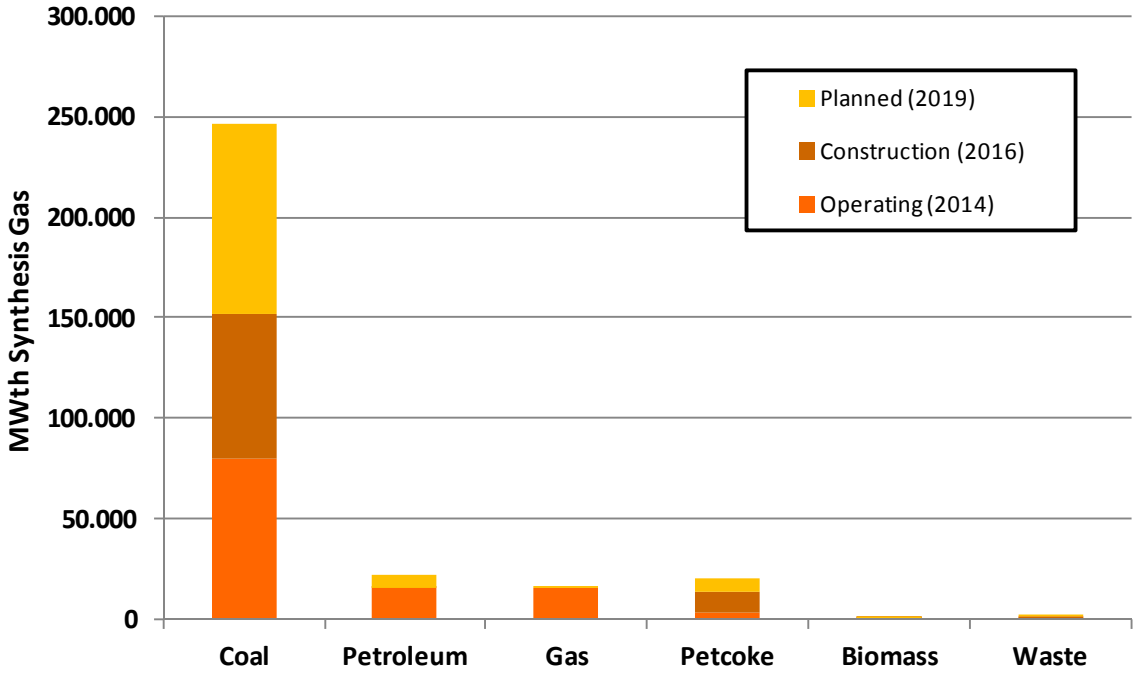

Figure 6, it is clear that this will continue to be so.

The gas feed capacity is largely that in the Bintulu and Pearl GTL plants. It does however include a number of much smaller plants for the production of CO-rich synthesis gas, where gasification technology can be competitive with steam reforming.

There is only a small capacity shown for plants that were designed for petroleum coke feed. One should not forget however that a number of plants originally designed for coal feed have been able to take advantage of their ability to process the cheaper petcoke feed. The Polk and Wabash IGCCs in the USA are examples.

Looked at on the capacity scale in

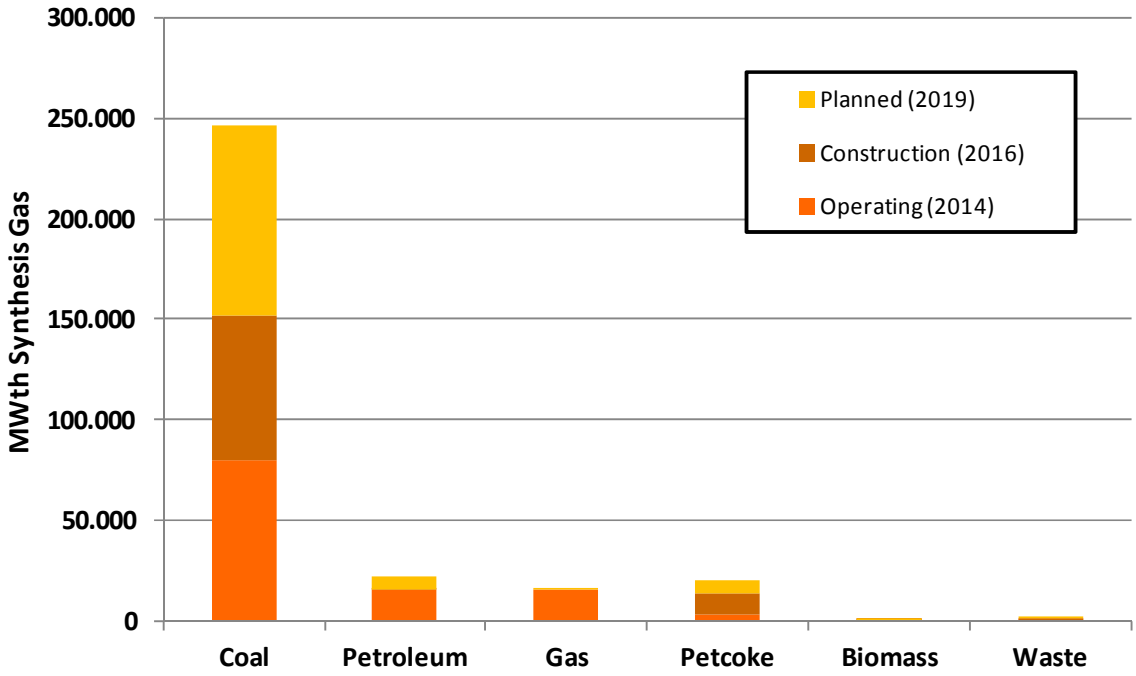

Figure 6, biomass and waste gasification appear negligible. Biomass and waste gasification projects tend to be small because of the high cost of bringing a large amount of biomass to a single point of use. When looking at the same feedstock classifications, but with the number of gasifiers as the metric as in

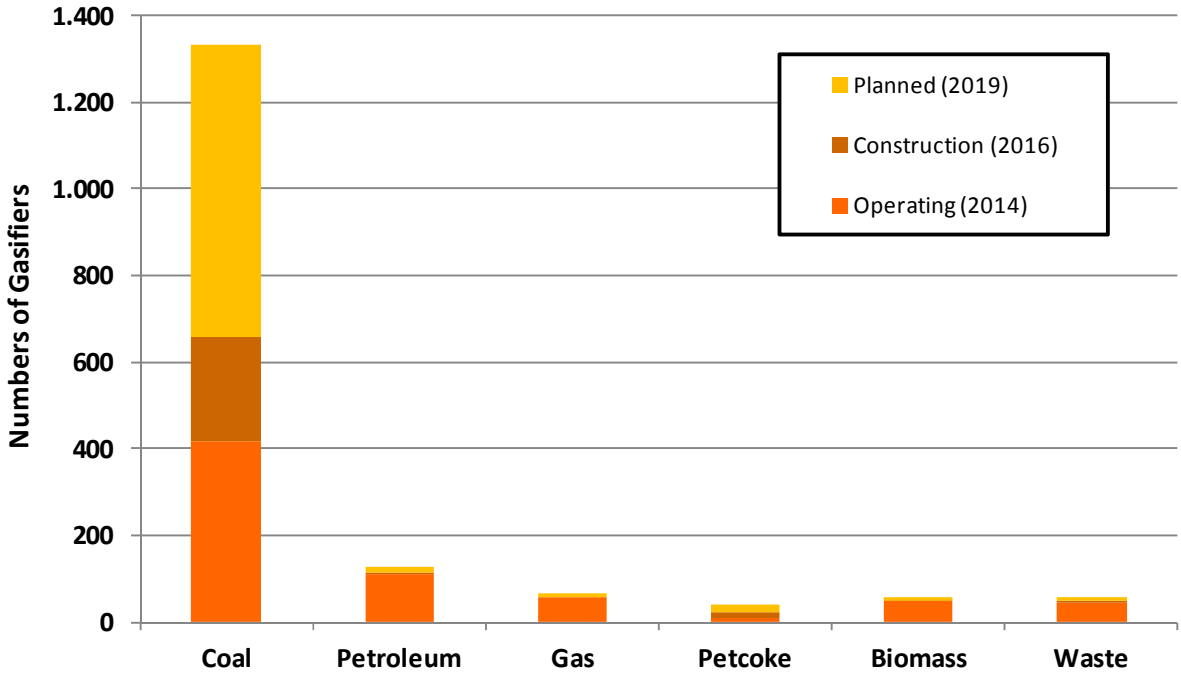

Figure 7, then one can see that there are more projects than for natural gas or petroleum coke feed. Nonetheless the dominance of coal as feedstock does not change.

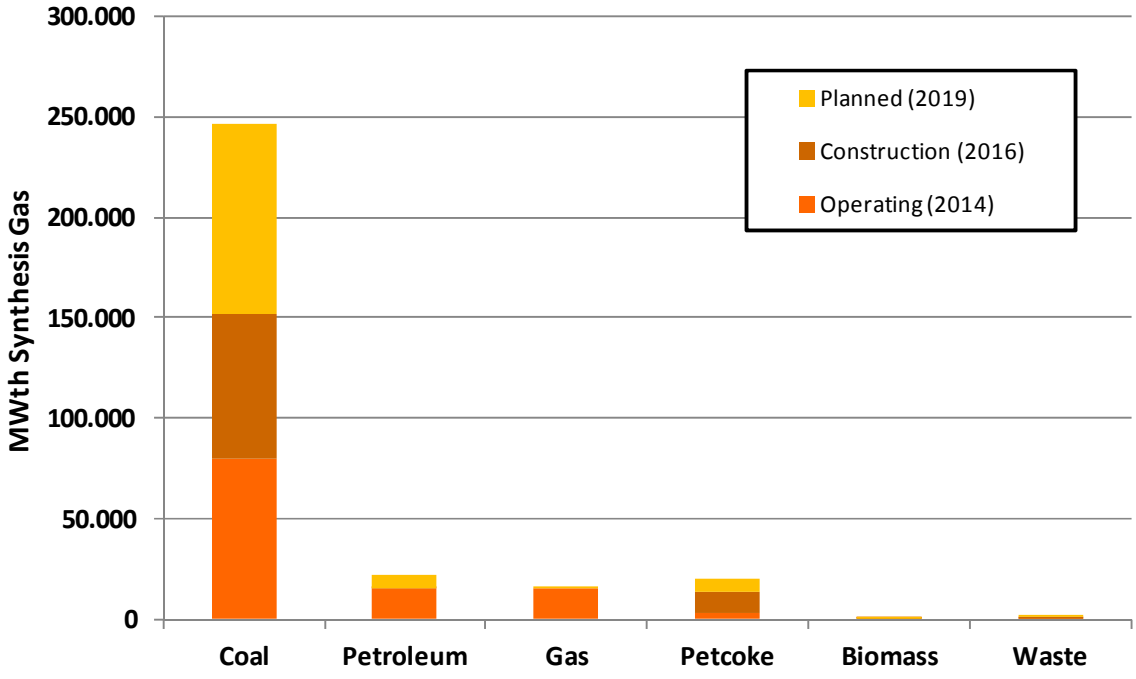

Figure 6 Gasification by Primary Feedstock

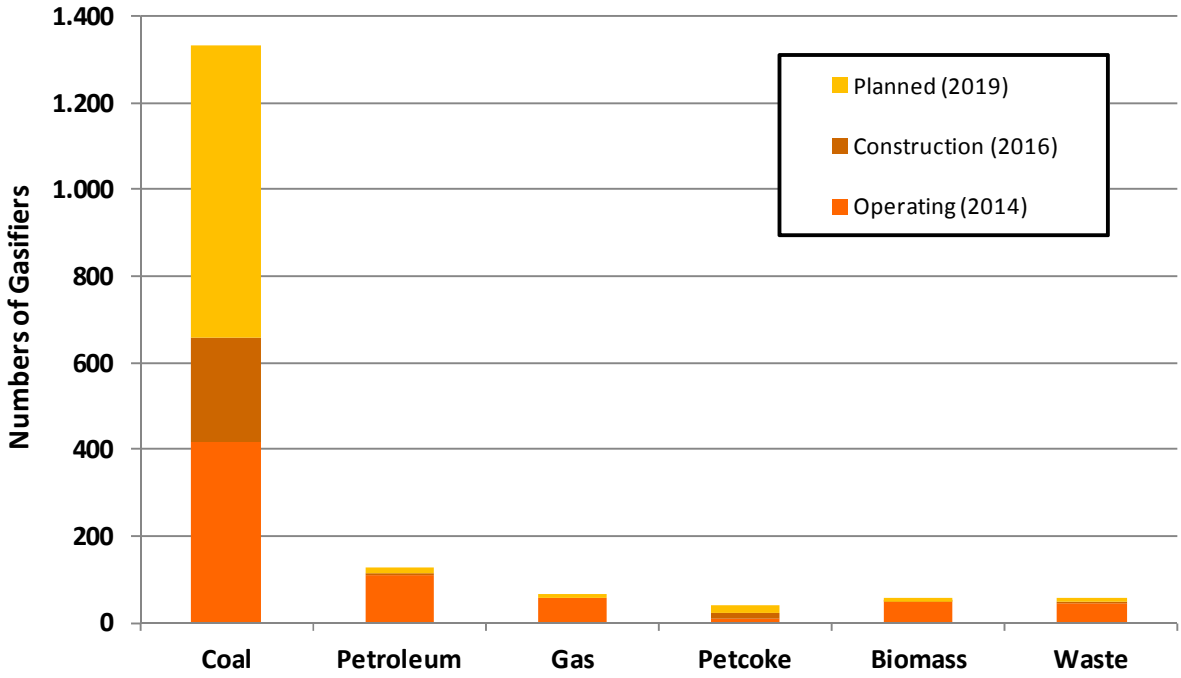

Figure 7 Numbers of Gasifiers by Primary Feedstock

The dominance of coal is such that the numbers for other feedstocks are so small that a separate diagram has become necessary to provide a readable scale. This is shown in Figure 8.

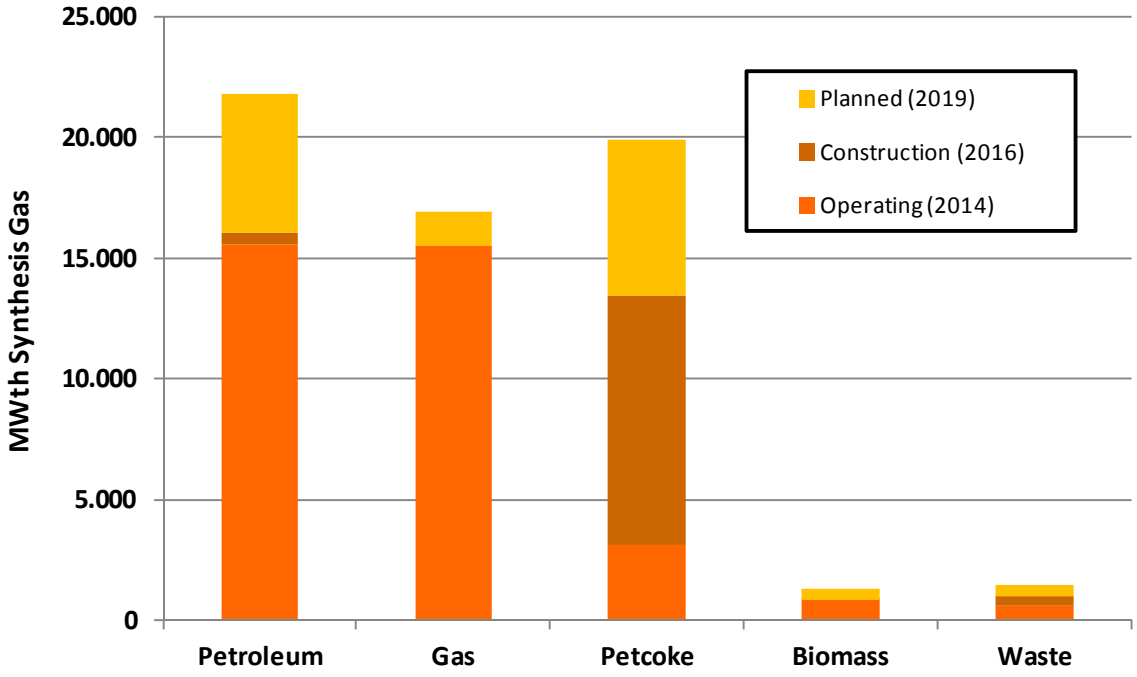

Figure 8 Non-Coal Gasification by Primary Feedstock

Gasification by Technology

The 2010 version of this database saw the first entry of a Chinese process (ECUST's OMB) into the analysis by technology. The development of the market in China has also seen additional processes from Chinese licensors such as Changzheng Engineering (CECO), Northwest Research (MCSG), and SEDIN making their mark. Nonetheless, the leading players remain GE and Shell, both of which also have a considerable number of projects in the pipeline.

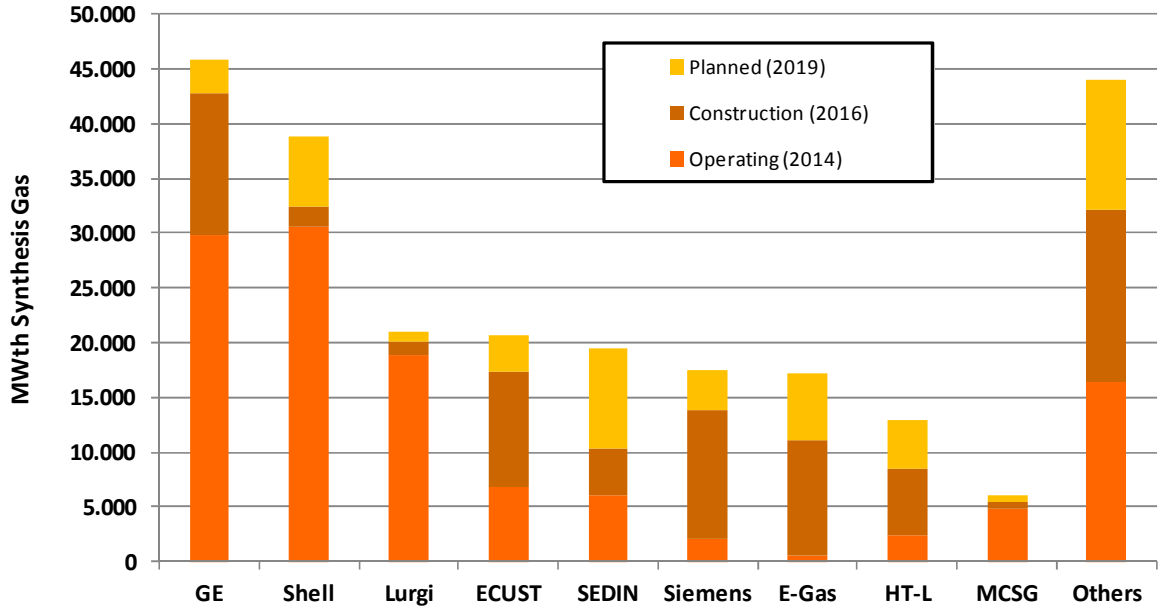

Figure 9 and

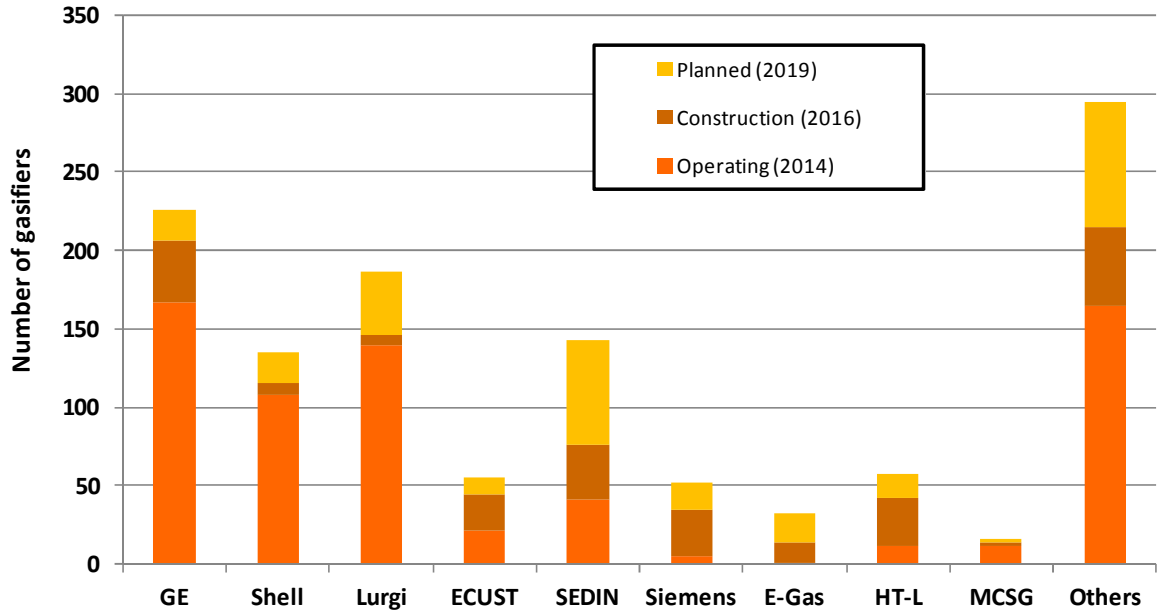

Figure 10 show the situation by capacity and numbers of gasifiers (excluding spares).

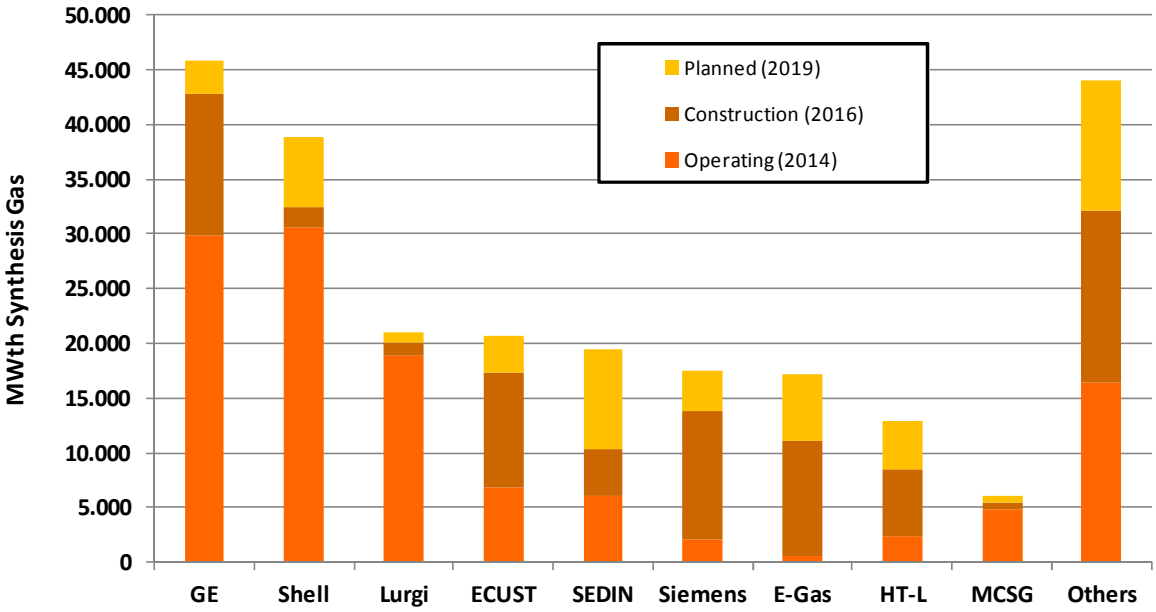

Figure 9 Gasification by Technology

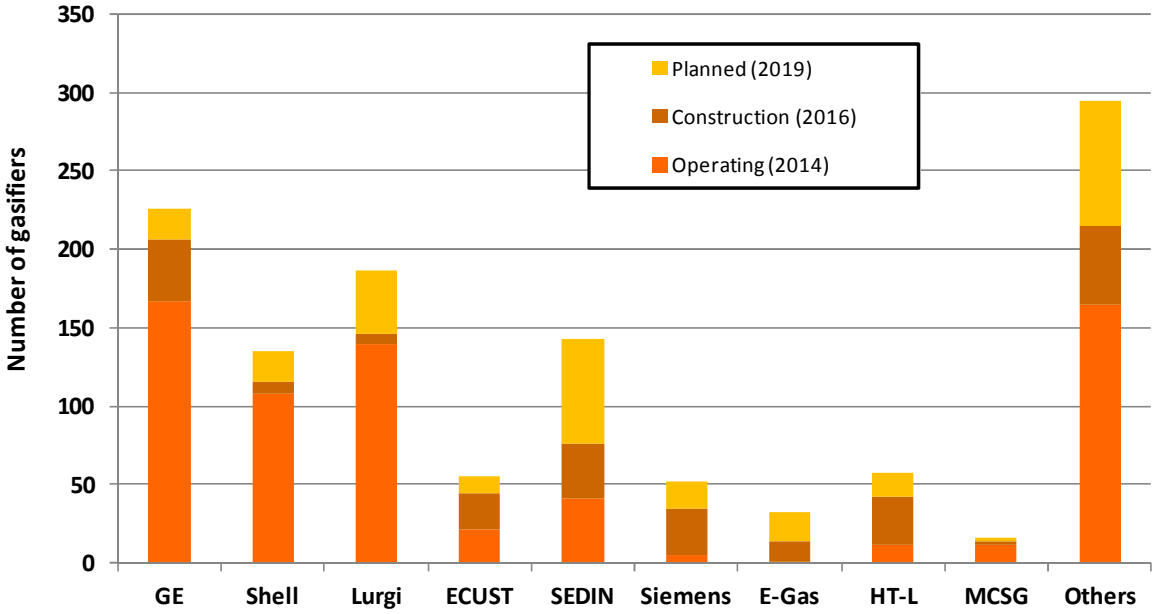

Figure 10 Numbers of Gasifiers by Technology

Conclusions

Gasification capacity continues to grow on a worldwide basis. While the majority of this growth is in Chinese coal-to-chemicals plants reflecting the dynamics of that market, other markets such as SNG in Korea and India are also developing. The development of 'mega-plants', particularly for such products as Fischer-Tropsch liquids, SNG and methanol-to olefins, but also in large refineries such as Jamnagar and Jazan, is also an important influence on the growth of gasification capacity worldwide.

Acknowledgements
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References
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