Environmental Infrastructure
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New York State's Installed Generating Capacity

Feasibility of Achieving the Clean Energy Standard

The state of New York is home to approximately 6.1% of total US population, and accounts for over 8% of total US GDP.[1 2] The state's ability to provide for its people can be attributed to a number of incredibly complex systems, with none being more important, or reliable, than the electrical power system. This system, which generates approximately 3.2% of total US generation, is comprised of approximately 707 existing generating facilities, spread out across 11 load-zones, with a total nameplate capacity of 44,231.70 MW.[3 4 5] The governmental body overlooking and advancing this system is the New York State Energy Research and Development Authority (NYSERDA), and the New York Independent System Operator (NYISO) is the agency in charge of operating the "competitive wholesale markets to manage the flow of electricity across New York-from the power producers who generate it to the local utilities that deliver it to residents and businesses."[6]

In 2015, Governor Cuomo launched the 'State Energy Plan' as a "comprehensive roadmap to build a clean, resilient, and affordable energy system for all New Yorkers."[7] Under this plan, the government, along with all state agencies and authorities involved

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1 "State Energy Profile Data - EIA." https://www.eia.gov/state/data.php?sid=NY. Accessed 10 Dec. 2017.
2 "List of U.S. states by GDP - Wikipedia." https://en.wikipedia.org/wiki/List_of_U.S._states_by_GDP. Accessed 10 Dec. 2017.
3 "State Energy Profile Data - EIA." https://www.eia.gov/state/data.php?sid=NY. Accessed 10 Dec. 2017.
4 "Zone Maps - NYISO." http://www.nyiso.com/public/markets_operations/market_data/maps/index.jsp. Accessed 10 Dec. 2017.
5 "Load & Capacity Data Report - NYISO." 1 Apr. 2017, http://www.nyiso.com/public/webdocs/markets_operations/services/planning/Documents_and_Resources/Planning_Data_and_Reference_Docs/Data_and_Reference_Docs/2017_Load_and_Capacity_Data_Report.pdf. Accessed 10 Dec. 2017.
6 "NYISO (Home)." http://www.nyiso.com/. Accessed 10 Dec. 2017.
7 "New York State Energy Plan - NY.Gov." https://energyplan.ny.gov/. Accessed 10 Dec. 2017.

in the energy industry, are implementing a bold energy strategy termed ‘Reforming the Energy Vision’(REV). REV’s aim is to “build an integrated energy network able to harness the combined benefits of the central grid with clean, locally generated power”, and the government plans to do this through the 7 goals and 40+ initiatives laid out by the plan.[8]

One of the core components of REV is the Clean Energy Standard (CES), which is an initiative to ensure that 50% of electrical generation be sourced from clean energy by 2030.[9] This incredibly ambitious standard has come to be understood as the linchpin of REV, and the broader State Energy Plan, but is it actually achievable?

To answer this question, I conducted a feasibility study of achieving the Clean Energy Standard, based on available data. This study began by compiling information on all New York State generating assets, and assessing the current installed generating capacity from a number of metrics. The data was compiled from many sources, including the NYISO Gold Book, and WNY Peace Center.[10] [11] From there, I assessed how the current installed capacity would evolve through time, out to 2030, based on planned closures, environmental regulations, and the age of the fleet. This analysis resulted in an estimated capacity shortfall of approximately 31.6% by 2026, if no new generating assets come online of course. To address this, I then analyzed the NYISO Interconnection Queue, and conducted a scenario analysis to assess how to best

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[8] "Reforming the Energy Vision." https://rev.ny.gov/. Accessed 10 Dec. 2017.
[9] "Clean Energy Standard (CES) - NYSERDA - NY.Gov." https://www.nyserda.ny.gov/All-Programs/Programs/Clean-Energy-Standard. Accessed 11 Dec. 2017.
[10] "2016 Load and Capacity Report - NYISO." 30 Apr. 2016, http://www.nyiso.com/public/webdocs/markets_operations/services/planning/Documents_and_Resources/Planning_Data_and_Reference_Docs/Data_and_Reference_Docs/2016_Load__Capacity_Data_Report.pdf. Accessed 10 Dec. 2017.
[11] "Environmental Justice » WNY Peace Center." http://wnypeace.org/wp/task-forces/environmental-justice/. Accessed 10 Dec. 2017.

make-up for this capacity shortfall, while also attempting to achieve the Clean Energy Standard. My preliminary finding concluded that by green-lighting all clean energy generation sources in the Interconnection Queue, New York State can come close to achieving the CES by 2030. If my methods were followed, and if my analysis is correct, the 2030 installed capacity mix would be comprised of approximately 47.4% of clean energy generation, approximately 47.6% of fossil-fuel based generation, and approximately 5% of Nuclear generation. In the following sections, I will provide comprehensive account of the results, and steps involved, along with detailed descriptions of various assumptions, reasonings, and the perceived limitations of my analysis. Please note that due to the scope of this analysis, it is very data intensive, and as such requires reference to multiple charts and graphs.

As stated earlier, and as can be seen in Figures 1 & 2, the NY State installed generating capacity is comprised of approximately 707 existing generating facilities, spread out across 11 load-zones, with a total nameplate capacity of 44,231.70 MW. [3] [4] [5] Zone J, which is where New York City resides, accounts for the largest share of installed capacity, with approximately 24.7%. The generation mix is split between 13 primary fuel types, with Natural Gas commanding the largest share of the pie, at 42.2%, and conventional hydro coming in second at 15.2%, as can be seen in Figures 3 & 4. To provide a more comprehensive breakdown of each zones installed capacity by primary fuel type, I've included Figures 5 & 6, which further highlight the high reliance on Natural Gas across zones. Of special notice should be zones F, G, J, and K, all of which rely on Natural gas as their primary fuel type for more than 57% of their total installed capacity.

To assess the age of all generating assets, I created four tranches to denote their stage in operational lifetime; assets that are younger than 20 years old, assets that are in between 20 and 40 years old, assets that are in between 40 and 60 years old, and assets that are older than 60 years old. I then compiled the data to assess the age breakdown of each zone, as can be seen in Figures 7 & 8. Across all zones, the age tranche with the highest amount of nameplate capacity is the 40 to 60 year old tranche, with 23,059 MW, or approximately 52.13% of total installed capacity. This is particularly alarming due the on-going operating and maintenance challenges, lower efficiency, and higher emissions associated with older generation technologies. The two oldest zones are H & G, but this is of little concern as both only account for small portions of the total installed capacity; 5.0% and 7.3%, respectively. I also analyzed the age of all generating assets by primary fuel type, as can be seen in Figures 9 & 10. Much to my surprise, I found the age mix across primary fuel types to be fairly evenly distributed, especially for Natural Gas, with approximately 40.8% of its installed capacity being 20 years old or younger, giving the total stock of natural gas generating assets an average age of 25.7 years old. The primary fuel type stock with the oldest average age is the conventional hydro fleet, with an average age of 58.6. The conventional hydro fleet is closely followed in age by the coal fleet, with an average age of 57.2, then by the No. 6 Fuel Oil fleet at 49.1, and the No. 2 Fuel Oil Fleet at 47.3 years old. A comprehensive breakdown of the average age of primary fuel type stocks, and their respective total installed capacity, can be found on Figure 11.

After analyzing the installed capacity mix from the perspectives of zone, primary fuel types, and age, I then analyzed how the mix would evolve through time as plants entered into retirement. To the best of my knowledge, at the time of this writing, the only planned retirement in New York State are Units 2 & 3 of the Indian Point Nuclear Station, located in Westchester. Together, these two units account for 2,150 MW of nameplate capacity in Zone H, or 97% of the zone total. The units are expected to come offline successively in 2020 and 2021.[12] Apart from this planned closure, there are many other closures that can be reasonably expected due to increased environmental regulations, and the ageing fleet.

In regards to increased environmental regulations, it is expected that under the new heating oil regulations, multiple plants will need to conduct a costly fuel switching, or permanently retire, by 2030.[13] According to compiled data, there is currently 6,011.6 MW of generating assets that rely on No. 6 Fuel Oil as their primary fuel type. Due to the significance, timeliness, and cost-prohibitive nature of retrofitting existing plants to meet the new regulations, as well as the relative age of the No. 6 Fuel Oil fleet, I've assumed that 5,183 MW, or approximately 86% of the fuel type fleet, will begin to be phased-out in 2022-2023.

The final component to assess in regard to closures is that of the ageing fleet. As stated earlier, there is a large and growing portion of the current installed generating

[12] "Entergy, NY Officials Agree on Indian Point Closure in 2020-2021 ...." http://www.safesecurevital.com/entergy-ny-officials-agree-on-indian-point-closure-in-2020-2021/. Accessed 10 Dec. 2017.
[13] "Heating Oil - NYC.gov." http://www.nyc.gov/html/dep/html/air/buildings_heating_oil.shtml. Accessed 10 Dec. 2017.

capacity that is approaching, or at, the end of its useful life. Apart from the approximate 52% of generating assets that are 40 to 60 years old, an additional 4.5% of the current installed capacity is older than 60 years old, meaning that 56.5% of total installed capacity is at least 40 years old. When assessing the range of scenarios that may occur, I concluded that the most reasonable set of assumptions to make would be to estimate that all generating assets currently older than 60 would begin to retire by 2023, and that all fossil fuel based assets older than 40 would be give a probability rating, ranging from 50% to 70%, that they would also begin to retire by 2023. I then phased these retirements in to the fuel mix over the next 4 years, from 2023-2026. Under these assumptions, the amount of expected closures due to old age came to a total of 6,714 MW.

When taken together, the currently planned and expected closures, due to environmental regulations and ageing fleet assets, total to 13,997.54 MW of generating assets retiring by 2026. This represents an expected capacity shortfall of approximately 31.6% of today's total installed capacity. Figures 12 & 13, and Tables 1 & 2, show these retirements, and associated capacity shortfall, across zones and by primary fuel type.

The next step in my analysis was to assess the current makeup of the NYISO Interconnection Queue.[14] This queue is provided by NYISO and serves as an overview of all statewide generation asset proposals for several years into the future. As of November 2017, the interconnection queue had a total of 182 proposed projects, with a total nameplate capacity of 26968.8 MW, that are slated to come online between 2017

[14] "Link to the NYISO Interconnection Queue." http://www.nyiso.com/public/webdocs/markets_operations/services/planning/Documents_and_Resources/Interconnection_Studies/NYISO_Interconnection_Queue/NYISO%20Interconnection%20Queue.xls. Accessed 10 Dec. 2017.

and 2022. The queue is comprised of projects in all zones, with 19 different project types, including conventional fossil fuels and clean energy sources. The project type that commands the lion's share of the queue is High Voltage DC Transmission Lines, which will import power from Hydro-Quebec and other clean energy projects in New Jersey. In all, High Voltage DC Transmission Line projects make up approximately 32.5% of the Interconnection queue with projects equaling approximately 8,775 MW. Second to High Voltage DC Transmission Lines is Wind projects, which account for approximately 4,500MW of Interconnection Queue projects, or 16.7% of the total. A full breakdown of the Interconnection Queue by Zone and Primary Fuel Type is provided in Figures 14, 15, & 16.

Based on all the information gathered and analyzed up to this point, I then assessed how projects in the Interconnection Queue could best be utilized to make-up for the anticipated capacity shortfall, while also attempting to achieve the Clean Energy Standard, I conducted a scenario analysis that gave priority to clean energy projects. To elaborate on how I conducted my scenario analysis, my clean energy prioritization was a simple binary assumption; if a project in the queue generated electricity from clean sources, it was green-lighted for development.

Second to that prioritization parameter, I assessed the probability of other queue projects coming on-line based on the zone in which they resided, and the relative loss incurred by each zone based on my plant closure assumptions. My argument for this is that apart from the direct loss of electricity generation for these zones, there would be other socio-economic losses associated with plant closures, such as employment and wage losses, which would need to be addressed, so refilling the anticipated zonal drawdowns makes socio-economic sense.

A final assumption I made, which can be heavily debated, is that energy demand will marginally increase from 2017-2030. I say that this assumption can be heavily debated because some reports state that, due to efficiency gains, total demand will remain flat.[15] Despite these claims, I've factored in a ~0.85% year-over-year increase in demand from 2017-2030.

When taken together, all of these factors and assumptions provided me with the information necessary to assess the total installed capacity mix from 2017 to 2030. As Tables 3 & 4 show, the total installed generating capacity in 2030 is approximately 49,226 MW. As can be seen in Figures 17,18, & 19, the capacity added from the Interconnection Queue under my scenario analysis brings the total capacity to a satisfactory level, while also maximizing the amount of clean energy in the mix. All together, the installed capacity derived from clean energy sources accounts for 47.38% of the total installed capacity, fossil fuels account for 47.62%, and nuclear accounts for roughly 5%.

It is important to note, however, that according to this analysis the state would be highly reliant on importing power from neighbor territories, of approximately 17.8%, which poses significant long-term supply risks. Its also important to note that this analysis purposely does not factor in cross-zone-energy-flows, nor does it factor in technology specific capacity factors, and how those factors will affect the overall

[15] "2017 Power Trends - NYISO." http://www.nyiso.com/public/webdocs/media_room/publications_presentations/Power_Trends/Power_Trends/2017_Power_Trends.pdf. Accessed 12 Dec. 2017.

balance of production and consumption. I readily admit that these are glaring oversights, but that level of analysis is beyond the scope of this paper, and my current analytical capabilities.

In conclusion, by following my methods, and if my analysis is correct, New York State can come close to achieving the CES by 2030, but in doing so, it must heavily rely on importing clean energy from neighboring territories. Without the addition of more clean energy projects in the interconnection queue, the State will need to rely on behind-the-meter distributed energy resources to drive down demand in order to achieve the Clean Energy Standard.

Additional Resources:

1. Marc Johnson || NYISO Goldbook 2016
   https://docs.google.com/a/columbia.edu/spreadsheets/d/1PXur5rp4jdfCAS5l_Muk691WtCUmAt_1DZl8PEK4OL4/edit?usp=sharing
2. Marc Johnson || NYISO Interconnection Queue
   https://docs.google.com/a/columbia.edu/spreadsheets/d/1GUH2_QC-Oa-dPFOgstenCMqclCRmJ1S36IeObjDnnFg/edit?usp=sharing

Figure 1: NYISO Load Zones

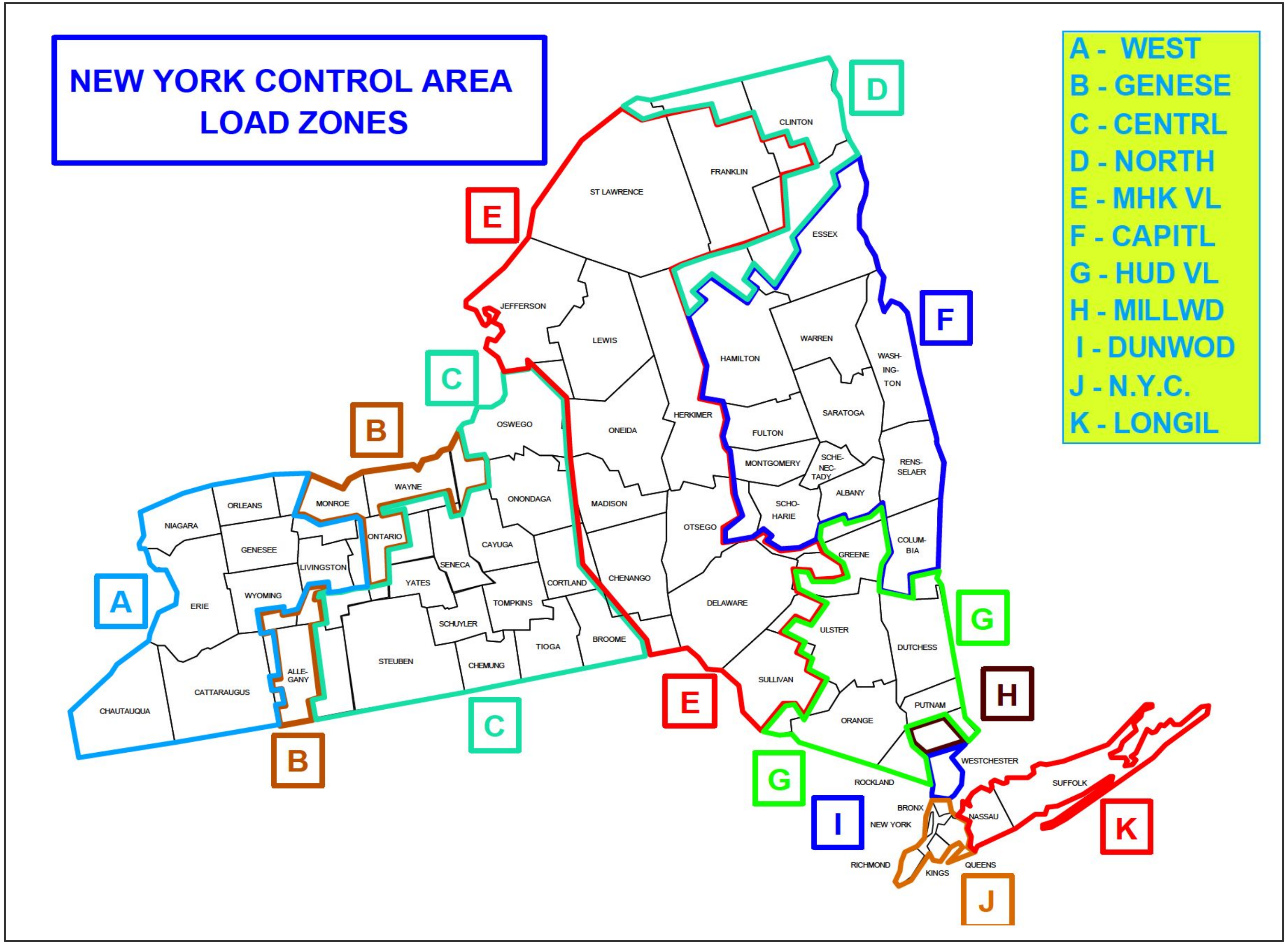

Figure 2: Total Installed Generating Capacity by Zone (Nameplate MW)

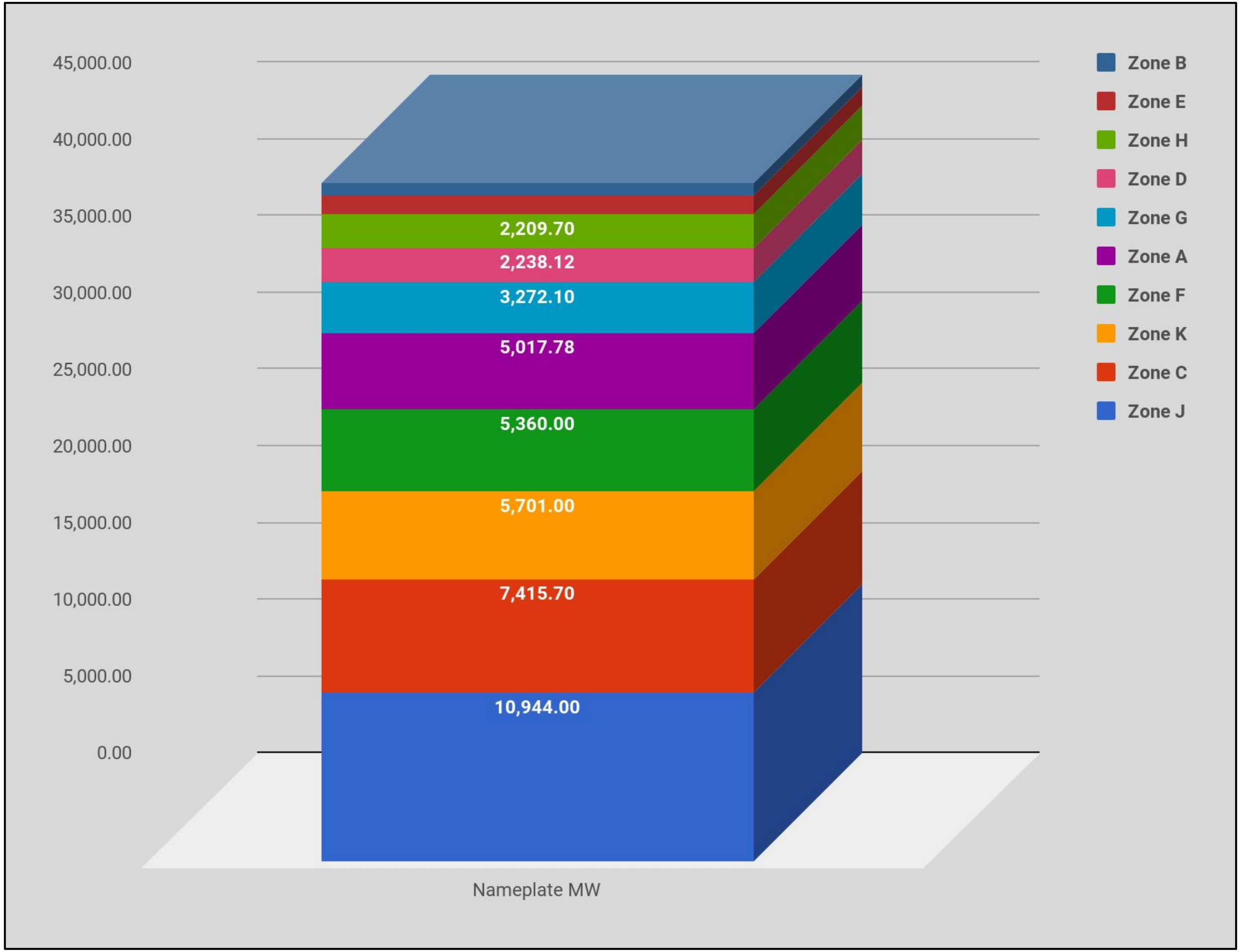

Figure 3: Total Installed Generating Capacity by Primary Fuel Type (Nameplate MW)

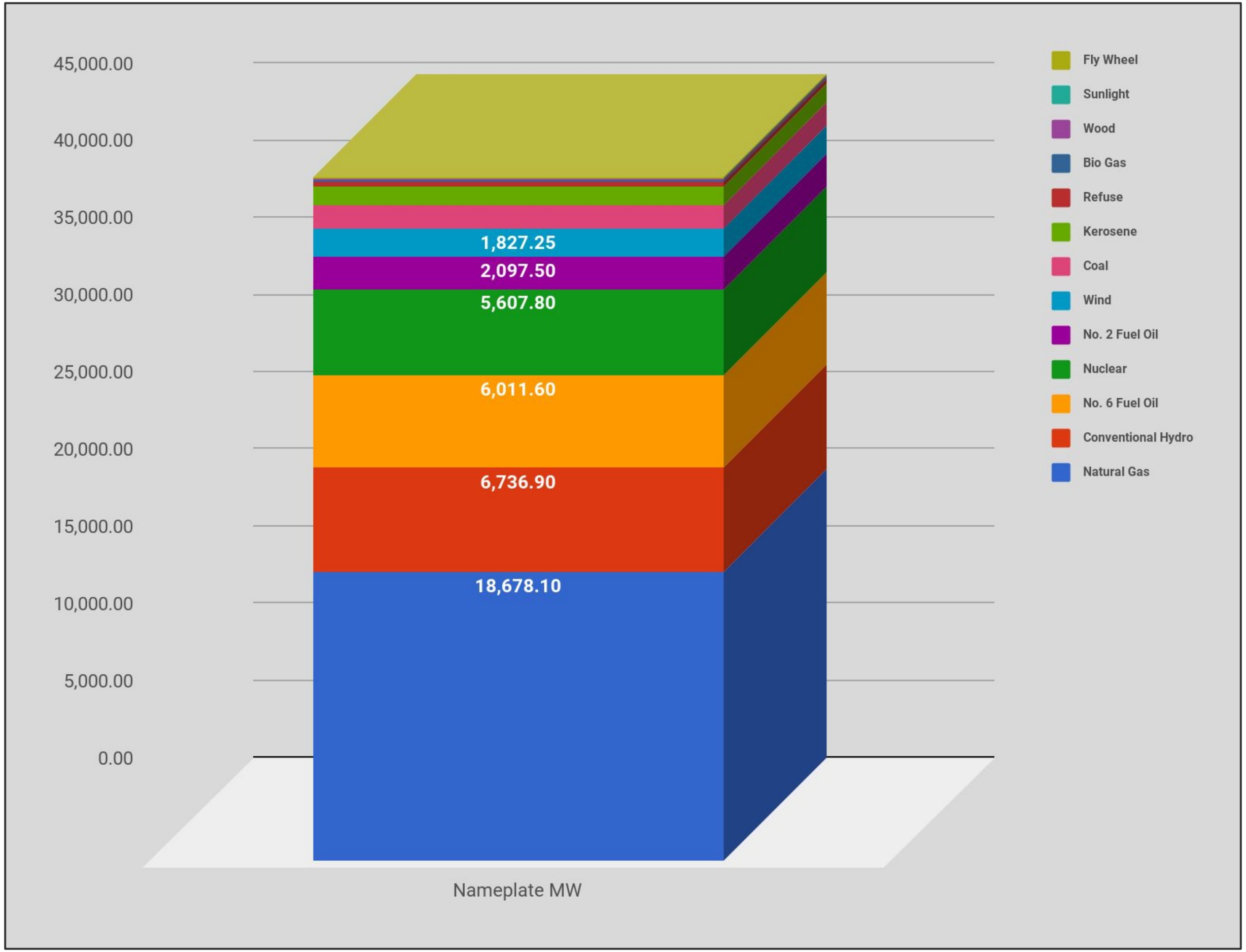

Figure 4: Percentage Breakdown of Total Installed Generating Capacity by Primary Fuel Type

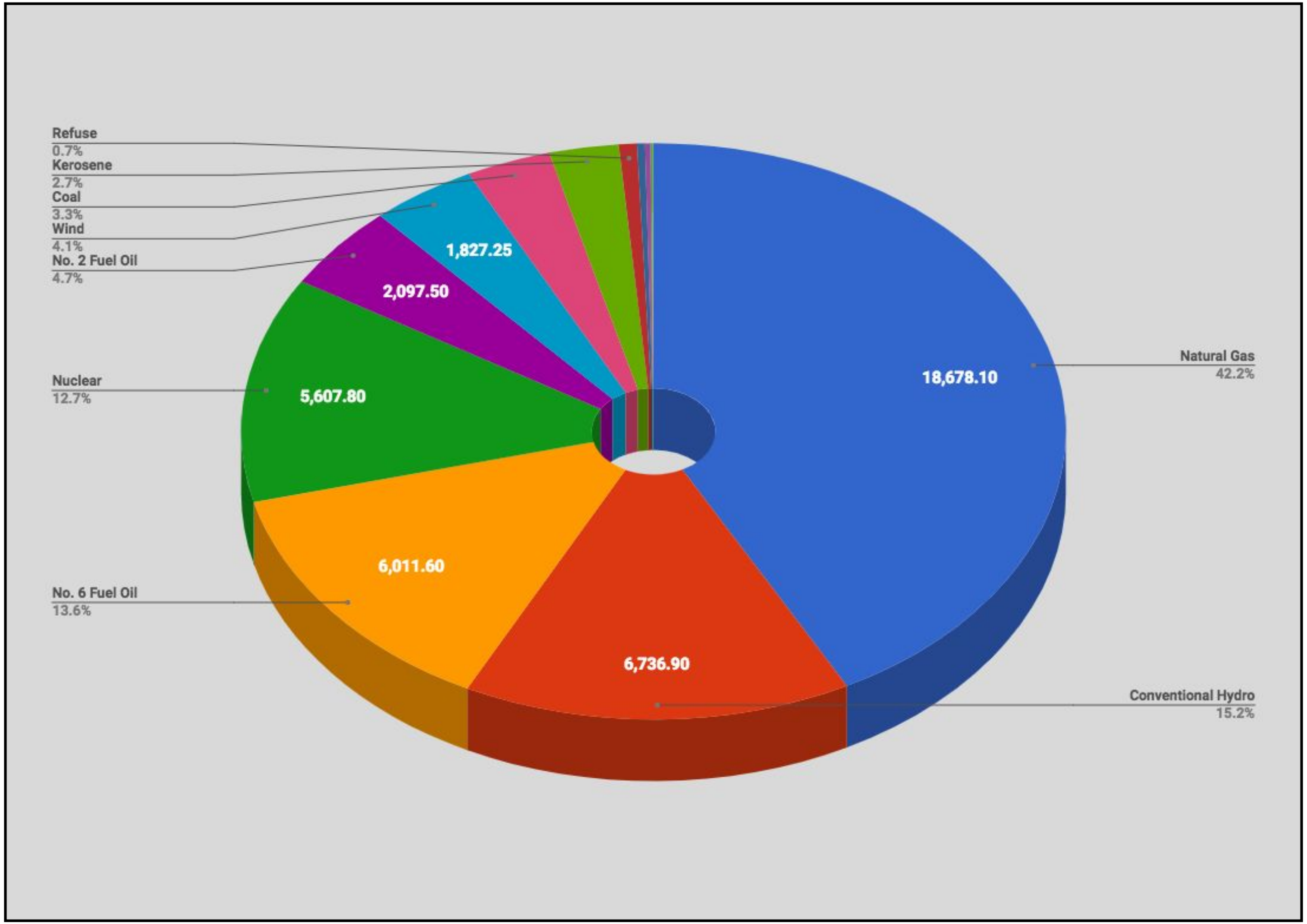

Figure 5: Breakdown of Zone by Primary Fuel Type

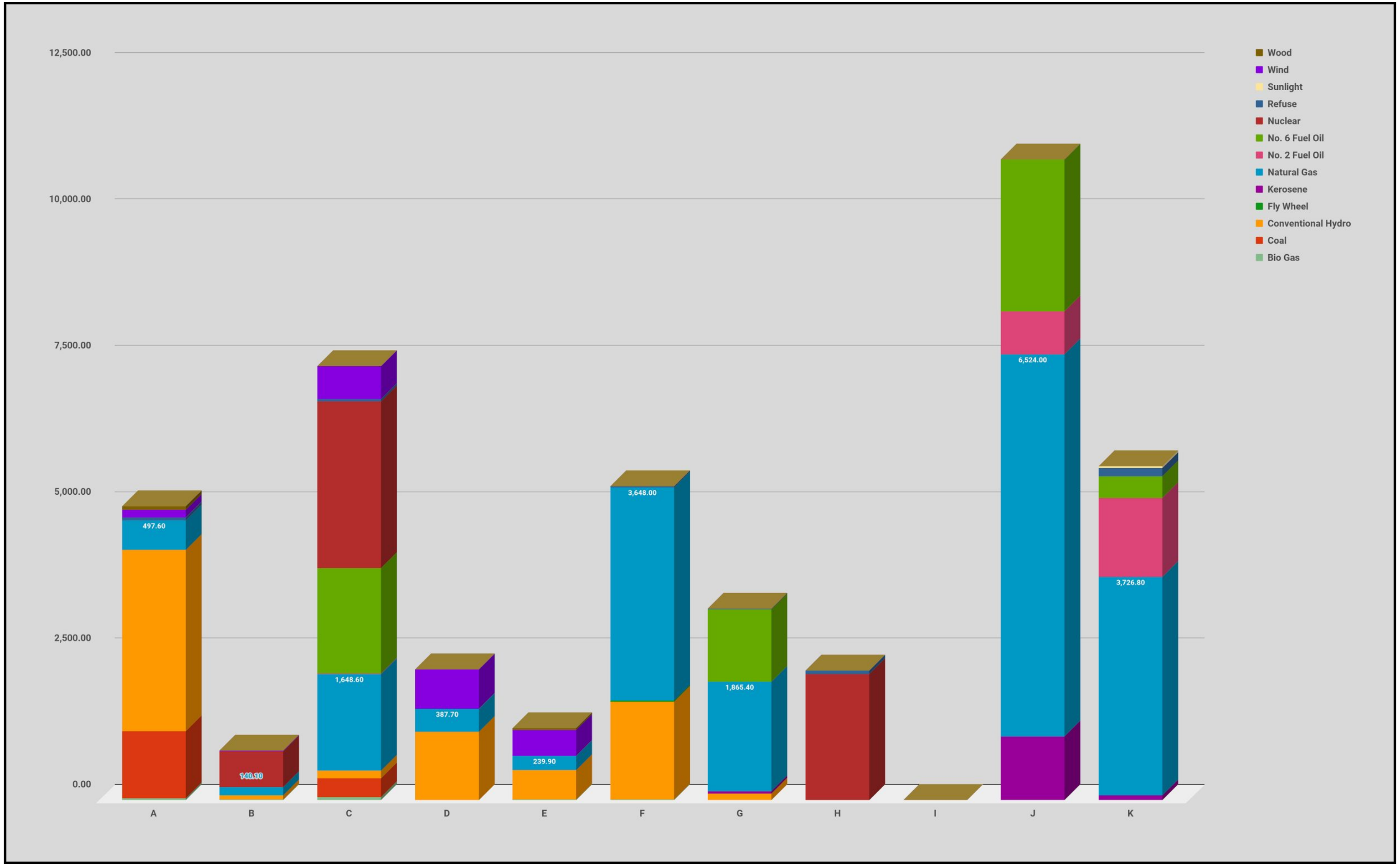

Figure 6: Percentage Breakdown of Zone by Primary Fuel Type

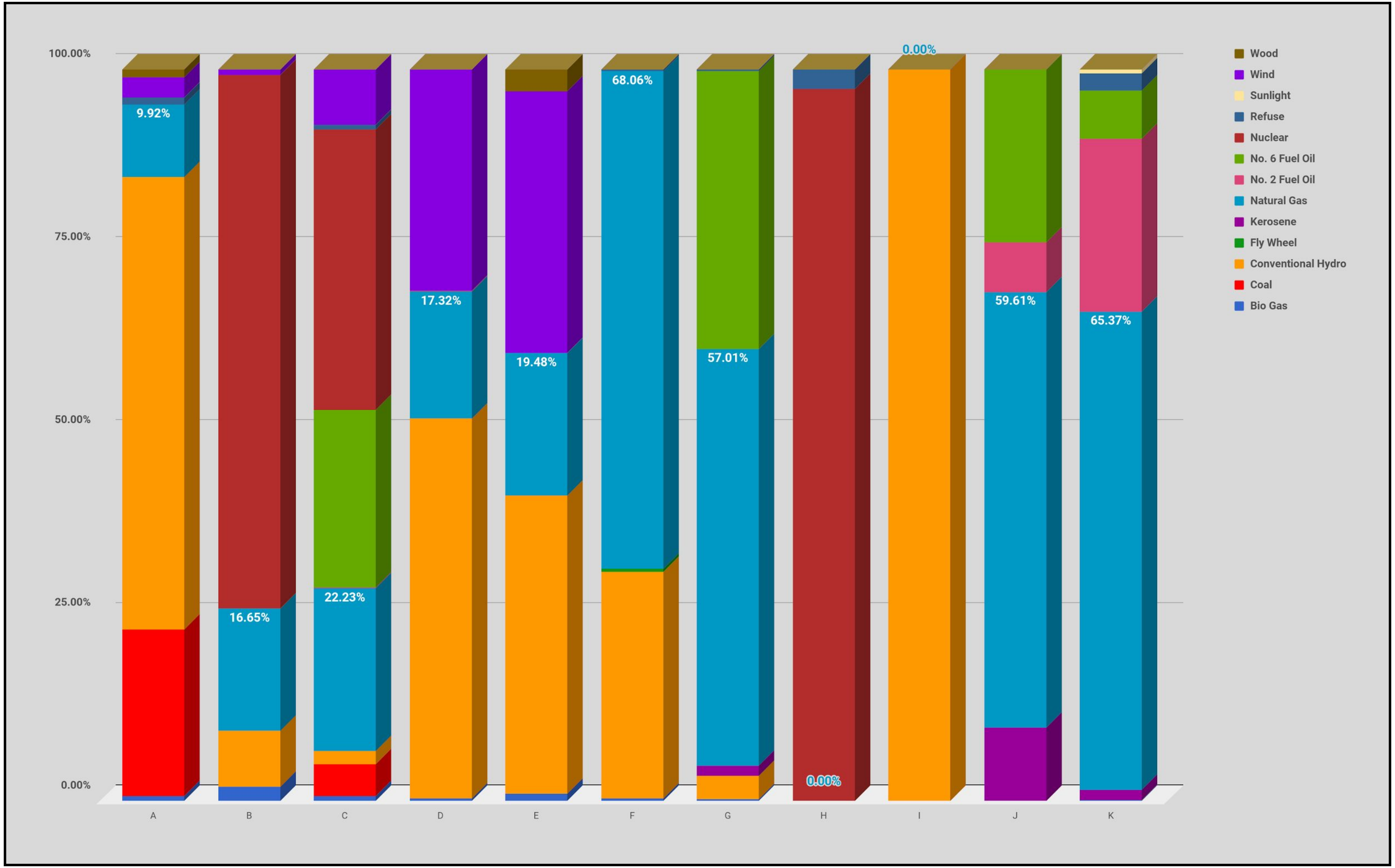

Figure 7: Age Breakdown by Zone

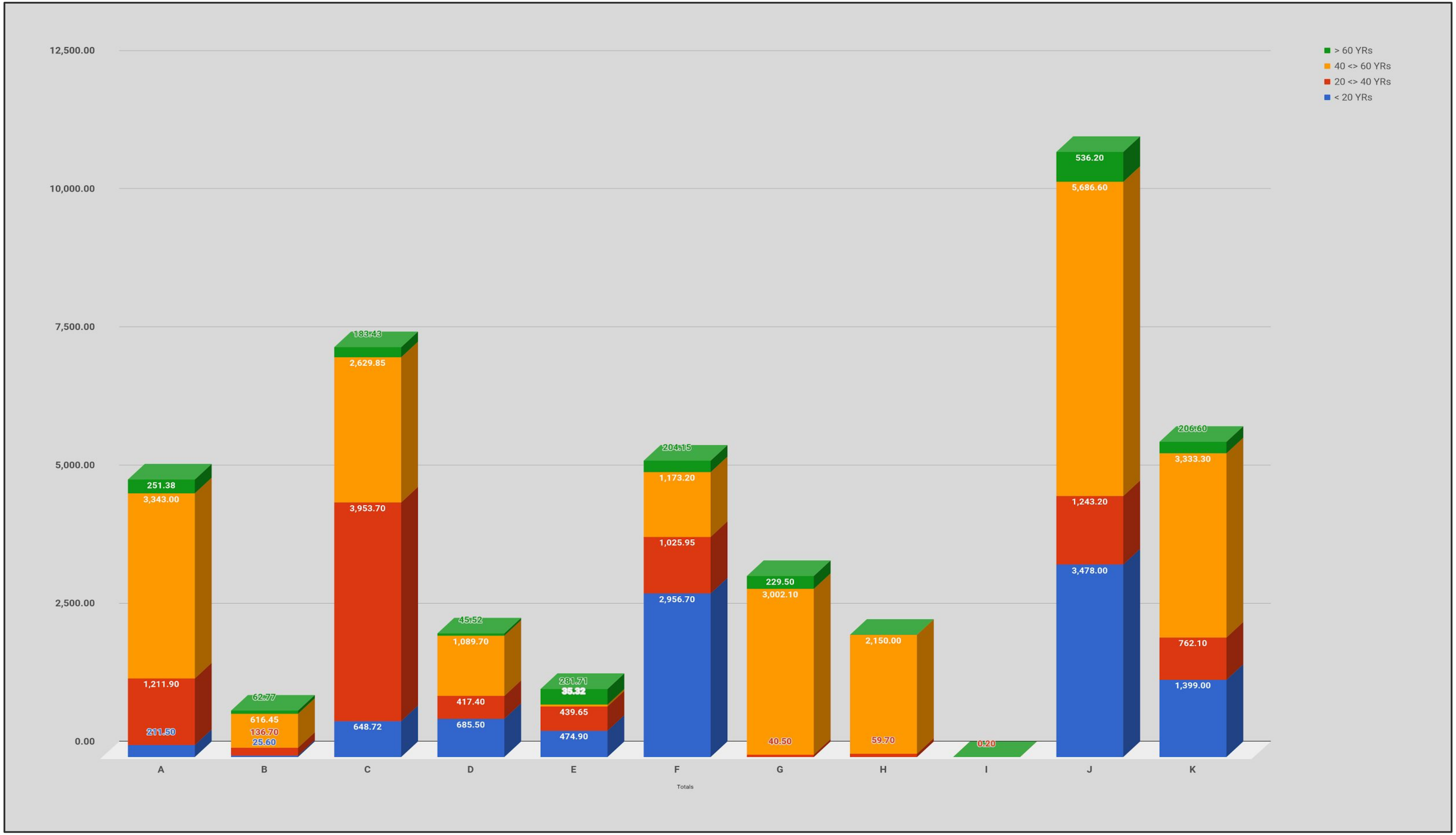

Figure 8: Percentage of Age Breakdown by Zone

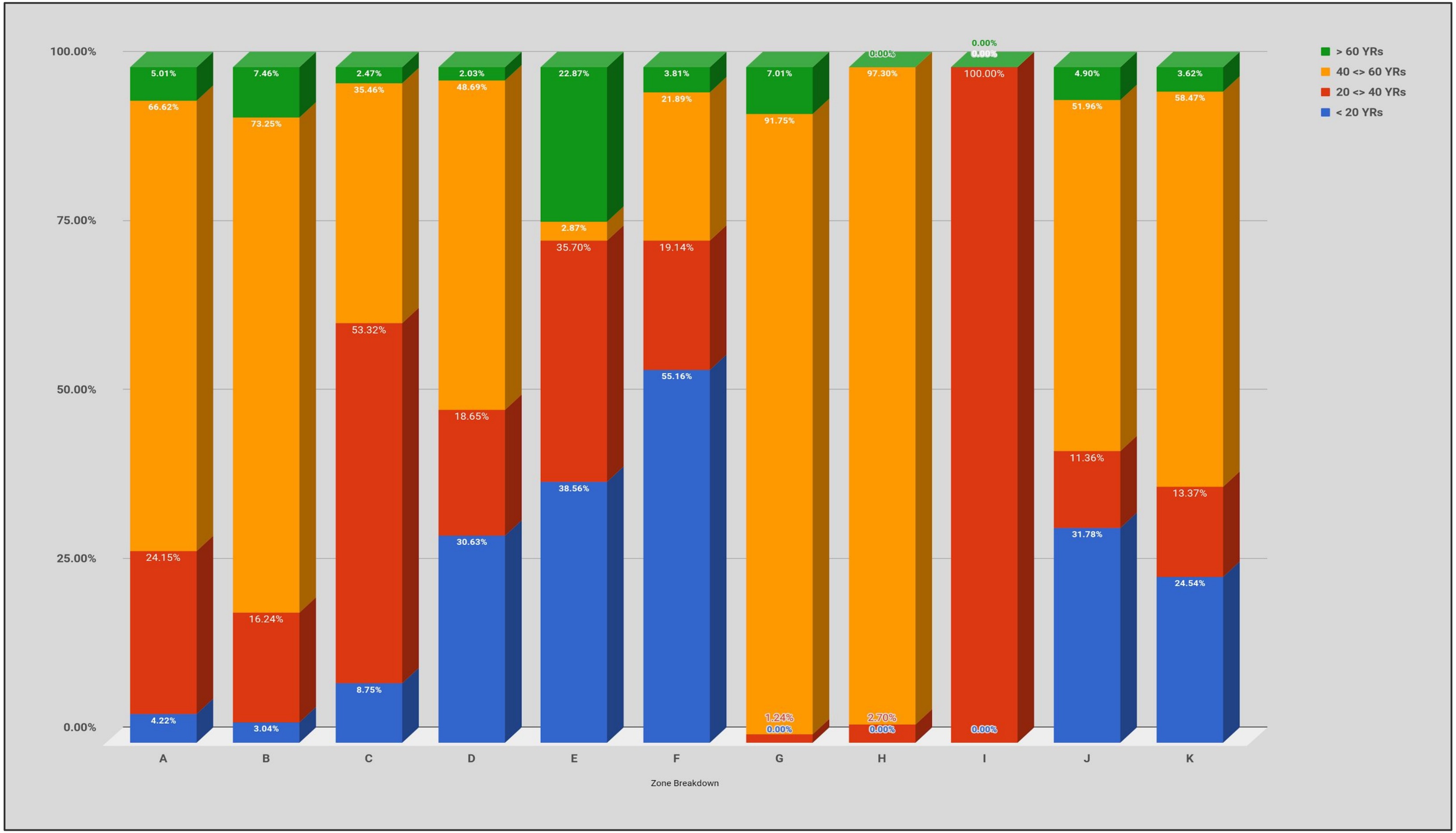

Figure 9: Age Breakdown by Primary Fuel type

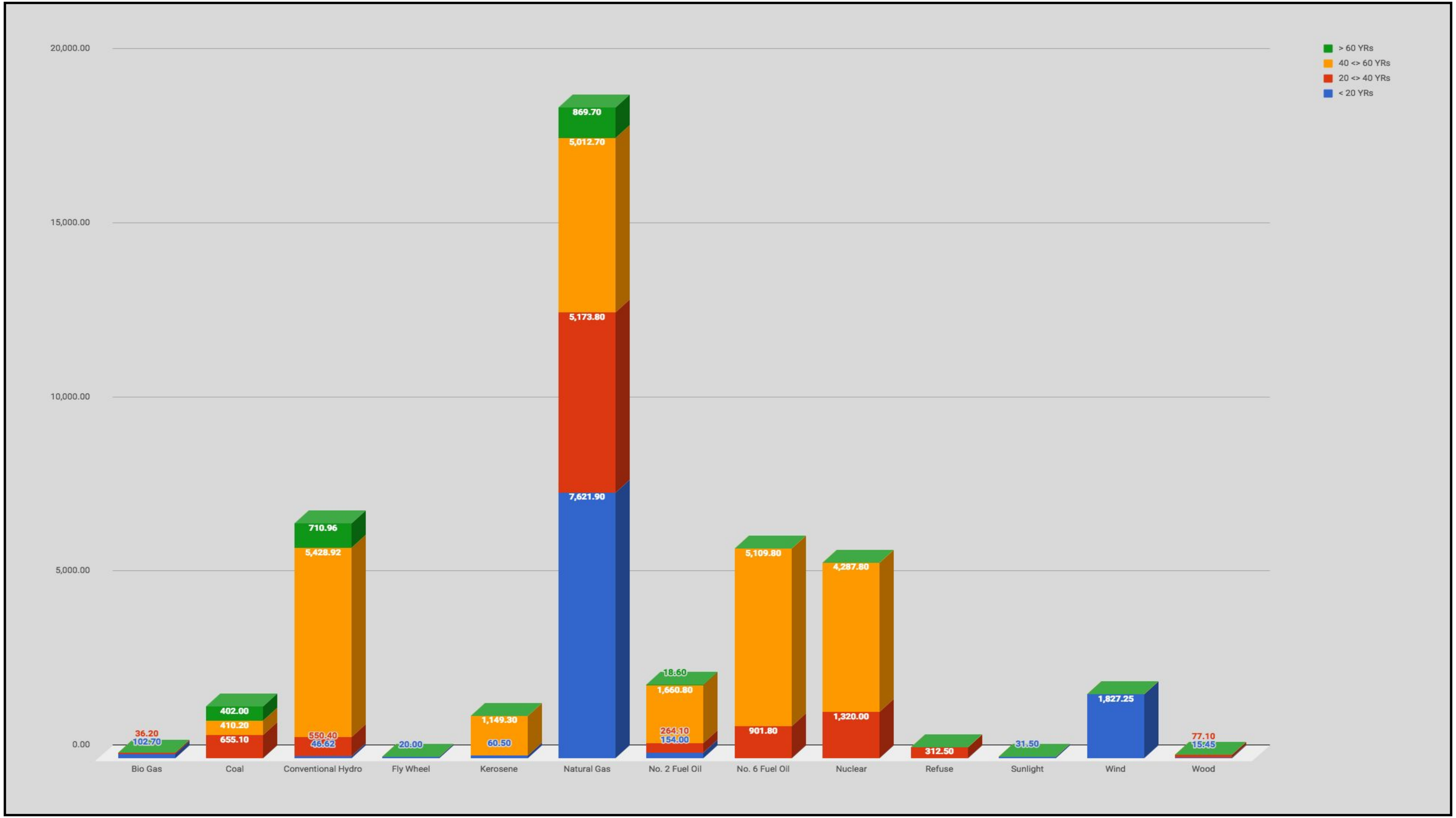

Figure 10: Percentage of Age Breakdown by Primary Fuel Type

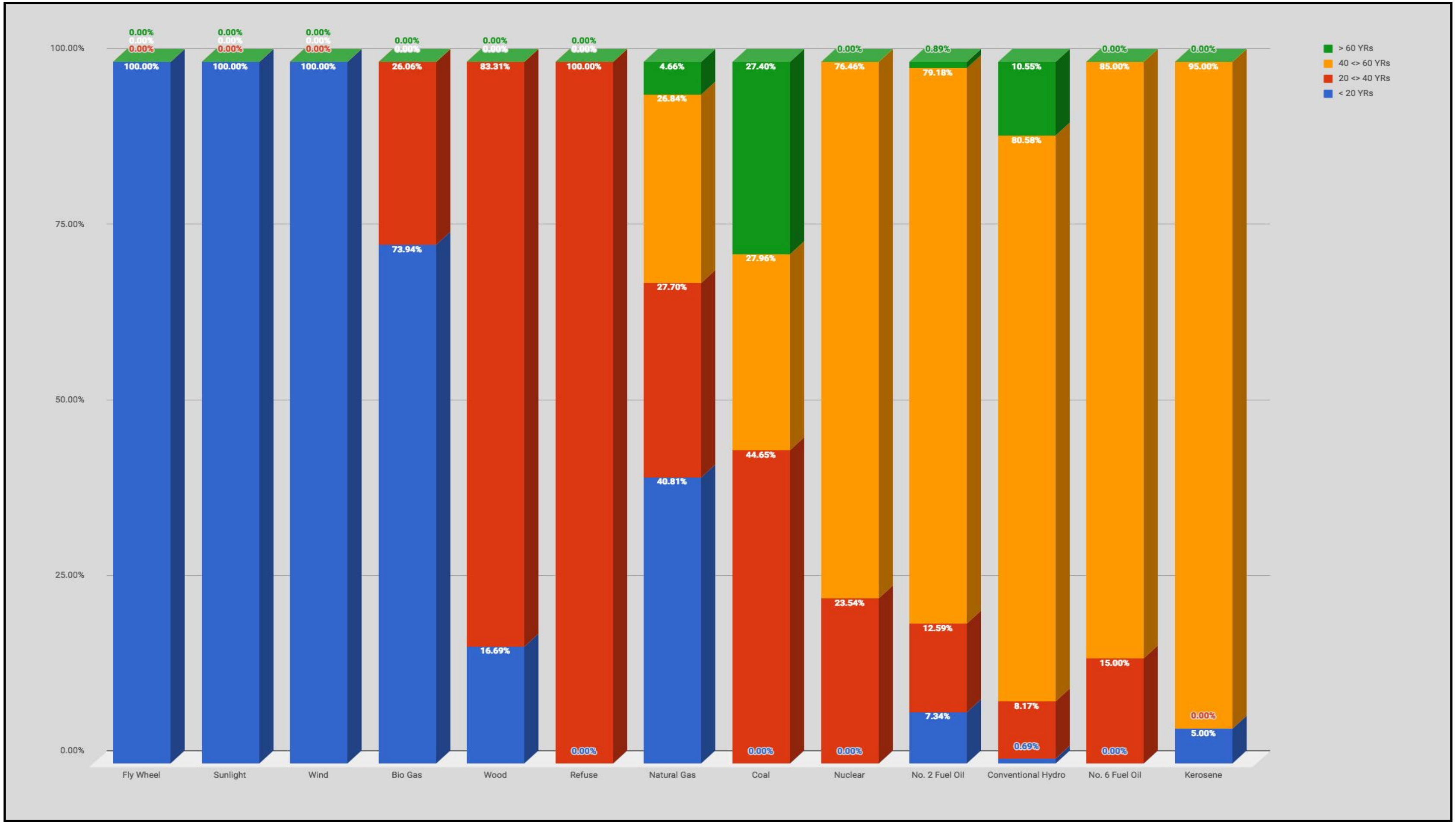

Figure 11: Average Age of Primary Fuel Type Fleets, Ranked by Respective Total Capacity Amounts

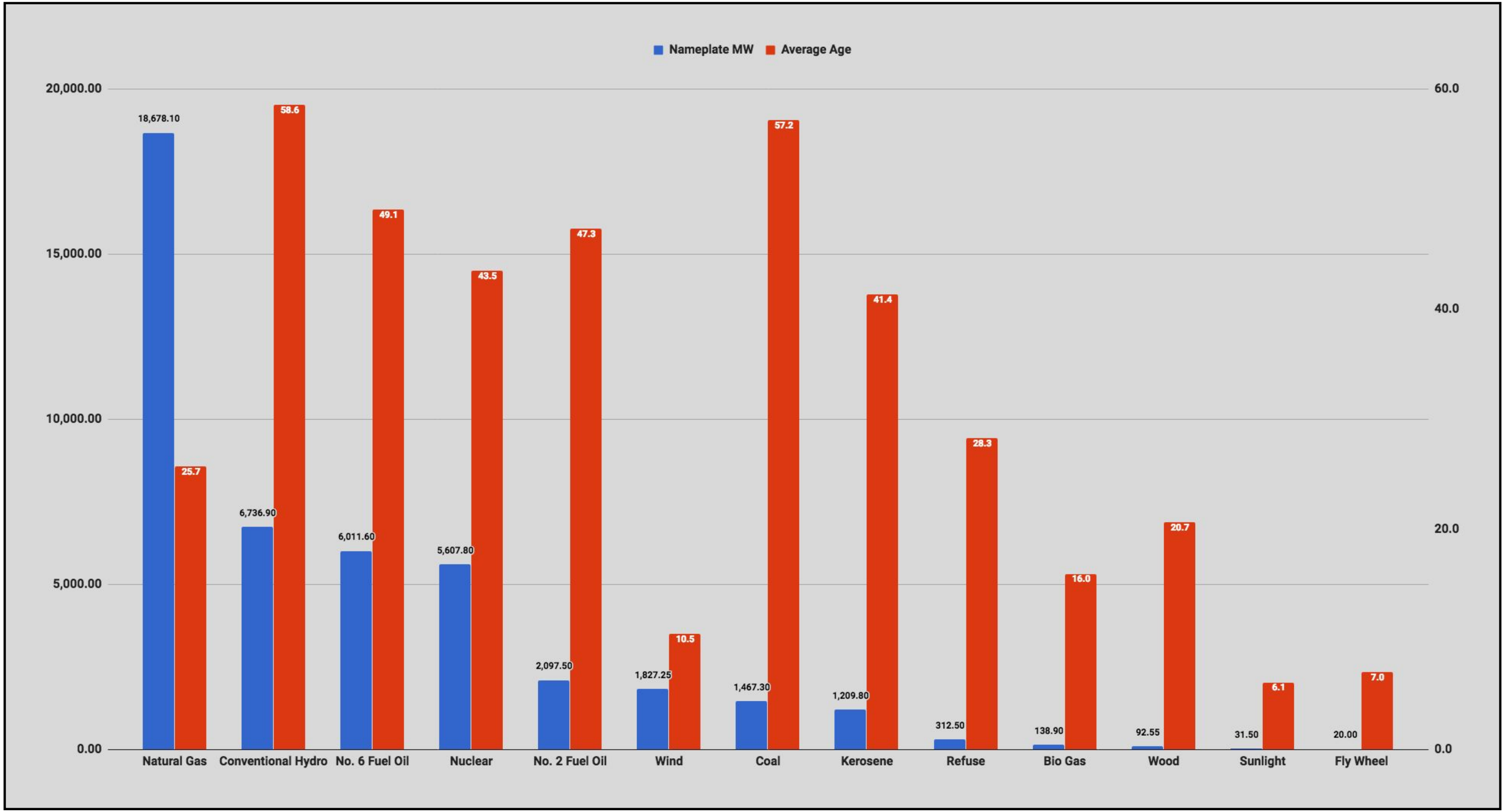

Figure 12: Expected Capacity Shortfall, Based on Closure Assumptions, by Zone

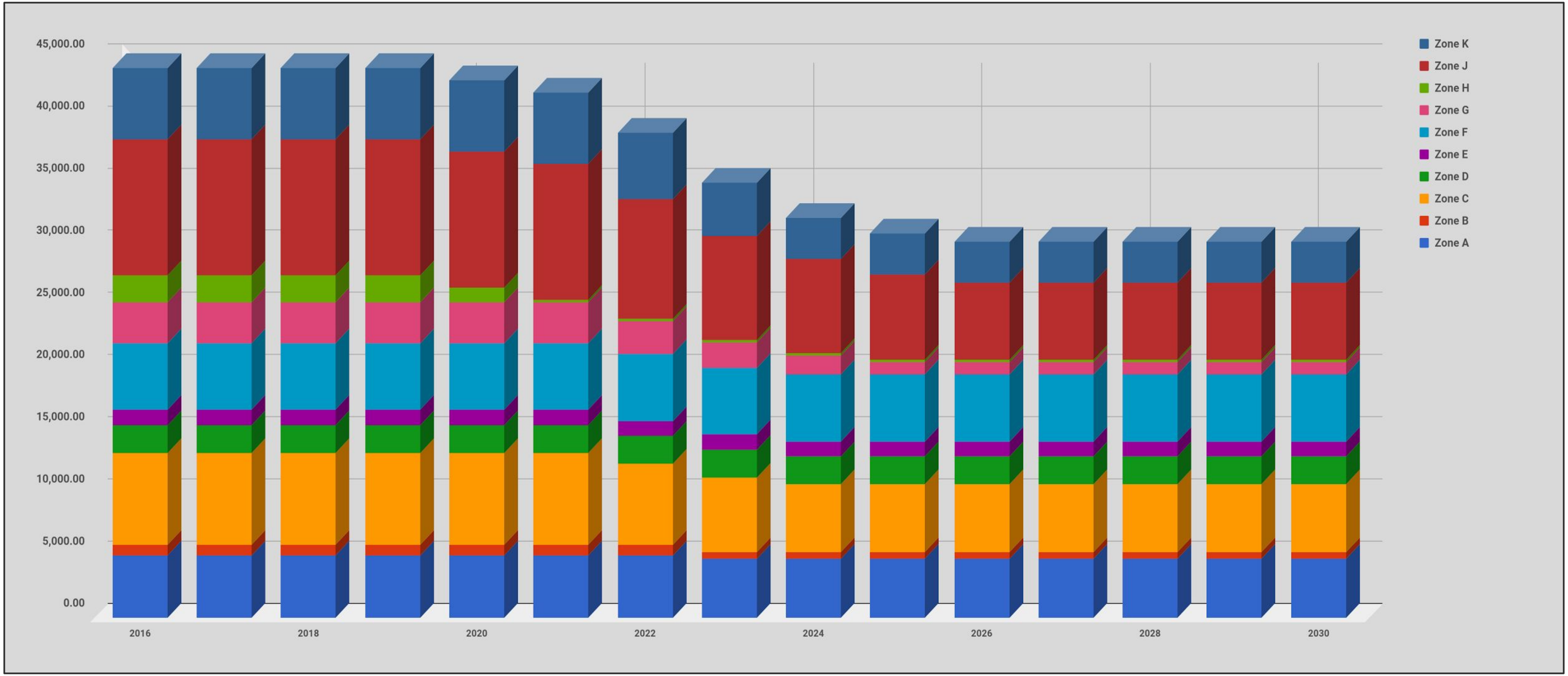

Figure 13: Expected Capacity Shortfall, Based on Closure Assumptions, by Primary Fuel Type

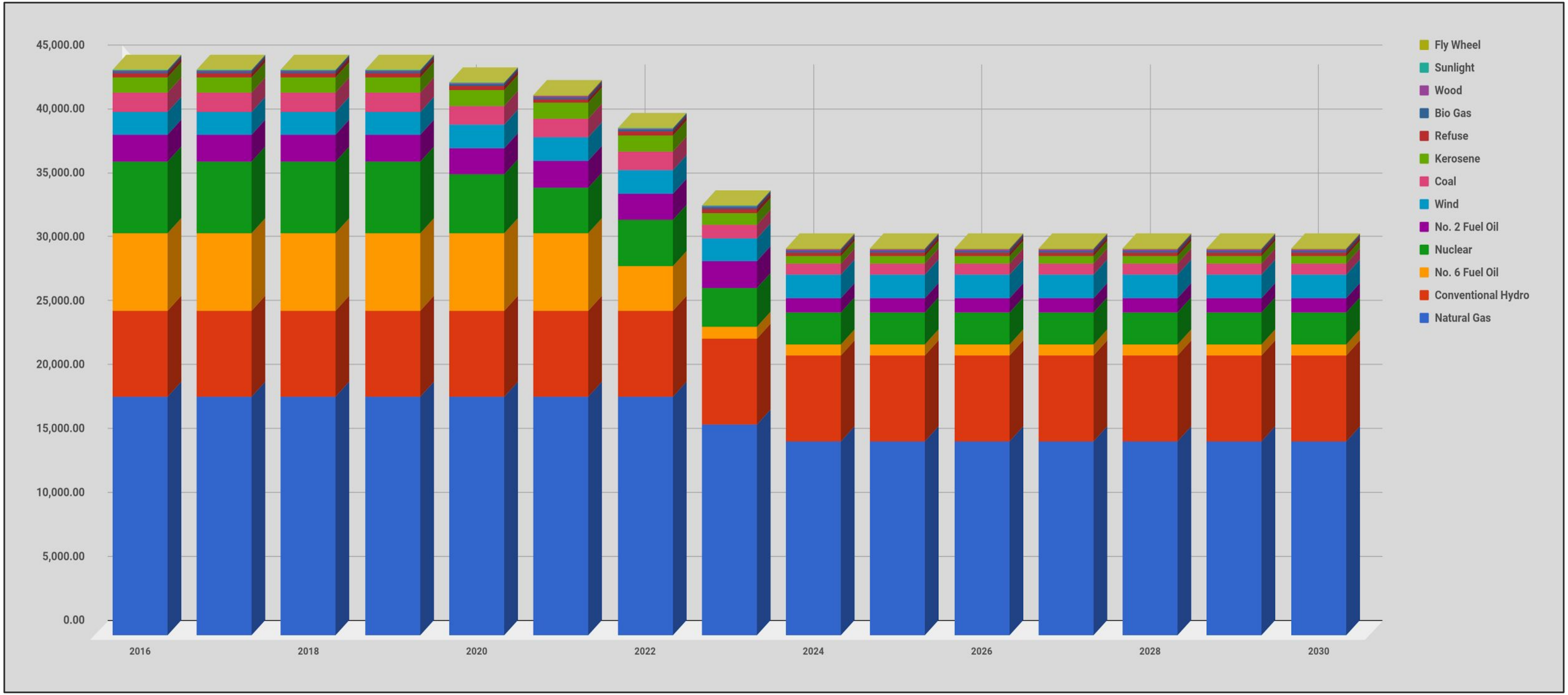

Table 1: Zone Totals to 2030, Based on Closure Assumptions

Zone Totals with Expected Closures	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Zone A	5,017.78	5,017.78	5,017.78	5,017.78	5,017.78	5,017.78	5,017.78	4,774.78	4,774.78	4,774.78	4,774.78	4,774.78	4,774.78	4,774.78	4,774.78
Zone B	841.52	841.52	841.52	841.52	841.52	841.52	841.52	534.52	534.52	534.52	534.52	534.52	534.52	534.52	534.52
Zone C	7,415.70	7,415.70	7,415.70	7,415.70	7,415.70	7,415.70	6,513.90	5,969.27	5,424.65	5,424.65	5,424.65	5,424.65	5,424.65	5,424.65	5,424.65
Zone D	2,238.12	2,238.12	2,238.12	2,238.12	2,238.12	2,238.12	2,238.12	2,238.12	2,238.12	2,238.12	2,238.12	2,238.12	2,238.12	2,238.12	2,238.12
Zone E	1,231.58	1,231.58	1,231.58	1,231.58	1,231.58	1,231.58	1,231.58	1,231.58	1,231.58	1,231.58	1,231.58	1,231.58	1,231.58	1,231.58	1,231.58
Zone F	5,360.00	5,360.00	5,360.00	5,360.00	5,360.00	5,360.00	5,360.00	5,360.00	5,360.00	5,360.00	5,360.00	5,360.00	5,360.00	5,360.00	5,360.00
Zone G	3,272.10	3,272.10	3,272.10	3,272.10	3,272.10	3,272.10	2,651.10	2,030.10	1,517.33	1,004.55	1,004.55	1,004.55	1,004.55	1,004.55	1,004.55
Zone H	2,209.70	2,209.70	2,209.70	2,209.70	1,209.70	209.70	209.70	209.70	209.70	209.70	209.70	209.70	209.70	209.70	209.70
Zone J	10,944.00	10,944.00	10,944.00	10,944.00	10,944.00	10,944.00	9,649.00	8,354.00	7,607.67	6,861.33	6,170.98	6,170.98	6,170.98	6,170.98	6,170.98
Zone K	5,701.00	5,701.00	5,701.00	5,701.00	5,701.00	5,701.00	5,325.00	4,305.04	3,285.09	3,285.09	3,285.09	3,285.09	3,285.09	3,285.09	3,285.09
Total	44,231.50	44,231.50	44,231.50	44,231.50	43,231.50	42,231.50	39,037.70	35,007.12	32,183.42	30,924.31	30,233.96	30,233.96	30,233.96	30,233.96	30,233.96

Blue Denotes #6 FO

Orange Denotes Aging FF Fleet

Denotes Indian Point Closure

Table 2: Primary Fuel Type Totals to 2030, Based on Closure Assumptions

Fuel Type with Expected Closures	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Natural Gas	18,678.10	18,678.10	18,678.10	18,678.10	18,678.10	18,678.10	18,678.10	16,472.83	15,137.26	15,137.26	15,137.26	15,137.26	15,137.26	15,137.26	15,137.26
Conventional Hydro	6,736.90	6,736.90	6,736.90	6,736.90	6,736.90	6,736.90	6,736.90	6,736.90	6,736.90	6,736.90	6,736.90	6,736.90	6,736.90	6,736.90	6,736.90
No. 6 Fuel Oil	6,011.60	6,011.60	6,011.60	6,011.60	6,011.60	6,011.60	3,456.70	901.80	901.80	901.80	901.80	901.80	901.80	901.80	901.80
Nuclear	5,607.80	5,607.80	5,607.80	5,607.80	4,607.80	3,607.80	3,607.80	3,035.26	2,462.71	2,462.71	2,462.71	2,462.71	2,462.71	2,462.71	2,462.71
No. 2 Fuel Oil	2,097.50	2,097.50	2,097.50	2,097.50	2,097.50	2,097.50	2,097.50	2,097.50	1,165.20	1,165.20	1,165.20	1,165.20	1,165.20	1,165.20	1,165.20
Wind	1,827.25	1,827.25	1,827.25	1,827.25	1,827.25	1,827.25	1,827.25	1,827.25	1,827.25	1,827.25	1,827.25	1,827.25	1,827.25	1,827.25	1,827.25
Coal	1,467.30	1,467.30	1,467.30	1,467.30	1,467.30	1,467.30	1,467.30	1,065.30	827.54	827.54	827.54	827.54	827.54	827.54	827.54
Kerosene	1,209.80	1,209.80	1,209.80	1,209.80	1,209.80	1,209.80	1,209.80	894.82	579.85	579.85	579.85	579.85	579.85	579.85	579.85
Refuse	312.50	312.50	312.50	312.50	312.50	312.50	312.50	312.50	312.50	312.50	312.50	312.50	312.50	312.50	312.50
Bio Gas	138.90	138.90	138.90	138.90	138.90	138.90	138.90	138.90	138.90	138.90	138.90	138.90	138.90	138.90	138.90
Wood	92.55	92.55	92.55	92.55	92.55	92.55	92.55	92.55	92.55	92.55	92.55	92.55	92.55	92.55	92.55
Sunlight	31.50	31.50	31.50	31.50	31.50	31.50	31.50	31.50	31.50	31.50	31.50	31.50	31.50	31.50	31.50
Fly Wheel	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Grand Total	44,231.70	44,231.70	44,231.70	44,231.70	43,231.70	42,231.70	39,676.80	33,627.11	30,233.96	30,233.96	30,233.96	30,233.96	30,233.96	30,233.96	30,233.96

Figure 14: Interconnection Queue by Project Type and Zone

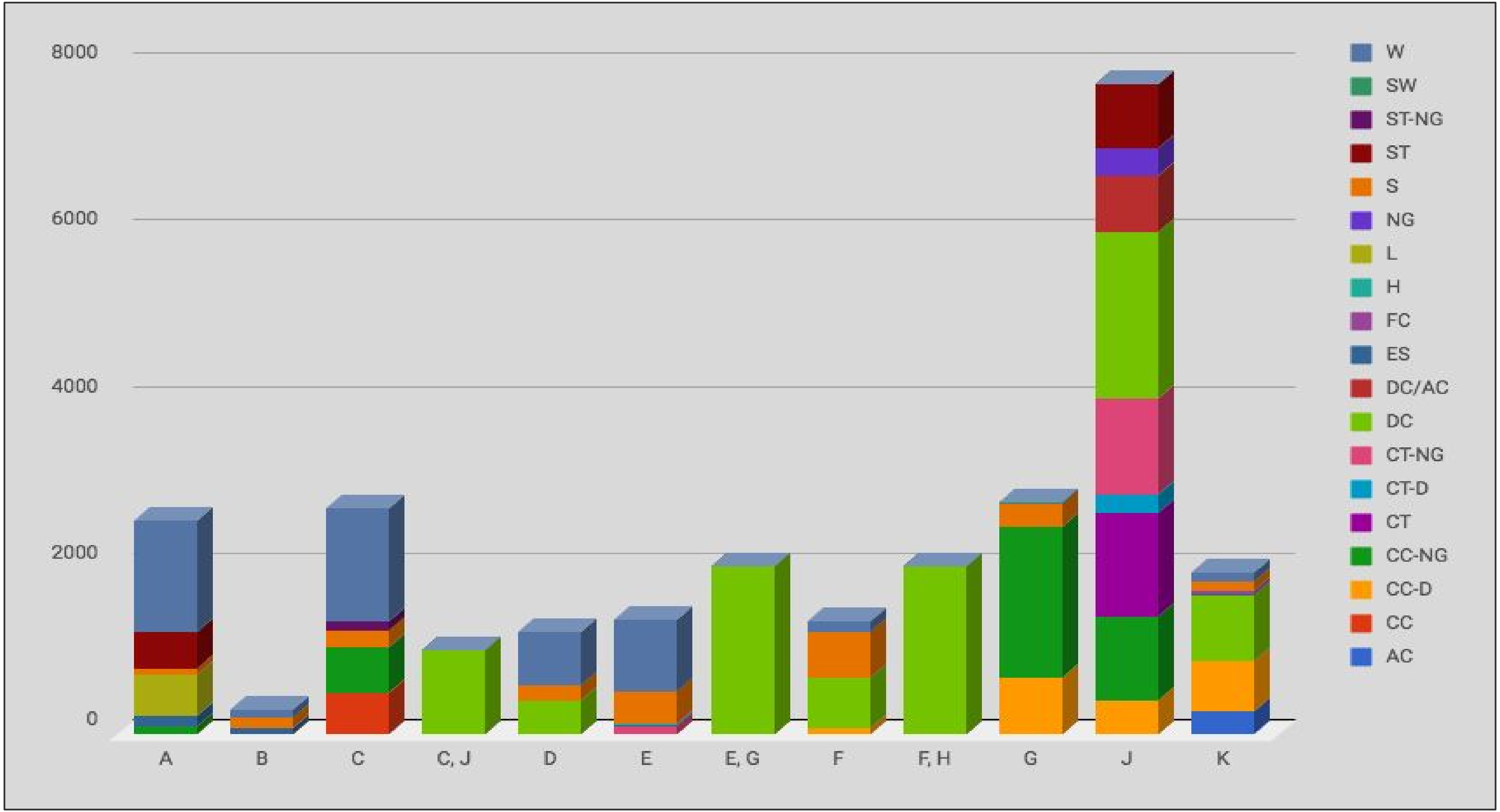

Figure 15: Percentage Breakdown of Interconnection Queue by Project Type

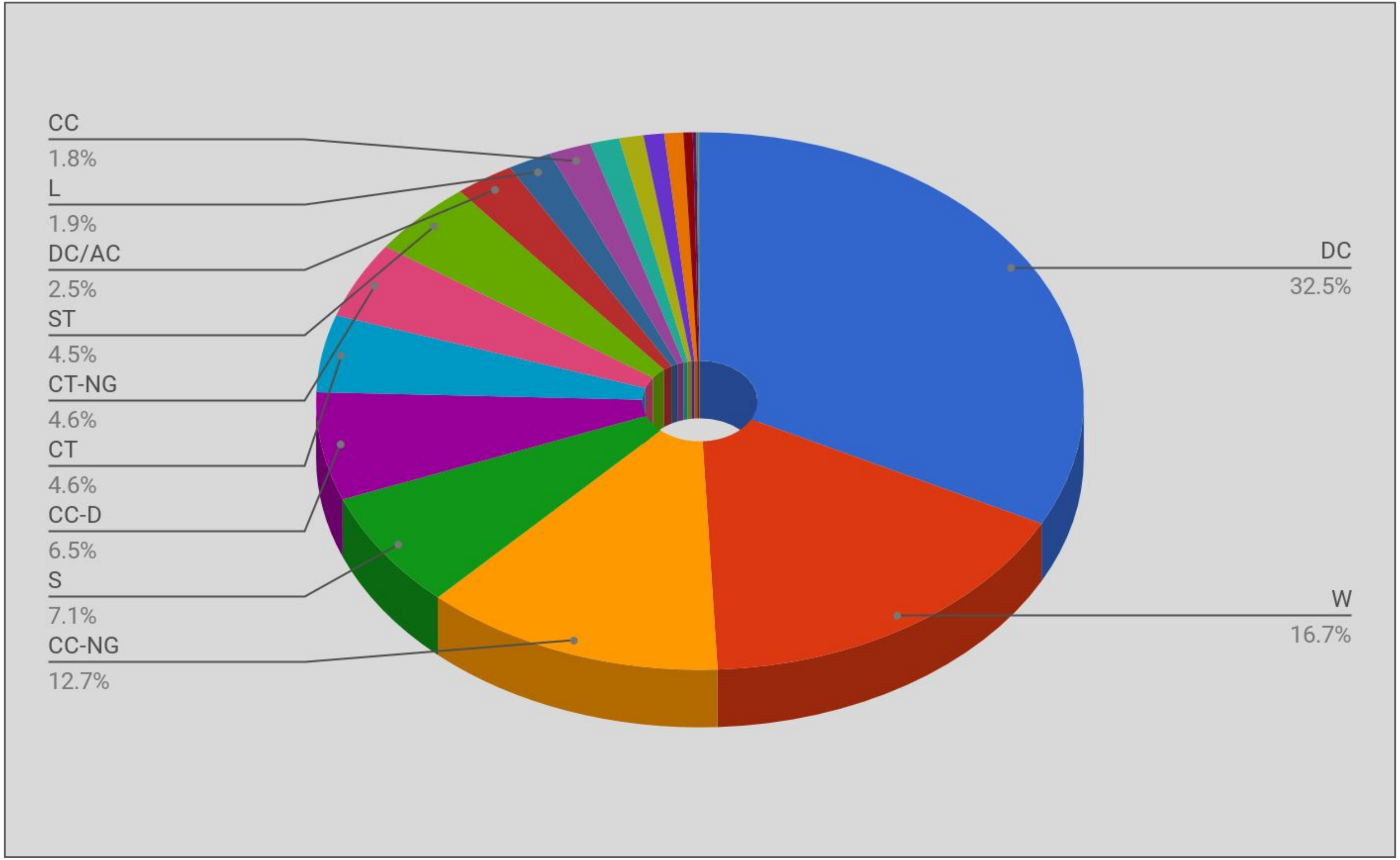

Figure 16: Zone Breakdown of Interconnection Queue by Year

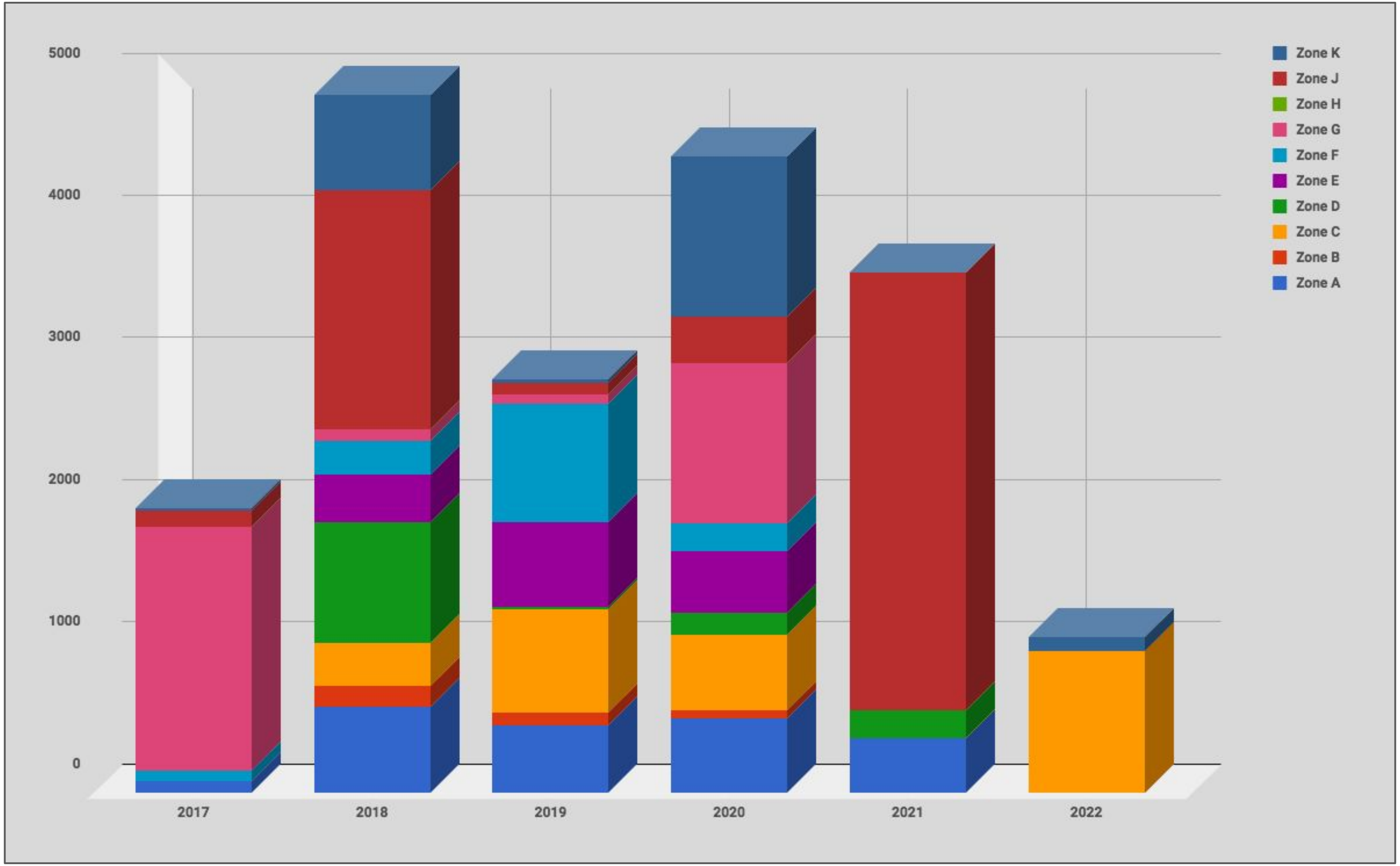

Table 3: Total Installed Capacity Mix by Zone to 2030, Based on Scenario Assumptions

Total Installed Capacity Mix by Zone	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Zone A	5,017.78	5,095.78	5,700.78	6,178.38	6,699.58	7,080.68	7,080.68	6,837.68	6,837.68	6,837.68	6,837.68	6,837.68	6,837.68	6,837.68	6,837.68
Zone B	841.52	841.52	987.82	1,072.52	1,134.52	1,134.52	1,134.52	827.52	827.52	827.52	827.52	827.52	827.52	827.52	827.52
Zone C	7,415.70	7,417.00	7,720.70	8,445.70	8,975.70	8,975.70	9,073.90	8,529.27	7,984.65	7,984.65	7,984.65	7,984.65	7,984.65	7,984.65	7,984.65
Zone D	2,238.12	2,238.12	3,087.12	3,107.12	3,257.12	3,457.12	3,457.12	3,457.12	3,457.12	3,457.12	3,457.12	3,457.12	3,457.12	3,457.12	3,457.12
Zone E	1,231.58	1,231.58	1,564.58	2,163.58	2,598.58	2,598.58	2,598.58	2,598.58	2,598.58	2,598.58	2,598.58	2,598.58	2,598.58	2,598.58	2,598.58
Zone F	5,360.00	5,432.00	5,670.00	6,499.80	6,699.80	6,699.80	6,699.80	6,699.80	6,699.80	6,699.80	6,699.80	6,699.80	6,699.80	6,699.80	6,699.80
Zone G	3,272.10	4,988.70	5,068.70	5,138.70	6,263.70	6,263.70	5,642.70	5,021.70	4,508.93	3,996.15	3,996.15	3,996.15	3,996.15	3,996.15	3,996.15
Zone H	2,209.70	2,209.70	2,209.70	2,209.70	1,209.70	209.70	209.70	209.70	209.70	209.70	209.70	209.70	209.70	209.70	209.70
Zone J	10,944.00	11,064.40	12,750.60	12,830.50	13,156.10	16,232.10	14,937.10	13,642.10	12,895.77	12,149.43	11,403.10	11,403.10	11,403.10	11,403.10	11,403.10
Zone K	5,701.00	5,711.00	6,382.50	6,401.00	7,532.30	7,532.30	7,251.80	6,231.84	5,211.89	5,211.89	5,211.89	5,211.89	5,211.89	5,211.89	5,211.89
Total	44,231.50	46,229.80	51,142.50	54,047.00	57,527.10	60,184.20	58,085.90	54,055.32	51,231.62	49,972.51	49,226.18	49,226.18	49,226.18	49,226.18	49,226.18

Table 4: Total Installed Capacity Mix by PRimary Fuel Type to 2030, Based on Scenario Assumptions

Total Installed Capacity Mix by Fuel Type	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Natural Gas	18,678.10	19,438.10	20,728.10	21,017.90	21,934.90	23,506.90	23,506.90	21,301.63	19,966.06	19,966.06	19,966.06	19,966.06	19,966.06	19,966.06	19,966.06
Conventional Hydro	6,736.90	6,736.90	6,736.90	6,736.90	6,736.90	7,612.72	7,612.72	7,612.72	7,612.72	7,612.72	7,612.72	7,612.72	7,612.72	7,612.72	7,612.72
No. 6 Fuel Oil	6,011.60	6,011.60	6,011.60	6,011.60	6,011.60	6,011.60	3,456.70	901.80	901.80	901.80	901.80	901.80	901.80	901.80	901.80
Nuclear	5,607.80	5,607.80	5,607.80	5,607.80	4,607.80	3,607.80	3,607.80	3,035.26	2,462.71	2,462.71	2,462.71	2,462.71	2,462.71	2,462.71	2,462.71
No. 2 Fuel Oil	2,097.50	2,097.50	2,097.50	2,097.50	2,097.50	2,097.50	2,097.50	2,097.50	1,165.20	1,165.20	1,165.20	1,165.20	1,165.20	1,165.20	1,165.20
Wind	1,827.25	1,905.25	2,838.25	4,497.25	5,663.25	6,244.35	6,339.85	6,339.85	6,339.85	6,339.85	6,339.85	6,339.85	6,339.85	6,339.85	6,339.85
Coal	1,467.30	1,467.30	1,467.30	1,467.30	1,467.30	1,467.30	1,467.30	1,065.30	827.54	827.54	827.54	827.54	827.54	827.54	827.54
Kerosene	1,209.80	1,209.80	1,209.80	1,209.80	1,209.80	1,209.80	1,209.80	894.82	579.85	579.85	579.85	579.85	579.85	579.85	579.85
Refuse	312.50	312.50	312.50	312.50	312.50	312.50	312.50	312.50	312.50	312.50	312.50	312.50	312.50	312.50	312.50
Bio Gas	138.90	138.90	138.90	138.90	138.90	138.90	138.90	138.90	138.90	138.90	138.90	138.90	138.90	138.90	138.90
Wood	92.55	92.55	92.55	92.55	92.55	92.55	92.55	92.55	92.55	92.55	92.55	92.55	92.55	92.55	92.55
Sunlight	31.50	31.50	31.50	31.50	31.50	31.50	31.50	31.50	31.50	31.50	31.50	31.50	31.50	31.50	31.50
Fly Wheel	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Imported Power (Hydro Source)			400	1000	3775	7775	8775	8775	8775	8775	8775	8775	8775	8775	8775
Grand Total	44,231.70	45,069.70	47,692.70	50,241.50	54,099.50	60,128.42	58,669.02	52,619.33	49,226.18	49,226.18	49,226.18	49,226.18	49,226.18	49,226.18	49,226.18

Figure 17: 2030 Installed Capacity Mix by Zone, Based on Scenario Assumption

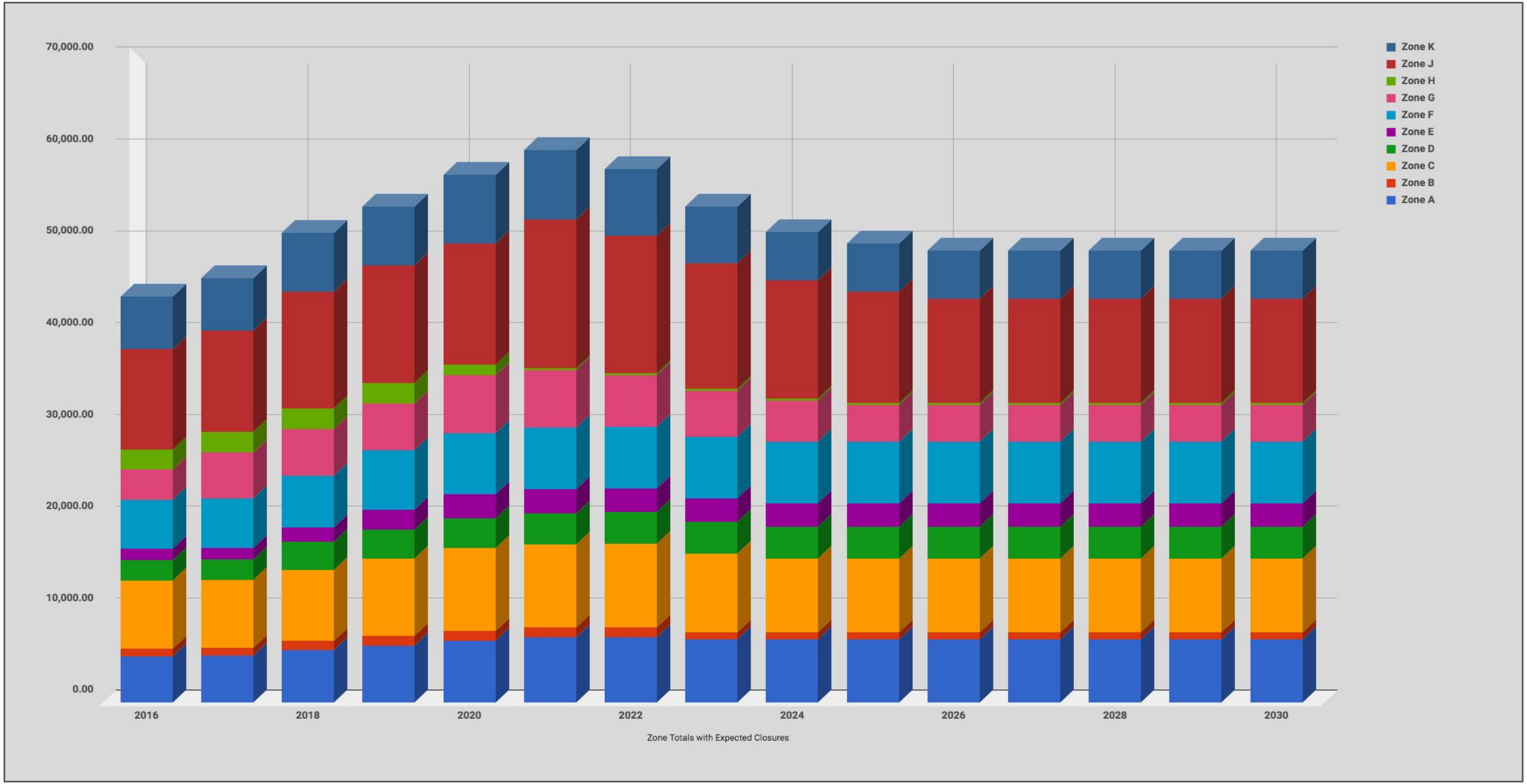

Figure 18: 2030 Installed Capacity Mix by Primary Fuel Type, Based on Scenario Assumption

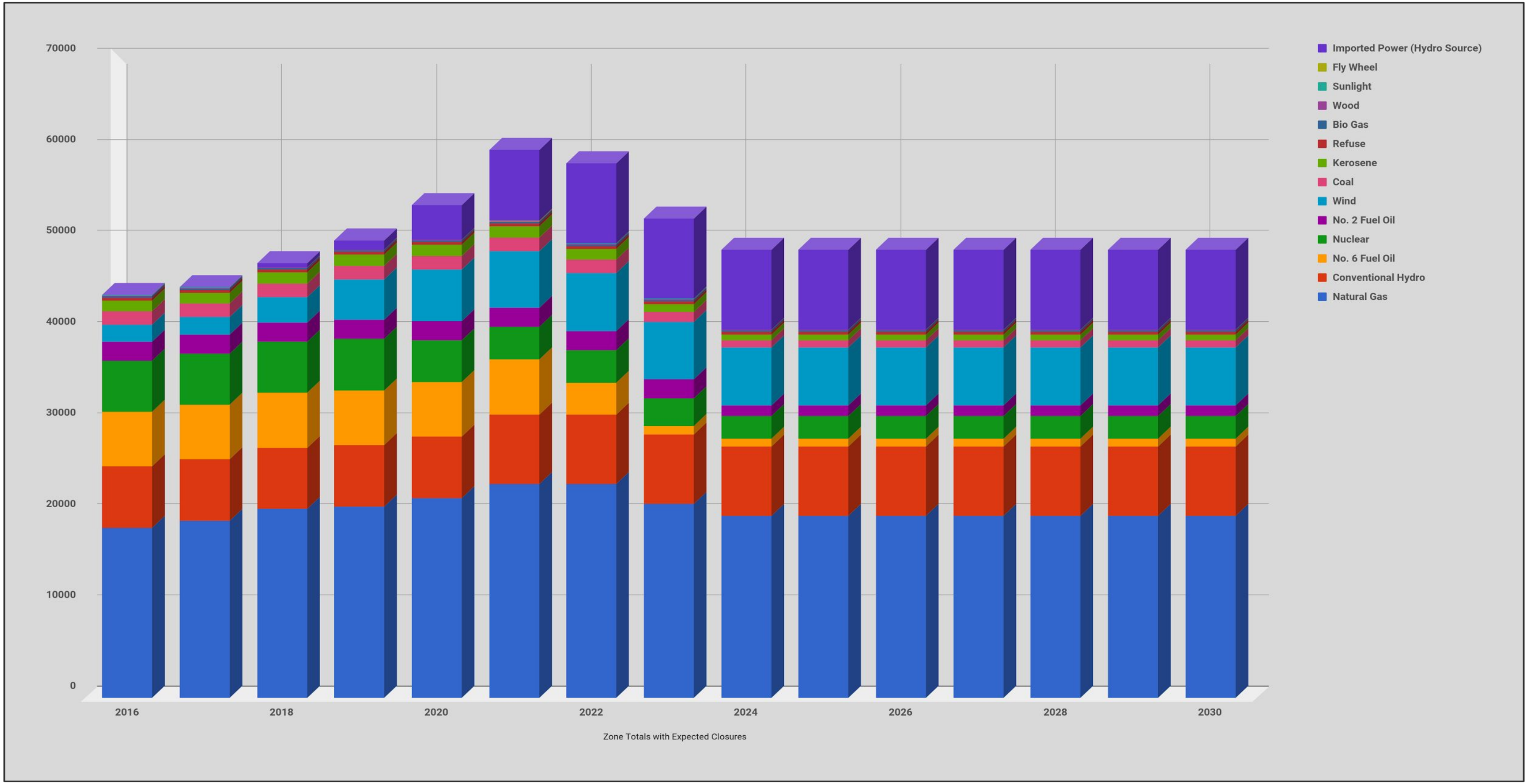

Figure 19: 2030 Installed Capacity Mix by Percentage of Primary Fuel Type, Based on Scenario Assumption