Study on Member State Notifications on Investment Projects in Energy Infrastructure, according to Regulation (EU) 256/2014

Prepared by Platts Analytics Consulting for the European Commission

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Overview

Member states were required to submit data on each subsector under Regulation 256: existing infrastructure, nonoperational infrastructure, infrastructure currently under construction, planned infrastructure with a final investment decision (FID), total additions to be commissioned, both under construction and projects with FID, by time frame of completion, either 0-2 years or 3-5 years, infrastructure to be decommissioned in the same time frame, and any projects related to the European Unions' Trans-European Network (TEN-E) strategy to strengthen EU energy interconnectivity.

The year 2015 was the third reporting period since the Regulation was implemented. Member-state participation in the Regulation in 2015 was the strongest since the Regulation was implemented, with only seven member states (Croatia, France, Germany, Italy, Luxembourg, Malta, and Slovenia), reporting no information. In the prior two reporting periods in 2011 and 2014, 16 and 17 member states, respectively, did not report. Additionally, reporting member states reported far more complete and accurate data than they historically reported under the Regulation.

The Regulation allows for data-reporting exceptions under the Regulation 617/2010 provision that aims to avoid placing undue inconvenience on the member states if they have already reported similar data to sources such as Euratom or ENTSO.

Platts Analytics was tasked to compare the member-state data with that of benchmark, or third-party, independent sources, both publically-available and proprietary to Platts. Platts utilized Platts' a variety of datasets for comparison: its proprietary crude oil refinery and crude oil pipeline databases, as well as information from the International Energy Agency (IEA), to analyze reported crude oil infrastructure data; the European Network of Transmission System Operators for Gas (ENTSO-G) and Gas Infrastructure (GIE) to analyze reported natural gas infrastructure data; Platts' proprietary Powervision product that tracks power generation in Europe, as well as data from the European Network of Transmission System Operators for Electricity (ENTSO-E), to analyze reported electricity infrastructure; ePURE and the European Biodiesel Board (EBB) to analyze reported biofuels infrastructure; and Platts' proprietary internal information collective to analyze carbon capture and storage (CCS) transport and storage infrastructure. The benchmark data was supplemented by primary research performed by Platts and the expert knowledge of Platts.

Platts' Conclusions

The data obtained from European Union member states provide much-needed transparency in a number of energy infrastructure sectors in Europe. Some of the information reported by member states, particularly the oil infrastructure, electricity transmission, and biofuels data, provides data and information not publically available. The data reported by member states in these sectors during this reporting period is valuable and enhances transparency in the sector, but could be improved with greater participation amongst member states. A majority of Europe's electricity and natural gas sectors are tracked by independent organizations and are already quite transparent. Some of the data reported by these independent organizations are more granular than the data-reporting requirement of the European Union. Because member states already report this data to independent organizations, the member states are exempt from reporting unless additional data is added in the submission pursuant to the reporting requirements.

Overall, Platts believes that the data obtained from European Union member states in this reporting period contributes little useful information to the Commission. The data, as is, does not contribute to a better understanding of European infrastructure or the potential gaps in European infrastructure. Despite the relatively high participation rate and relative accuracy of the reported data, without participation from the key member states in the European energy market, in particular Germany, France, and Italy, the data fails to provide comprehensive analysis of European infrastructure as a whole.

Accuracy of Member-State Data by Dataset -- Existing Infrastructure														
	O1	O2	O3	O4	G1	G2	G3	G4	E1	E2	E3	B1	C1	C2
Austria	Y	Y	Y	N	DNR	DNR	n/a	Y	Y	N	Y	Y	n/a	n/a
Belgium	DNR	n/a	DNR	DNR	DNR	DNR	DNR	Y	Y	Y	N	Y	n/a	n/a
Bulgaria	Y	N	n/a	N	Y	Y	n/a	Y	Y	Y	Y	DNR	n/a	n/a
Croatia	DNR	DNR	DNR	DNR	DNR	DNR	n/a	DNR	DNR	DNR	DNR	DNR	n/a	n/a
Cyprus	n/a	n/a	n/a	N	n/a	n/a	n/a	n/a	Y	Y	n/a	DNR	n/a	n/a
Czech Republic	Y	Y	Y	N	Y	N	Y	N	Y	Y	N	Y	Y	Y
Denmark	Y	N	Y	Y	Y	N	Y	Y	Y	N	Y	DNR	Y	Y
Estonia	n/a	n/a	n/a	DNR	DNR	DNR	n/a	n/a	DNR	Y	Y	DNR	n/a	n/a
Finland	Y	Y	n/a	Y	Y	Y	Y	n/a	Y	Y	Y	Y	n/a	n/a
France	DNR	DNR	DNR	DNR	DNR	DNR	DNR	DNR	DNR	DNR	DNR	DNR	DNR	DNR
Germany	DNR	DNR	DNR	DNR	DNR	DNR	n/a	DNR	DNR	DNR	DNR	DNR	DNR	DNR
Greece	Y	N	Y	Y	Y	Y	Y	n/a	DNR	DNR	DNR	Y	n/a	n/a
Hungary	Y	Y	Y	N	Y	DNR	n/a	Y	N	Y	DNR	Y	n/a	n/a
Ireland	n/a	n/a	n/a	DNR	DNR	DNR	n/a	Y	Y	Y	Y	N	n/a	n/a
Italy	DNR	DNR	DNR	DNR	DNR	DNR	DNR	DNR	DNR	DNR	DNR	DNR	n/a	n/a
Latvia	n/a	Y		DNR	Y	Y	n/a	Y	Y	Y	Y	DNR	n/a	n/a
Lithuania	DNR	DNR	DNR	N	N	N	Y	n/a	Y	N	N	DNR	n/a	n/a
Luxembourg	n/a	n/a	n/a	DNR	DNR	n/a	n/a	n/a	DNR	n/a	DNR	n/a	n/a	n/a
Malta	n/a	n/a	n/a	DNR	n/a	n/a	n/a	n/a	DNR	n/a	n/a	n/a	n/a	n/a
Netherlands	Y	DNR	N	Y	DNR	DNR	Y	N	Y	Y	DNR	Y	N	Y
Poland	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	DNR	n/a	n/a
Portugal	Y	Y	n/a	Y	Y	N	Y	Y	Y	Y	N	Y	n/a	n/a
Romania	DNR	N	DNR	DNR	Y	Y	n/a	Y	Y	N	Y	Y	n/a	n/a
Slovakia	Y	Y	N	Y	N	Y	n/a	Y	N	Y	Y	Y	n/a	n/a
Slovenia	n/a	n/a	n/a	Y	Y	Y	n/a	n/a	Y	Y	Y	DNR	n/a	n/a
Spain	DNR	DNR	Y	N	Y	Y	Y	Y	DNR	Y	N	N	n/a	n/a
Sweden	Y	n/a	n/a	Y	Y	N	Y	N	Y	N	Y	Y	n/a	n/a
United Kingdom	N	N	Y	N	DNR	DNR	DNR	DNR	Y	Y	Y	Y	Y	Y

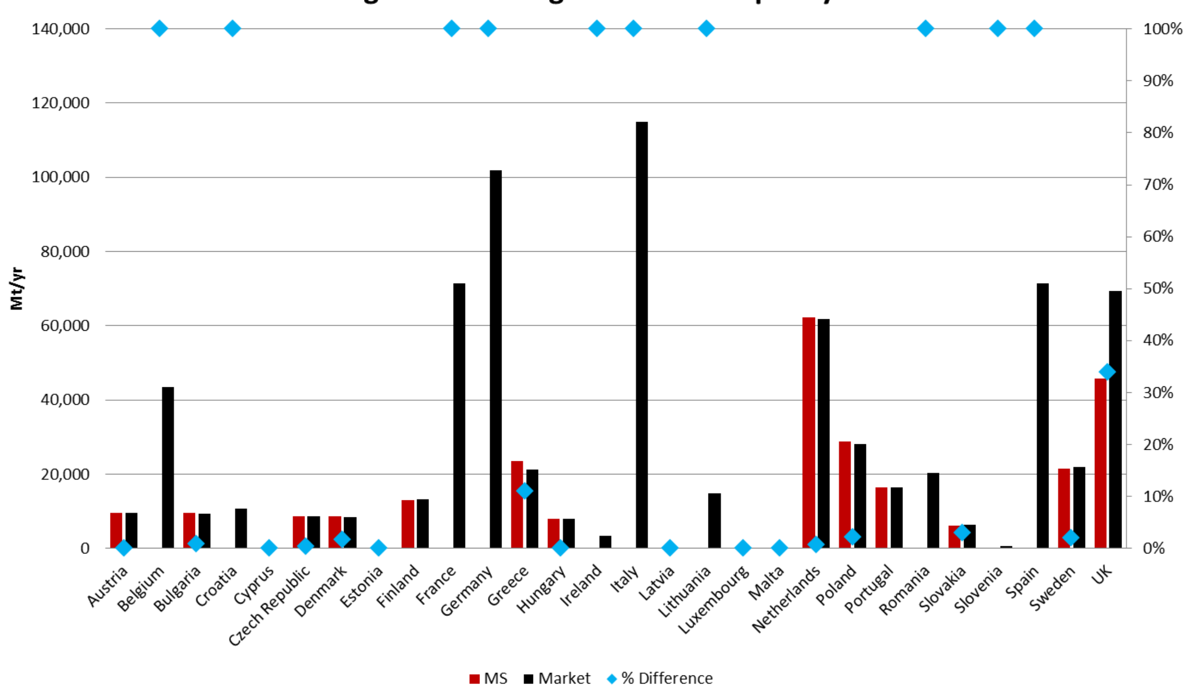
The table above summarizes the accuracy of the member-state data by member state and category with cells highlighted in gray marking missing data. Cells marked "Y" indicate that the member state has reported mostly or entirely accurate data as verified by third-party data sources. Cell marked "N" indicate that the member state has reported mostly or entirely inaccurate data as verified by third-party data sources or if the member state reporting included a major error that affects overall understanding of energy infrastructure in the member state. Cells marked "DNR" indicate that the member state did not report energy infrastructure in the given category, though third-party data sources indicate that the member state does have applicable infrastructure. Finally, cells marked "N/A" indicated that the member state did not report, but third-party data sources indicate that member state does not have applicable infrastructure.

O1 – Oil Refining

State of the European Refinery Infrastructure

With the collapse in global crude prices, European refineries once again became profitable after years of barely profitable margins. As global feedstock prices fell and refined product prices remained high, refinery margins in Europe grew fourfold, calling into question the number of refineries idled earlier in the decade. The number of operating refineries in Europe is unlikely to decline further, or grow substantially. However, European refineries have embarked on a number of refinery upgrades to optimize operations and, in particular, to consume additional volumes of heavy crude, as the simplest of refineries have failed to remain economic even with low feedstock prices. Upgrades and construction of more complex refining units are likely to continue to be the more economic changes made to sustain refinery operations in Europe. Higher margins have provided the necessary profits to reinvest in certain refineries. Meanwhile, refinery closures throughout the middle of the decade have, to some extent, remedied the oversupply of refining capacity in Europe. Some European refineries are still up for sale and at risk of being idled, especially if they are of relatively simple configuration.

Figure 1: Existing Distillation Capacity



Comparison of Member-State Data to Third-Party Sources

Under the Regulation, member states are required to report, in thousand tonnes per year (Mt/yr), the capacity of distillation plants with a capacity of greater than one million tonnes per year and any extension of distillation capacity, capacity of reforming and cracking plants with a minimum capacity of 500 tonnes per year, and the capacity of desulphurization plants for residual fuel, gas oil, feedstock, and other petroleum products.

Thirteen of the 28 member states reported 259,501 Mt/yr of atmospheric distillation refining capacity. Of the total distillation capacity of European refineries, the thirteen member states reported 100,913 Mt/yr of vacuum distillation. The member states also reported 33,423 Mt/yr of thermal cracking capacity, 72,461 Mt/yr of catalytic cracking, 38,784 Mt/yr of reforming capacity, and 169,485 MT/yr of desulphurization capacity. Member states report cumulative alkylation, polymerization, and isomerization capacity as 7,110 Mt/yr and total etherification (MTBE,TAME, ETBE, etc.) as 2,179 Mt/yr.

Of the member states that reported data, the reported data was mostly accurate when compared to the third-party source, Platts' refinery database. The Platts refinery database is a comprehensive collection of global refineries, tracking nameplate capacity and capacities of the various and complex units of refineries all over the world. Platts used the Platts' refinery database to compare member state-reported data and assess the accuracy of the reported data, as well as collect refinery unit capacities for member states that did not report refinery capacity data.

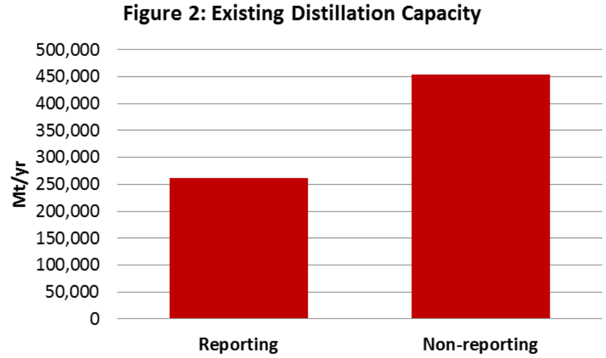
Platts was unable to verify which facilities had carbon capture and storage (CCS) capabilities as that information is not readily available, nor does it significantly impact the analysis of European infrastructure.

Some member states provided additional information on their refinery capacity. The Czech Republic and Bulgaria, for example, noted that their catalytic cracking capacity is from a Fluid Catalytic Cracker (FCC) unit. Portugal reported FCC capacity and hydrocracking capacity of 2,126 Mt/yr and 2,314 Mt/yr, respectively, when reporting catalytic cracking capacity. Sweden reported FCC capacity and hydrocracking capacity of 1,800 Mt/yr and 2,900 Mt/yr, respectively, when reporting catalytic cracking capacity. Poland reports its catalytic cracking capacity as catalytic cracking, hydrocracking, and other cracking.

Austria reported isomerization capacity and platformate capacity of 913 Mt/yr and 432 Mt/yr, respectively, when reporting reforming capacity. Portugal reports its reforming capacity as platformate capacity and reports its desulphurization capacity by refined product (gasoil, naphtha/gasoline, VGO).

Many of the small discrepancies in the data can be attributed to rounding errors and unit conversions, as the Platts' refining databases tracks many refinery capacities in barrels per day, as opposed to the thousand tonnes per year reported by member states. Platts assumes that a 2% difference or less between member-state data and third-party data implies the member-state data has been verified as correct.

Figure 2: Existing Distillation Capacity



Individual Member-State Reporting

Austria reported nearly complete data on its single Schewchat refinery, according to Platts' refinery database. Austria reported the capacity of some of its refinery units in million tonnes per year, rather than the thousand tonnes per year metric suggested by the Regulation, but upon correction, Platts confirms operating capacities of refinery units reported by the member state. Austria provided useful, additional information on cracking capacity such as carbonization capacity and "other" cracking capacity, as well as isomerization and platformate reforming capacity. Through primary research, Platts can affirm that there are no publicly announced refinery upgrades, renovations, new builds, or decommissioning in Austria.

Bulgaria reports its single refinery in Burgas has a total capacity of 9,520 Mt/yr, which is comparable to Platts' refinery database's 9,461 Mt/yr estimate. Bulgaria reports that 2,800 Mt/yr of atmospheric distillation capacity and 600 Mt/yr of desulphurization is non-operational. Platts is unable to verify if this capacity is actually non-operational. Bulgaria reports its vacuum distillation capacity as "A 040," an unclear indicator of capacity, but Platts' refinery database estimates that vacuum distillation capacity is about 3,829 Mt/yr. Bulgaria also reports that Burgas' thermal cracking capacity of 1,600 Mt/yr is slated for decommissioning in the next 0-2 years, but Platts cannot confirm the project. Platts can confirm the 2,500 Mt/yr-hydrocracking project that Bulgaria currently reports as under construction. The project was completed in May 2015 and also included a sulfur recovery unit. Platts confirms operating capacities of the remaining refinery units reported by the member state. Through primary research, Platts can affirm that there are no further publicly announced refinery upgrades, renovations, new builds, or decommissioning in Bulgaria beyond the projects mentioned above.

The **Czech Republic** reported nearly complete data on its two refineries at Kralupy and Litvinov. Platts' refinery databases estimates total refining capacity at 8,664 Mt/yr for the Czech Republic, very near the 8,699 Mt/yr reported by the member state. Platts also confirms operating capacities of refinery units reported by the member state. The Czech Republic included additional, useful information in their reporting, noting that their catalytic cracking capacity is from a Fluid Catalytic Cracker (FCC) unit.

The Czech Republic reports that 720 Mt/yr of vacuum distillation capacity is non-operational. Platts has been unable to confirm this operational status through primary research. However, the Litvinov refinery recently underwent upgrades to its vacuum distillation unit (VDU), increasing capacity to 2,000 Mt/yr. Platts' refinery database does not track any vacuum distillation capacity for the Kralupy refinery. Therefore, it can be assumed that the additional 796 Mt/yr reported by the member state beyond the VDU capacity of Litvinov, can be attributed to the Kralupy refinery, which is no longer operational. Through primary research, Platts can affirm that there are no publicly announced refinery upgrades, renovations, new builds, or decommissioning in the Czech Republic.

Denmark reported nearly complete data on its two refineries at Fredericia and Kalundborg. Platts' refinery database estimates total refining capacity at 8,515 Mt/yr, very near the 8,659 Mt/yr reported by the member state. Platts also confirms operating capacities of refinery units reported by the member state. Through primary research, Platts can affirm that there are no publicly announced refinery upgrades, renovations, new builds, or decommissioning in Denmark.

Finland reported nearly complete data on its two refineries at Naantali and Porvoo. Platts' refinery database estimates total refining capacity at 13,146 Mt/yr for Finland, very near the 13,126 Mt/yr reported by the member state. Platts also confirms operating capacities of refinery units reported by the member state. Through primary research, Platts can confirm that an additional 650 Mt/yr of reforming capacity is under construction, as reported by the member state, at the Porvoo refinery. The new hydrogen reformer is expected to begin operations in May 2016. Platts can affirm that there are no further publicly announced refinery upgrades, renovations, new builds, or decommissioning in Finland.

Data reported from **Greece** differs significantly from Platts' refinery database. Platts' refinery database estimates total refining capacity at 21,312 Mt/yr, while the member state reports distillation capacity at 23,653 Mt/yr, a difference of nearly 10%. Platts is currently assuming that Greece's Thessaloniki refinery is closed or idled. The Thessaloniki refinery was idled briefly during a period of low product prices that made operations at the refinery uneconomic, but Hellenic Petroleum indicates that the refinery is still in operation. The member state data could be including the Thessaloniki refinery, which Platts' estimates at a capacity of 4,133 Mt/yr. However, if Platts includes the Thessaloniki refinery in its estimates, total refining capacity increases to 25,445 Mt/yr, which far exceeds the member state-reported capacity. In the event that the member state is not including the Thessaloniki refinery due to its idling or closure, Platts's estimated capacity could be slightly lower than reported data due to varying public estimates of Greece's three operating refineries. Platts estimates that the Agii Theordori refinery has a capacity of 8,963 Mt/yr, but Motor Oil has indicated that the refinery is capable of refining crude in excess of 8,963 Mt/yr and has also reported capacity as 9,212 Mt/yr. Platts estimates the Aspropygros refinery has a capacity of 7,370 Mt/yr, but alternative sources have reported capacity at 7,967 Mt/yr. Finally, Hellenic Petroleum has announced that their Elefsis refinery often operates beyond its reported 4,980 Mt/yr-capacity.

Capacities of refinery units reported by the member state are also slightly higher than Platts' refinery database estimates, likely due to one of the reasons mentioned above. Through primary research, Platts can affirm that there are no publicly announced refinery upgrades, renovations, new builds, or decommissioning in Greece.

Hungary reported nearly complete data on its single Duna refinery, according to Platts' refinery database. Platts also confirms operating capacities of refinery units reported by the member state. Platts can affirm that there are no publicly announced refinery upgrades, renovations, new builds, or decommissioning in Hungary.

The Netherlands reported nearly complete data on its six refineries, according to Platts' refinery database. Platts also confirms operating capacities of refinery units reported by the member state. Platts can affirm that there were no publicly announced refinery upgrades, renovations, new builds, or decommissioning in The Netherlands as of member-state reporting. Since member states reported in 2014, a number of upgrades to Dutch refineries have been announced, including an expansion of a hydrocracking unit at ExxonMobil's Rotterdam refinery and a new solvent deasphalter unit at Shell's Pernis refinery.

Poland member-state data was reported in Polish, hindering complete understanding of the submitted data. To the extent Platts was able to interpret the data, Poland reported nearly complete data on its two refineries with capacity greater than a million tonnes per year. Platts' refinery databases estimates total refining capacity at 28,184 Mt/yr for Poland, very near the 28,793 Mt/yr reported by the member state. Platts also confirms operating capacities of refinery units reported by the member state. Poland provided useful, additional information in its report, reporting its catalytic cracking capacity as catalytic cracking, hydrocracking, and other cracking. Though not explicitly stated, Platts finds that Poland's reported hydrocracking capacity of 1,587 Mt/yr roughly matches that of Platts' refinery database of FCC capacity. Platts can affirm that there are no publicly announced refinery upgrades, renovations, new builds, or decommissioning in Poland.

Portugal reported nearly complete data on its two refineries, the Porto and Sines refineries, according to Platts' refinery database. However, errors in the reporting data hinder the aggregation of European refinery capacity. Portugal reports the capacity of its refinery units in barrels per day, rather than the thousand tonnes per year suggested by the Regulation. Portugal provided useful, additional information in its report. Portugal reported FCC capacity and hydrocracking capacity of 2,126 Mt/yr and 2,314 Mt/yr, respectively, when reporting catalytic cracking capacity, clarified that its thermal cracking capacity stemmed from visbreaking units, and provided capacities for desulphurization of gasoil, naphtha/gasoline, and vaccum gas oil. Platts can affirm that there are no publicly announced refinery upgrades, renovations, new builds, or decommissioning in Portugal.

Slovakia member-state data was reported in Slovakian, hindering complete understanding of the submitted data. To the extent Platts was able to interpret the data, Slovakia reported nearly complete data on its sole refinery in Bratislava. Platts' refinery databases estimates total refining capacity at 6,075 Mt/yr for Slovakia, very near the 6,278 Mt/yr reported by the member state. Platts also confirms operating capacities of refinery units reported by the member state and can confirm that there are no publicly announced refinery upgrades, renovations, new builds, or decommissioning in Slovakia.

Sweden reported nearly complete data on its three refineries at Gothenburg and Lysekil. Platts' refinery databases estimates total refining capacity at 21,860 Mt/yr for Finland, very near the 21,450 Mt/yr reported by the member state. Platts confirms operating capacities of refinery units reported by the member state. Sweden also reported FCC capacity and hydrocracking capacity of 1,800 Mt/yr and 2,900 Mt/yr, respectively, when reporting catalytic cracking capacity. Platts can affirm that there are no publicly announced refinery upgrades, renovations, new builds, or decommissioning in Sweden as of reporting in 2014. Since reporting, Sweden's Lysekil refinery has announced the addition of a new vacuum distillation unit.

The **United Kingdom** reported 45,810 Mt/yr of distillation capacity, which differs greatly from Platts' refinery database that estimates total refining capacity of 69,441 Mt/yr. Platts believes that the United Kingdom is most likely reporting distillation capacity from four of its six operating refineries. The Fawley, Grangemouth, Pembroke, and Stanlow refineries have a cumulative distillation capacity of 46,535 Mt/yr, according to Platts' refinery database, which compares to the member state-reported data. The Humber refinery is primarily a thermal cracking and coking facility and, therefore, does not have distillation capacity, though it is operating at a throughput capacity of 11,951 Mt/yr.

The Lindsey refinery has a nameplate distillation capacity of 10,955 Mt/yr, but this capacity appears to be included in the member state-reported data as non-operational capacity and capacity slated for decommissioning. The United Kingdom reports 3,633 Mt/yr of non-operational distillation capacity and 7,993 Mt/yr of capacity slated for decommissioning, roughly totaling the capacity of the Lindsey refinery. Early in 2014, Total announced that it reduced throughput capacity by a third and by the end of 2014, Total further reduced throughput capacity on the refinery in response to overcapacity in the European refining sector. The Milford Haven refinery was also decommissioned in 2014, and capacity from the 5,478 Mt/yr-Milford Haven refinery could be accounted for in the planned-for-decommissioned reported data.

Platts, therefore, affirms the member-state reporting of atmospheric distillation, vacuum distillation, and reforming capacity planned for decommissioning. The member state also reports three desulphurization units totaling 1,732 Mt/yr. Platts has confirmed that the Lindsey and Milford Haven refineries have idled desulphurization units, but the third desulphurization decommissioning cannot be confirmed.

Platts' refinery database confirms operating capacities of the various refinery units reported by the member state and can confirm that there are no further publicly announced refinery upgrades, renovations, new builds, or decommissioning beyond the decommissioning projects reported.

Conclusions

The member-state data indicates that investment in refinery upgrades has increased since the last reporting period and that the rate of refinery closure, indicative of the last reporting period, has slowed, which accurately reflects market trends. European refinery data is currently not publically available information, in particular the operating capacities of a refineries' various units. Though this information is reported in Platts' refinery database, receiving this information directly from the member states would be useful to the analysis of refinery infrastructure in Europe. However, a number of steps can be taken to increase the utility of the member state-reported data. The states are not required to report the number of operating refineries. The discrepancies in the benchmark data and the member state-reported data in Greece or the United Kingdom, for example, could be explained with an indication of the number of operating refineries included in the cumulative capacity estimate. Similarly, refinery-by-refinery information would prove the most useful and can enhance the understanding of the location of the refining capacity relative to pipelines, seaways, and refined product demand centers.

The refinery units for which the member states are encouraged to report capacities by the Regulation's reporting template are not comprehensive of refineries and can be ambiguous. The reporting can be improved with more clearly defined parameters for what constitutes the various categories of refining units. Desulphurization units and reforming capacity are difficult to compare to Platts' refinery database information, for example. The ability to report various units as the refineries define the units would result in a more comprehensive view of refinery capabilities in each member state, especially if this data was reported on a refinery-by-refinery basis.

2.Ten European member states that did not report under the Regulation are home to 61 of Europe's 93 refineries and account for nearly 60% of total refining capacity in the European Union. Platts' refinery database estimates total capacity from Belgium (43,471 Mt/yr), Croatia (10,673 Mt/yr), Ireland (3,353 Mt/yr), France (71,361 Mt/yr), Germany (101,931 Mt/yr), Italy (115,027 Mt/yr), Lithuania (14,939 Mt/yr), Romania (20,317 Mt/yr), Slovenia (672 Mt/yr), and Spain (71,506 Mt/yr) account for cumulative refining capacity of 453,432 Mt/yr.

Additionally, the non-reporting states account for the bulk of refinery projects. For example, in Belgium, a 2,390 Mt/yr-hydrocracker is under construction at Total's Antwerp refinery and a delayed coker unit is under construction at ExxonMobil's Antwerp refinery. Romania is adding 1,195 Mt/yr of hydrocracking capacity, likely completed in 2014. The 3,984-Mt/yr Porto Marghera Venice refinery in Italy is slated for decommissioning as early as 2015 in order to be refashioned into a bio-refinery and France's Le Mede 7,619-Mt/yr refining will be decommissioned in 2016 to be refashioned into a bio-refinery, as well.

With only 40% of total refining capacity being reported, the dataset is not comprehensive enough to inform analysis on European infrastructure needs.

O2 – Oil Transport

State of the European Oil Pipeline Infrastructure

The European oil market boasts established transportation infrastructure that require few modifications or new infrastructure in the next decade. Oil pipelines typically run from an established supply source, such as domestic production, terminals for waterborne imports, or pipeline supply from Russia, to a refinery. Product pipelines typically run from the refinery to export terminals or population centers. Given the lack of new refinery infrastructure, the pipeline infrastructure, too, is expected to remain relatively consistent in the next five years. The bulk of expected projects are intended to increase connectivity in Eastern Europe, where the infrastructure is slightly less established. If Europe endeavored to diversify crude oil supply away from dependence on Russia, additional oil infrastructure

Figure 3: Existing Crude Pipeline Length

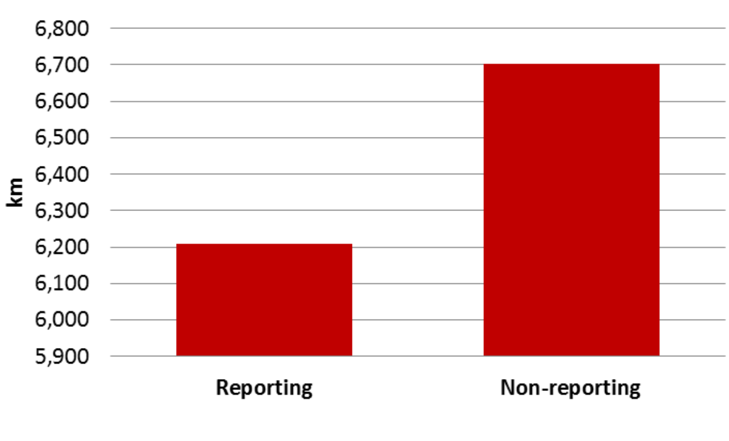
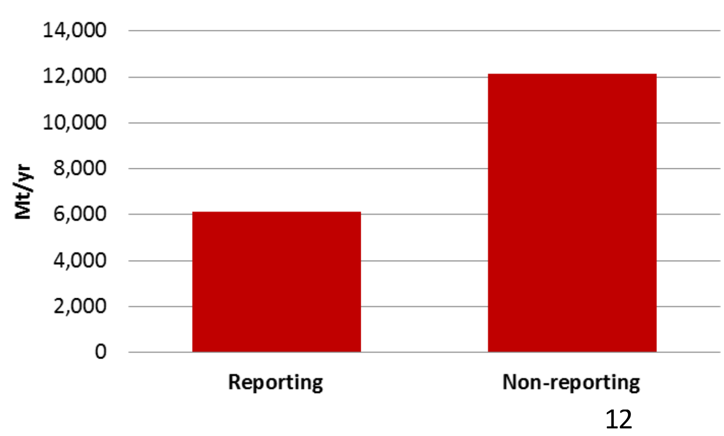


Figure 4: Existing Product Pipeline Length



could be necessary. Incremental product pipelines could also be necessary should Europe experience substantial economic growth in any given region of Europe.

Figure 5: Existing Crude Pipeline Length

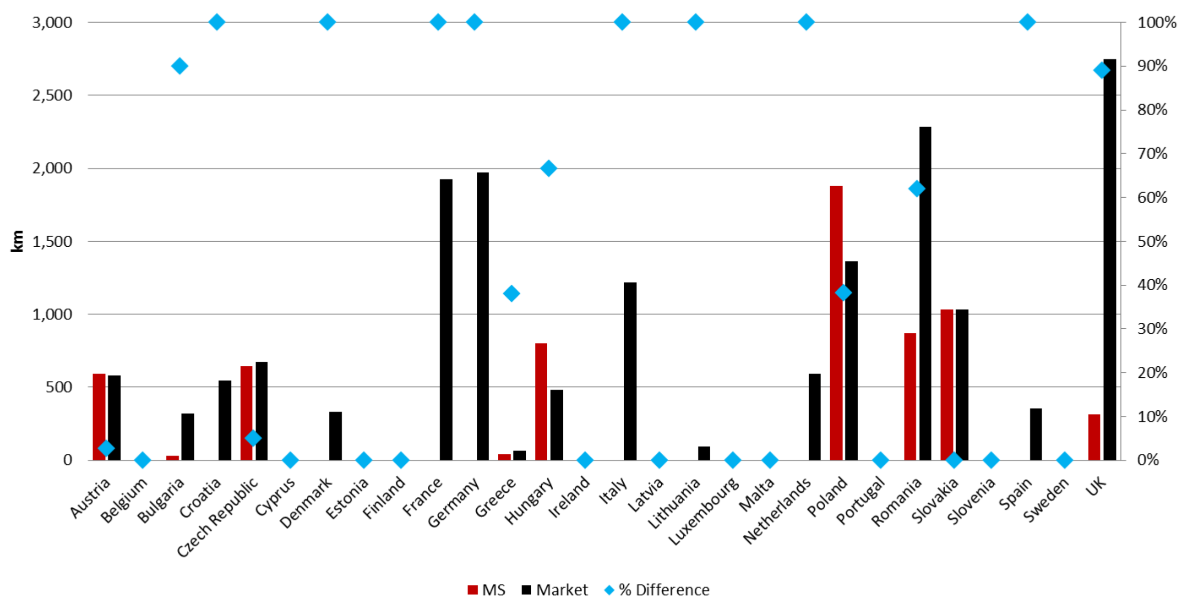
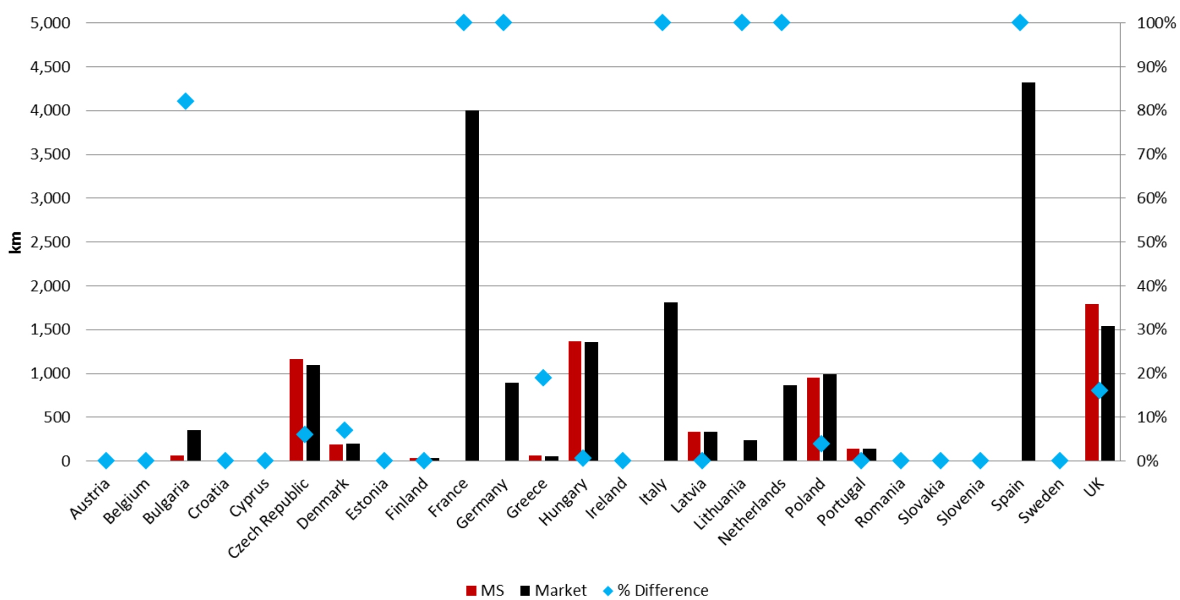


Figure 6: Existing Product Pipeline Length



Comparison of Member-State Data to Third-Party Sources

Under the Regulation, member states are required to report crude oil pipelines and petroleum product pipelines with a capacity of not less than 3 million metric tonnes per year and 1.5 million metric tonnes per year, respectively, and extensions and lengthening of these pipelines not less than 30 kilometres long, as well as pipelines that constitute essential links in national or international interconnecting networks and projects of common interest. The reporting template established by the Regulation requires member states to report these pipelines in length of pipeline in kilometres (km).

Of the member states that reported data, the reported data was relatively accurate when compared to the third-party source, Platts' liquids pipeline database. The Platts' liquids pipeline database is a comprehensive collection of European liquids pipelines and the capacity, length, diameter, throughway, and other information. Platts used the Platts' pipeline database to compare member state-reported data and assess the accuracy of the reported data, as well as collect pipeline lengths for member states that did not report pipeline data.

The discrepancies between the data could be attributed to reporting nuances. Platt's pipeline database reports the total length of any given pipeline that originates or ends in any given member state, whereas states may be reporting only the length of pipeline that lies within its border.

Twelve of the 28 member states reported 6,178 km of oil pipeline and 6,113 km of product pipeline. The non-reporting member states accounted for 6,703 km of oil pipeline and 12,757 km of product pipeline.

Individual Member-State Reporting

Austria reported 595 km of crude oil pipelines and no product pipelines. According to Platts' pipeline database, two crude oil pipelines run through Austria, the Adria-Wien Pipeline and the Transalpine Pipeline, with a cumulative length of 580 km. The Platts' pipeline database attributes 160 km to the Austrian portion of the Transalpine, or the TAL-IG segment. The greater Transalpine pipeline system is much longer and includes pipelines that veer from the TAL-IG segment to supply crude to the Schwechat refinery, for example, which would not be included in Platts' pipeline database, but could be reported by Austria as an additional 15 km of crude pipeline. Platts' pipeline database also tracks one product pipeline in Austria that was not reported by the member state, as the pipeline has a capacity of 1.4 Mt/yr, just shy of the 1.5 Mt/yr threshold for reporting. Through primary research, Platts can affirm that there are no publicly announced pipeline expansions, extensions, or decommissions in Austria.

Bulgaria reported 32 km of crude oil pipelines and 62 km of petroleum product pipeline. Platts cannot confirm the existence of these pipelines. Publically available data indicates that there is approximately 320 km of crude oil pipeline moving production from the Tulebovo oil field offshore in the Black Sea to Pleven, Bulgaria. However, the refinery at Pleven to which crude oil was presumably transported was idled in 2008, and the pipeline was likely idled in turn. Publically available data also indicates that there is approximately 350 km of petroleum product pipeline moving refined products from Bulgaria's sole refinery at Burgas to Sofia, the state capital. However, the latest data verifying the operational status of this pipeline was updated in 2013 and the operational status of this pipeline may have changed. Platts suspects the data has been reported in error, as the member-state data has changed substantially since the previous reporting period without mention of idling pipelines. Through primary research, Platts can affirm that there are no publicly announced pipeline expansions, extensions, or decommissions in Bulgaria.

The **Czech Republic** reported 642 km of crude oil pipelines and 1,167 km of petroleum product pipelines. According to Platts' pipeline database, the Czech segment of the Druzhba Pipeline accounts for 506 km of crude pipelines in the Czech Republic. An additional 169 km of the Transalpine pipeline runs through the Czech Republic for a cumulative pipeline length of 675 km. Platts is unable to find the cause behind this small discrepancy, but a 5% margin of error indicates that the member-state data is mostly accurate. Platts estimates that there is roughly 1,100 km of petroleum product pipeline in the Czech Republic, operated by state-owned CEPRO Company, comparable to the member state-reported data. Through primary research, Platts can affirm that there are no publicly announced pipeline expansions, extensions, or decommissions in the Czech Republic.

Denmark reported no crude oil pipelines and 187 km of petroleum product pipelines. According to Platts' pipeline database, Denmark does, in fact, have a single crude pipeline flowing Denmark's offshore production to the refinery and export terminal at Fredericia. The DONG Oil Pipe A/S is 330 km and may not be reported, because the bulk of the pipeline is offshore. Two refined product pipelines for gasoline and gasoil, roughly 100 km each, connect Statoil's Kalundborg refinery to Statoil's export terminal in Copenhagen, which roughly compares to the member state-reported data. Through primary research, Platts can affirm that there are no publicly announced pipeline expansions, extensions, or decommissions in Denmark.

Finland reported no crude oil pipelines and 40 km of petroleum product pipelines. Though Platts is unable to confirm the existence of 40 km of product pipeline, the single product pipe line is likely transporting jet fuel from Finland's Porvoo refinery to the Helsinki airport, which is approximately 40 km from the refinery. Through primary research, Platts can affirm that there are no publicly announced pipeline expansions, extensions, or decommissions in Finland.

Greece reported 40 km of crude oil pipelines and 63 km of petroleum product pipelines. According to Platts' pipeline database, there is one crude pipeline in Greece, the Thessaloniki Skopje Pipeline, a 213-km pipeline that spans both Greece and the Former Yugoslavic Republic of Macedonia (FYROM). Approximately 65 km of the Thessaloniki Skopje Pipeline runs through Greece, with the remainder running through FYROM. Platts' pipeline database tracks 53 km of petroleum product pipeline that transports jet fuel from Greece's Aspropyrgos refinery to the Athens airport. Therefore, the state-reported data is mostly accurate. Through primary research, Platts can affirm that there are no publicly announced pipeline expansions, extensions, or decommissions in Greece.

Hungary reported 800 km of crude oil pipelines and 1,364 km of petroleum production pipelines. Two major crude oil pipelines run through Hungary – Southern Druzhba pipeline and Adria pipeline. The Druzhba pipeline runs through Hungary for approximately 286 km and the Adria pipeline accounts for approximately 485 km of pipeline for a cumulative of about 771 km of pipeline, comparable to the member state-reported data. Platts estimates there is about 1,356 km of petroleum production pipelines in Hungary, comparable to the member-state data. As noted in the reporting, the 120 km of pipeline being decommissioned is being replaced by 120 km of new pipe and coincides with the construction project in the reporting. The project is, therefore, a pipe replacement project. Through primary research, Platts can affirm that there are no further publicly announced pipeline expansions, extensions, or decommissions in Hungary.

Latvia reported no crude oil pipelines and 340 km of petroleum product pipelines. Platts' pipeline database affirms that there are no operating crude oil pipelines in Latvia and the Polotsk-Ventspil Product Pipeline runs 340 km through Latvia. Through primary research, Platts can affirm that there are no further publicly announced pipeline expansions, extensions, or decommissions in Latvia.

Poland member-state data was reported in Polish, hindering complete understanding of the submitted data. To the extent Platts was able to decipher the data, Poland reported 1,880 km of crude oil pipelines and 954 km of petroleum product pipelines. Platts pipeline database tracks two pipelines in Poland, the Polish section of the Druzhba pipeline and the Pomerania pipeline, with 1,124 km and 237 km, respectively, totaling only 1,361 km of crude oil pipelines in Poland, over 500 km shy of member state-reported data. Platts is unable to account for the discrepancies between the reported data and Platts' pipeline database. Platts' pipeline database tracks 995 km of petroleum product pipelines from the Pern Product System and the Plock-Ostrow Wielkopolski-Wroclaw product pipeline, which is comparable to the memberstate-reported data. Poland reports one 62.5 km crude oil pipeline under construction and one planned 250-km crude pipeline. Poland also reports two petroleum product pipeline projects with a cumulative length of 345 km. The projects are likely under severe delays as the project details, as reported by the member state, have not changed since the previous reporting year, indicating that they have been under construction and planned for over three years without progress. Through primary research, Platts can affirm that there are no further publicly announced pipeline expansions, extensions, or decommissions in Poland beyond the potentially delayed projects currently reported by the member state.

Portugal reported no crude oil pipelines and 147 km of petroleum product pipelines. Platts' pipeline database affirms that there are no operating crude oil pipelines in Portugal and the Portugal-Aveiras Product Pipeline runs 147 km through Portugal. Through primary research, Platts can affirm that there are no publicly announced pipeline expansions, extensions, or decommissions in Portugal.

Romania reported 873 km of crude oil pipelines and no petroleum product pipelines. Platts' pipeline database, however, tracks 2,285 km of crude oil pipelines in Romania. CONPET S.A. operates the extensive Crude Oil National Transport System in Romania that transports Romania's domestic production as well as imported volumes to Romania's refineries. The most likely reason for this discrepancy is that Platts is tracking multiple oil pipelines within a right-of-way. For instance, there are three operational pipelines in the ground between Constanta and Ploiesti for a total of 680 km of pipelines in the ground, but the right-of-way, between Constanta and Ploiesti, is only 320 km. It is likely that Romania is reporting the length of right-of-ways rather than the miles of crude oil pipeline in the ground. Platts' pipeline database affirms that there are no operating product pipelines in Romania. Romania reports no pipeline projects, but Platts' is tracking two crude oil pipeline projects, part of the greater Pan-European Oil Pipeline, with a cumulative 440 km of pipeline within Romania.

Slovakia reported 1,032 km of crude oil pipelines and no petroleum product pipelines. Platts' pipeline database affirms that the Slovakia segment of the Druzhba pipeline runs 1,032 km through Slovakia and that there are no operating petroleum product pipelines in Slovakia. Slovakia reports one crude oil pipeline project with a length of 81-152 km. Platts' pipeline database affirms that the Bratislava-Schwechat crude oil pipeline is currently planned to contribute 152 km of pipeline to both Slovakia and Austria. Through primary research, Platts can affirm that there are no further publicly announced pipeline expansions, extensions, or decommissions in Slovakia.

The **United Kingdom** reports 314 km of crude oil pipelines and 1,788 km of petroleum product pipelines. Platts' pipeline database tracks 2,751 km of crude oil pipelines in the United Kingdom longer than 30 km. However, Platts tracks both onshore and offshore crude oil pipelines. Platts tracks approximately 392 km of onshore crude oil pipeline from BP's Wytch-Hamble Pipeline (90 km), Ineos' Finnart Pipeline (93 km), and 209 km of onshore pipeline associated with BP's Forties Charlie-Kinneil pipeline, which compares to the member state-reported data. Platts' pipeline database tracks 5,825 km of both onshore and offshore petroleum product pipelines longer than 30 km. The United Kingdom is home to a number of petroleum liquid pipelines. Platts' pipeline database includes pipelines that transport aviation/jet fuel, ethane, ethylene, fuel oil, gasoline, kerosene, gas oil, diesel, jet fuel, and propylene. Onshore pipelines that transport only gasoline, kerosene, gas oil, diesel, and jet fuel equate to approximately 1,998 km for petroleum product pipe, comparable to the member state-reported data, implying that the United Kingdom is reporting only onshore pipelines of this variety. Through primary research, Platts can affirm that there are no publicly announced pipeline expansions, extensions, or decommissions in the United Kingdom.

Conclusion

Publically available data on crude oil pipelines is scarce and the data provided by member states under the Regulation could prove useful to understanding European infrastructure. A number of modifications could be made in order to increase the utility of member state-reported liquids pipeline data. The number of operating pipelines would be useful in addition to the total length of the pipeline. More clearly defined parameters for what constitutes a product pipeline would aid the reporting of all liquids pipelines and proper understanding of the movement of products around Europe. Given the discrepancy in the member state-reported data and the benchmark data, it appears likely that member states, such as Denmark and the United Kingdom, are not reporting offshore pipelines. An additional category for offshore pipelines would encourage member states to report this data as well as onshore pipeline data.

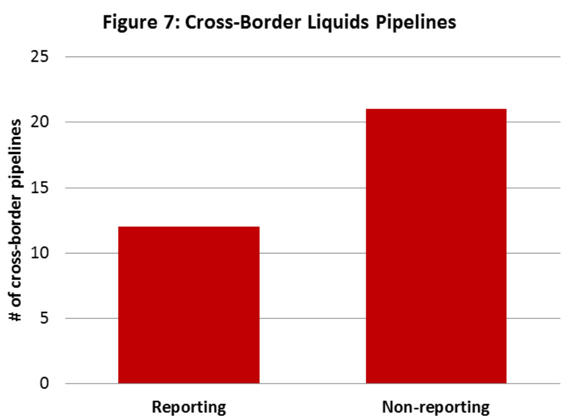
Finally, the capacity of crude oil and product pipelines, rather than the length of pipeline would better aid in identifying any additional need for pipeline infrastructure between supply and demand sources, as well as estimated origins and destinations. Such data could be paired with refinery capacity data reported by the member states to provide a comprehensive understanding of flows, required infrastructure, and where potential investments could be made to increase optionality of supply.

O3 – Oil Cross-Border Transport

State of the European Cross-Broder Oil Pipeline Infrastructure

The European market has largely established crude oil and product pipeline connections between supply and demand sources. Cross-border transport of crude and liquids is relatively minimal due to the fact that a majority of European member states have ports for access to imported crude, domestic refineries, and domestic demand markets for refined products. Few new projects are planned in terms of cross-border oil and product transport with the exception of three projects intended to increase connectivity in Eastern Europe.

Comparison of Member-State Data to Third-Party Sources



Under the Regulation, member states are required to report both crude oil and petroleum product pipelines and crude oil and petroleum product pipeline projects that constitute essential links in national or international interconnecting networks and projects of common interest. The reporting template established by the Regulation requires member states to report the capacity in metric tonnes per day of cross-border pipelines by cross-border or interconnecting points to and from the member state.

Ten of the 28 member states reported cross-border crude oil or petroleum product pipelines. The accuracy of the data reported varied, as did the format of the reporting, making it difficult ascertain the validity of the data.

Of the member states that reported data, the reported data differs substantially from the third-party source, Platts' liquids pipeline database. The Platts' liquids pipeline database is a comprehensive collection of European liquids pipelines and the capacity, length, diameter, throughway, and other information of these pipelines. Platts used the Platts' pipeline database to compare member state-reported data and assess the accuracy of the reported data, as well as collect pipeline lengths for member states that did not report pipeline data.

Individual Member-State Reporting

Austria reported one cross-border crude oil pipeline flowing from Germany, through Austria, and into Italy. Platts' pipeline database affirms that the Transalpine pipeline crosses the German-Austrian border and the Austrian-Italian border and tracks no other cross-border pipelines in Austria. Austria member-state data was reported in Austrian, hindering complete understanding of the submitted data.

The **Czech Republic** member-state data was unclear and unique in its formatting. To the extent Platts was able to decipher the data, the Czech Republic reported two cross-border crude oil pipelines flowing from the Czech Republic to Slovakia and from the Czech Republic to Denmark. The provided data indicates that these pipelines have a capacity of 25 Mb/d and 28 Mb/d, respectively. Platts' pipeline database also tracks one cross-border crude oil pipeline that flows crude oil from Germany to the Czech Republic.

The Czech Republic reports one cross-border product petroleum pipeline flowing diesel and gasoline from the Czech Republic to Slovakia. The provided data indicates that this pipeline has a capacity of 4.1 Mb/d of diesel and 4.4 Mb/d of unleaded petrol. Platts pipeline database confirms that the Druzhba oil pipeline and the DONG oil pipeline cross Czech borders into Slovakia and Denmark, respectively. Platts is unable to confirm the existence of a petroleum product pipeline that crosses the Czech-Slovakian border, as Slovakia member-state data indicates no existing petroleum product pipelines.

Denmark reported no cross-border pipelines, despite the fact that Czech Republic's reporting of a Czech-to-Denmark cross-border pipeline. Platts' pipeline database tracks no pipelines that flow crude oil or petroleum products out of Denmark to other countries, which likely explains Denmark's reporting.

Greece reported one cross-border petroleum product pipeline with a capacity of 6,500 Mt/d from Greece to FYROM, which Platts' pipeline database confirms as the Thessaloniki-Skopje pipeline, the sole cross-border pipeline in Greece.

Spain and the **United Kingdom** reported no cross-border pipelines, which Platts' pipeline database confirms.

Hungary member-state data was unclear and unique in its formatting. To the extent Platts was able to decipher the data, Hungary reported two cross-border crude oil pipelines flowing from Hungary to the Ukraine and from Hungary to Croatia. The provided data indicates that the Hungary-to-Ukraine pipeline has a capacity of 22 Mb/d, a capacity of 27 Mb/d from Croatia to Hungary, and 19 Mb/d from Hungary to Croatia. Platts' pipeline database confirms that the Druzhba oil pipeline and the Adria pipeline cross Hungary's border. Hungary also reports one cross-border product petroleum pipeline flowing from Hungary to the Ukraine at a capacity of 3.2 Mb/d. Platts' pipeline database can also confirm the existence of a petroleum product pipeline that crosses the Hungarian border.

The Netherlands reported one cross-border crude oil pipeline from Antwerp, Belgium, to Rotterdam. The Netherlands indicated a number "30" for the capacity, but the significance of this number cannot be confirmed. Platts' pipeline database confirms a cross-border pipeline between Antwerp and Rotterdam, but tracks this pipeline as an ethylene pipeline, or a refined products pipeline. Because Netherlands' reporting is identical to Hungary's posted data, aside from the Antwerp-to-Rotterdam pipeline, Platts believes that Netherlands' data is either missing or contains significant errors.

Platts was unable to affirm whether **Poland** did or did not report data on cross-border pipeline, because the data reported is entirely blank.

Slovakia member-state data was reported in Slovakian, hindering complete understanding of the submitted data. To the extent Platts was able to decipher the data, Slovakia reported three existing crude oil cross-border pipelines from Slovakia to the Ukraine, from Slovakia to Croatia, and from Slovakia to Hungary. Platts is unable to decipher the significance of the numbers attributed to the pipelines.

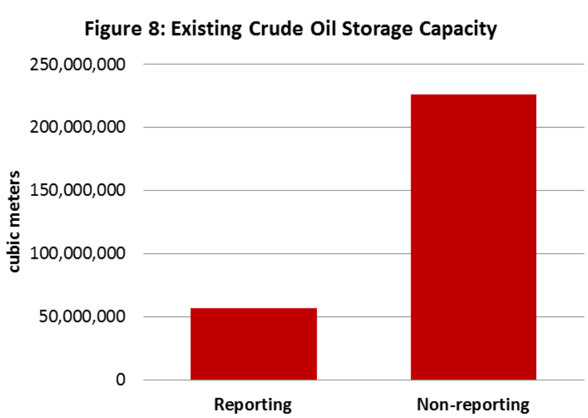
Conclusion

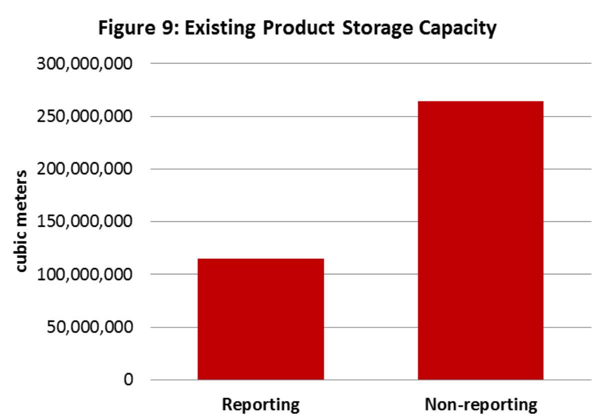
As mentioned, the European oil market is relatively established and few pipelines cross borders given the location and dynamics of the supply and demand for crude oil and refined products. Therefore, this particular dataset does not appear to be useful in the analysis of infrastructure in Europe. The utility of the dataset is further hindered by its inaccuracy and multilingual reporting. Platts' pipeline database reports 21 cross-border pipelines, while the member-state data reports only 12. The discrepancy is in part due to the fact that only ten member states reported any data. Origins and destinations of the pipeline would be of greater use for analysis purposes than simply the admission of cross-border pipelines.

O4 – Oil Storage

State of the European Oil Storage Infrastructure

Given the fairly sparse infrastructure enhancements or new builds in Europe's oil and refined product markets, little incremental storage capacity is expected to be added in Europe in the next five years. This appears true even as current inventories for crude oil and refined products are reaching record highs caused by low demand. Most new storage projects are associated with refinery expansion projects. Meanwhile, product storage is often underutilized due to the segregation of the various refined products and fluctuating demand for each of those products. However, refined product inventories are also at record levels. This is unlikely to result in increased investment in storage capacity unless economic growth indicators in Europe imply fundamental growth in demand for oil products in Europe. Even economic growth, though, will not necessarily lead to growth in oil demand and demand for incremental storage capacity given Europe's endeavors to diversify away from products like diesel and high-sulfur fuel oil.





Comparison of Member-State Data to Third-Party Sources

Under the Regulation, member states are required to report storage installations for crude oil and petroleum products in cubic metres (cm) with installations with a capacity of 150,000 cm or more or, in the case of tanks, with a capacity not less than 100,000 cm.

Figure 10: Existing Crude Oil Storage Capacity

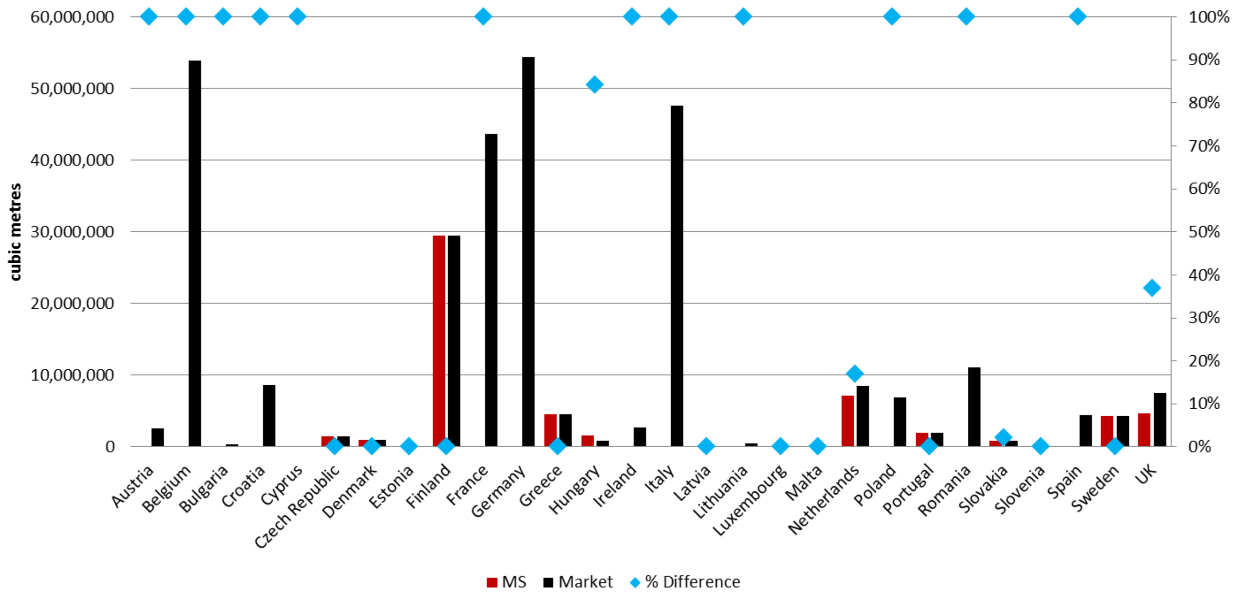
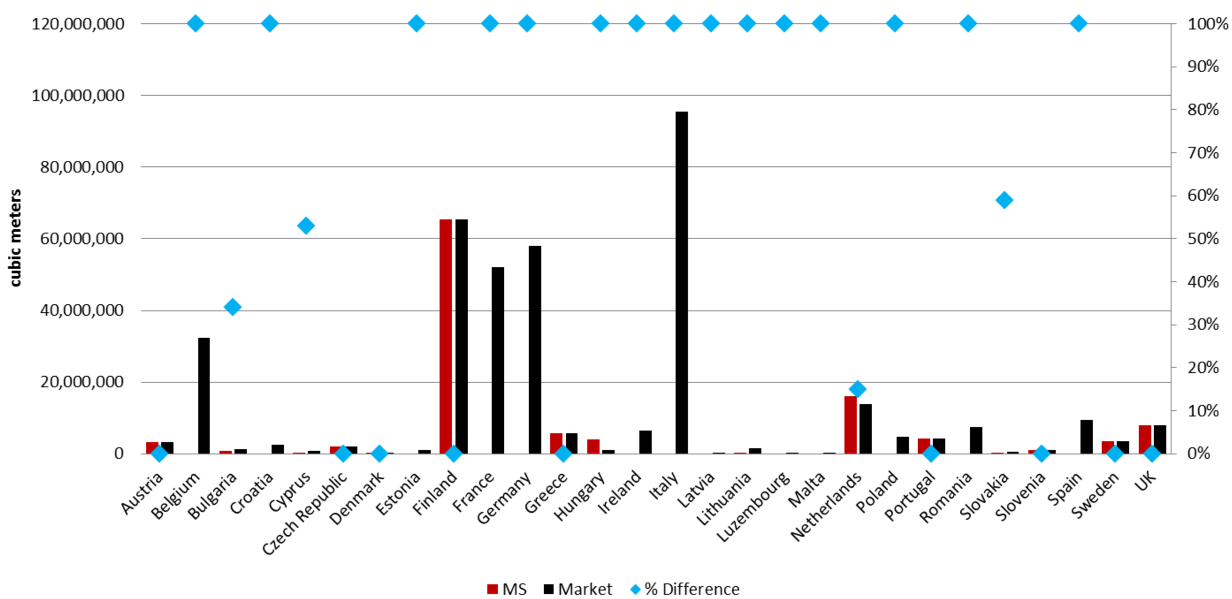


Figure 11: Existing Product Storage Capacity



The reported data is difficult to affirm with third-party data, as global storage capacity is not tracked by any publically available source. In order to judge the accuracy of the data, Platts has collected primary research from sources such as the International Energy Agency (IEA), though the data is potentially out-of-date. Platts has also collected maximum utilization of crude and petroleum product storage from the IEA and the Joint Organizations Data Initiative (JODI). Platts uses the assumption that maximum utilization of crude storage ranges from 60-80% of capacity and maximum utilization of product storage ranges from 40-60% utilization. Platts assumes the data is accurate when the maximum utilization of storage is within these ranges of the capacity reported by the member state. Given the lack of publically available information or data that can be obtained through primary research, Platts is unable to confirm if storage capacity is in tanks or installations or track projects or retirements.

SSeventeen of the 28 member states reported 57,205,236 cm of crude oil storage and 121,720,502 cm of petroleum product storage. The data is difficult to affirm, but based on the available data, Platts deems most of the member-state data to be inaccurate or incomplete.

Individual Member-State Reporting

Austria reports 380 cm of crude oil storage and 3,218,859 cm of petroleum product storage. Platts believes Austria is incorrectly reporting their crude oil storage. Maximum utilization of product storage is 2,520,271 cm, according to the IEA, which equates to 78% utilization and in line with average utilization rates. However, Platts cannot affirm Austria's crude oil storage capacity of 380 cm. The IEA estimates that crude oil storage capacity in Austria is about 2,623,000 cm, or 417 Mb. Platts suspects that Austria accurately reported its storage capacity for crude oil, except in thousands of barrels rather than cubic meters.

Bulgaria reports no crude oil storage and 859,500 cm of operational and non-operational petroleum product storage. Platts cannot confirm the accuracy of the reported data. According to JODI data, Bulgaria does possess crude oil storage and maximum utilization of crude oil storage capacity reached 404,386 cm. Assuming 80% of storage capacity is used during maximum utilization, crude oil storage in Bulgaria is approximately 485,265 cm. Similarly, maximum utilization of petroleum product storage in Bulgaria far exceeds reported capacity at 1,296,544 cm, which suggests operational capacity of around 1,555,852 cm. Though Platts cannot confirm the validity of the petroleum product storage projects listed by the member state, Bulgaria did include useful information regarding the existing and planned storage facilities, such as whether the installations included an outdoor area roof, an indoor area roof, or a stationary roof.

Cyprus reports no crude oil storage and 355,788 cm of petroleum product storage. Platts cannot confirm the accuracy of the reported data. According to JODI data, Cyprus does possess crude oil storage and maximum utilization of crude oil storage capacity reached 109,097 cm. Assuming 80% of storage capacity is used during maximum utilization, crude oil storage in Cyprus is approximately 130,917 cm. Similarly, maximum utilization of petroleum product storage in Cyprus far exceeds reported capacity at 629,591 cm, which suggests operational capacity of around 755,509 cm.

The **Czech Republic** reports 1,457,200 cm of crude oil storage and 1,922,400 cm of petroleum product storage. As of 2011, the IEA estimates total storage capacity in the Czech Republic was about 4,200,000 cm, split almost even between crude oil and petroleum product storage, which is significantly higher than the member state-reported data. However, maximum utilization of crude oil and petroleum product storage stood at 533,085 cm and 847,245 cm, respectively. Such data suggests extremely low utilization of storage capacity in the Czech Republic. Platts presumes that the member state-reported is the most accurate estimate of storage capacity, as storage decommissioning likely occurred since the latest publically available data from 2011, given the low utilization rates of the existing facilities.

Denmark reports 958,704 cm of crude oil storage and 6,948,113 cm of petroleum product storage. The IEA estimates total storage capacity at 7,800,000 cm, which is comparable to the cumulative 7,906,817 cm reported by the member state. Similarly, maximum utilization of crude oil storage and refined product storage reaches 765,574 cm and 3,273,077 cm, respectively, and confirms the accuracy of the Denmark-reported data.

Finland reports 29,538,300 cm of crude oil storage and 66,029,300 cm of petroleum product storage. Maximum utilization of crude oil storage and refined product storage reaches 1,273,649 cm and 2,677,669 cm, respectively, and confirms the accuracy of the Finland-reported data. Finland also reports 208,000 of non-operational crude oil storage, but Platts is unable to confirm the accuracy of this information.

Greece reports 4,592,285 cm of crude oil storage and 5,646,290 cm of petroleum product storage. Maximum utilization of crude oil storage and refined product storage reaches 2,564,946 cm and 3,918,408 cm, respectively, and confirms the accuracy of the Greece-reported data.

Hungary reports 1,633,400 cm or crude oil storage and 4,066,500 cm of petroleum product storage in both storage tanks and installations. Maximum utilization of crude oil storage and refined product storage reaches 886,992 cm and 1,047,569 cm, respectively, which implies extremely low utilization rates of existing storage facilities. Platts cannot confirm the accuracy of the reported data, but suspects that Hungary is double-counting some storage capacity when aggregating tank capacity versus installation capacity.

Lithuania reports no crude oil storage and 792.9 cm of petroleum product storage. According to JODI data, Lithuania does possess crude oil storage and maximum utilization of crude oil storage capacity reached 495,564 cm. Assuming 80% of storage capacity is used during maximum utilization, crude oil storage in Lithuania is approximately 595,677 cm. Similarly, maximum utilization of petroleum product storage in Lithuania far exceeds reported capacity at 1,209,577 cm, which suggests operational capacity of around 1,451,493 cm. Therefore, Platts deems the member state-reported data inaccurate.

The Netherlands reports 7,119,946 cm of crude oil storage and 16,012,055 cm of petroleum product in both storage tanks and installations. Maximum utilization of crude storage reached 8,562,116 cm, which exceeds the member state-reported capacity estimate. Maximum utilization of petroleum product storage reached 13,939,553 cm, in line with average utilization. Since the IEA estimates a total storage capacity for crude oil and petroleum products at about 30,000,000 cm, Platts suspects that the Netherlands is underestimating crude storage while accurately reporting petroleum product storage. The Netherlands reported two new crude oil tank projects with a total capacity of 189,552 cm. Though Platts cannot confirm the accuracy of these projects, Platts assumes this data is correct, given the Netherlands role as a global storage hub for crude oil and refined products.

Poland data was reported in the Polish and storage capacity estimates cannot be deciphered. The IEA estimates that Poland has about 6,960,000 cm of crude oil storage and 4,640,000 cm of petroleum product storage.

Portugal reports 1,968,185 cm of crude oil storage and 4,372,342 cm of petroleum product storage in both storage tanks and installations. Maximum utilization of crude oil and petroleum product storage was estimated by the IEA to reach 1,110,846 cm and 2,929,187 cm, respectively. Given average utilization of storage facilities, Platts affirms the accuracy of Portugal-reported data.

Slovakia reports 860,000 cm of crude oil storage and 248,000 cm of petroleum product storage. The IEA estimates crude oil storage in Slovakia at about 842,634 cm, in line with member state-reported data, and 604,153 cm in petroleum product storage, which is much higher than Slovakia's reported estimates. Therefore, Platts affirms the accuracy of crude oil storage capacity, but finds the petroleum product storage capacity to be inaccurate when compared to third-party sources. Slovakia reported one new crude oil tank project with a capacity of 50,000 cm. Given the small volume of the project, which falls below the Regulation's threshold for reporting, it is difficult to affirm the existence of the project.

Slovenia reports no crude oil storage and 1,046,842 cm of petroleum product storage in both storage tanks and installations. Platts can affirm that there are no existing crude oil storage facilities in Slovenia. Maximum utilization of petroleum product storage in Slovenia reaches 293,809 cm, which indicates very low utilization rates of existing storage if the member state-reported data is correct. However, given Slovenia's relatively sparse crude oil and petroleum product infrastructure, low utilization of storage facilities is possible. Therefore, Platts affirms the accuracy of Slovenia-reported data.

Spain reported no crude oil or petroleum product storage. The IEA estimates total crude oil and petroleum product storage capacity in Spain to be around 14,980,000 cm. Maximum utilization of crude oil and petroleum product storage reached 4,470,094 cm and 9,348,151 cm, respectively, indicating high utilization of storage infrastructure in Spain, as well as the existence of both crude oil and petroleum product storage.

Sweden reported 4,334,000 cm of crude oil storage and 3,610,000 cm of petroleum product storage in both storage tanks and installations. The IEA estimates that total crude oil and petroleum product storage in Sweden to be about 15,200,00 cm in cumulative, much larger than the member state-reported data. However, maximum utilization of crude oil and petroleum product storage reached 2,416,134 cm and 4,836,879 cm, respectively, in line with average utilization rates and the member state-reported data. Platts, therefore, affirms that accuracy of Sweden-reported data. Sweden also reports one new crude oil storage installation with a capacity of 700,000 cm. Platts affirms that the Port of Gothenburg underground storage facility is currently under construction.

The **United Kingdom** estimates 4,742,836 cm of crude oil storage and 7,939,670 cm of petroleum product storage. Maximum utilization of crude oil storage and petroleum product storage in the UK reached 7,529,651 cm and 8,379,281 cm, respectively, which far exceeds reported capacity. However, given the reported 80,000 cm of non-operational crude oil storage, 300,000 cm non-operational petroleum product storage, and 372,000 cm of planned decommissions, storage facilities may have been decommissioned since storage levels reached maximum utilization. As late as 2015, though, crude oil and petroleum product stocks reached 5,876,975 cm and 6,591,307 cm, respectively. The latest utilization rates indicate that the United Kingdom may have reported accurate petroleum product storage capacity, but the crude oil storage capacity is likely underestimated.

Conclusion

Given the lack of publicly available data on crude oil and refined product storage in Europe, this data could be extremely useful if the data could be proven accurate. Currently, the member-state data is deemed mostly inaccurate or incomplete and is, therefore, not useful. Aside from better accuracy, the data could be utilized more efficiently if it was reported in barrels rather than cubic meters, which is more in line with industry standards of reporting crude oil and refined product inventories and capacities. As with other member-state datasets, Germany, France, and Italy account for a substantial portion of total crude and product storage capacity. Without member-state data from three of the most energy-intensive member states, the data is incomplete.

G1 – Gas Transmission

State of the European Natural Gas Pipeline Infrastructure

Demand for natural gas in Europe has lagged as European countries have sought to decrease their reliance on hydrocarbons for power generation in favor of renewable sources. However, natural gas will remain the most economic and cleanest-burning baseload supply for power generation in lieu of the ability to store power produced by renewable sources. Natural-gas fired power generation is expected to grow throughout the decade, necessitating some incremental natural gas transmission infrastructure. Much of Eastern Europe is dependent on Russia for its natural gas supply, which poses geopolitical risk. Incremental infrastructure connecting Eastern Europe to supply sources in Western Europe and LNG supply will aid in diversification of supply to Europe.

Comparison of Member-State Data to Third-Party Sources

Under the Regulation, member states are required to report natural gas, including natural gas and biogas, transport pipelines that form part of a network which mainly include high-pressure pipelines, excluding pipelines that form part of an upstream pipeline network and excluding high-pressure pipelines primarily used in the context of local distribution of natural gas. The template requires member states to report the length of the pipeline kilometres and the total power of the compressor stations along the pipeline in megawatts (MW).

Because many of the cross-border pipeline projects tracked by ENTSO-G do not specify the length of pipelines in each country, Platts assumes that half of the total length of the new pipeline is attributable to each of the two countries whose border the pipeline crosses. Though an inexact science, this method has been useful in judging the accuracy of the member state-reported data. No publically available data sources tracks power at compressor substations. Platts, therefore, could not verify the accuracy of this data.

Sixteen of the 28 member states reported 59,198 km of natural gas pipeline. Of the member states that reported data, the reported data was relatively accurate when compared to the third-party source, the

Ten-year Network Development Plan (TYNDP) from 2015. The TYNDP is an annual report from the European Network of Transmission System Operators for Gas (ENTSO-G) that tracks European gas infrastructure with the intent to anticipate any potential gaps in future investment. ENTSO-G also tracks new infrastructure in its Expansions Report. Platts used the TYNDP to track the length of existing pipelines.

The 12 member states that did not report account for 139,484 km of natural gas pipeline in Europe, or about 72% of total natural gas transmission in Europe. As estimated by TYNDP, the reported data is missing a cumulative of 3,549 km of pipeline from Austria, 4,100 km from Belgium, 5,576 km from Croatia, 885 km from Estonia, 37,056 km from France, 38,125 km from Italy, 412 km from Luxembourg, 12,500 km from the Netherlands, and 7,891 km from the UK. Germany, France, and Italy alone account for over 50% of natural gas pipeline infrastructure in Europe. Similarly, there is an estimated 8,805 km of new pipeline planned for the member states that did not report, accounting for 48% of total pipeline length from new projects.

Figure 12: Existing Length of Gas Pipelines

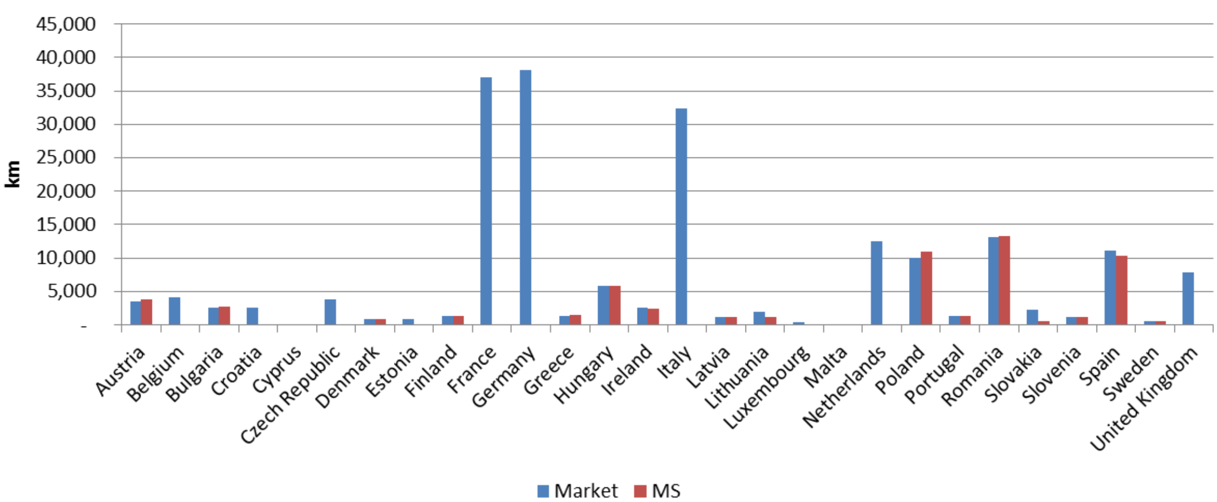
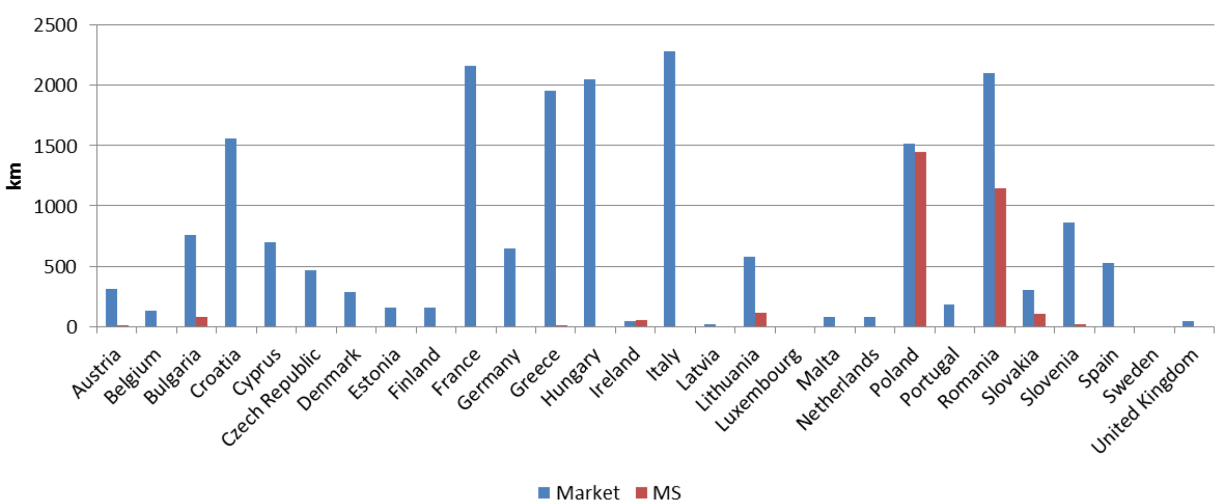


Figure 13: Length of New Gas Pipelines



Individual Member-State Reporting

The **Czech Republic** reported 3,819 km of natural gas pipeline, in line with TYNDP's estimate of 3,818 km of pipeline. The Czech Republic also reported one pipeline project under construction and two planned pipeline projects. The lengths associated with these projects were 1 km and 0.08 km, respectively, and were likely misreported. The ENTSO-G's Expansions Report estimates there are 471 km of pipeline projects in the Czech Republic stemming from the Bidirectional Austrian-Czech interconnector and the Poland-Czech Republic interconnection projects.

Bulgaria reported 2,660 km of natural gas pipeline, in line with TYNDP's estimate of 2,645 km of pipeline. Bulgaria also reported one pipeline project under construction at a length of 80 km, while the ENTSO-G's Expansion Report estimates there are 758 km of pipeline projects in Bulgaria. The discrepancy likely stems from ENTSO-G's tracking of the Trans-Adriatic Pipeline, as well as a number of other projects that have not yet reached FID.

Denmark reported 925 km of natural gas pipeline, in line with TYNDP's estimate of 860 km. **Finland** reported 1,287 km of natural gas pipeline, in line with TYNDP's estimate of 1,286 km. **Hungary** reported 5,873 km of natural gas pipeline, in line with TYNDP's estimate 5,784 km. **Latvia** reported 1,239 km of natural gas pipeline, in line with TYNDP's estimate of 1,239 km. **Portugal** reported 1,375 km of natural gas pipeline, in line with TYNDP's estimate of 1,375 km. **Sweden** reported 620 km of natural gas pipeline, in line with TYNDP's estimate of 620 km. These member states reported no natural gas pipeline projects. However, with the exception of Sweden, ENTSOG's Expansions Report is tracking pipeline projects for these states with a total of 2,692 km of new pipeline.

In **Denmark**, 32 km of pipeline is being added to extend the Gasunie Deutschland Transport system, 88 km of pipeline is being added to tie-in the Norwegian offshore natural gas transmission system to Danish offshore natural gas infrastructure, and 162 km of pipeline is being added to the Poland-Denmark interconnection on the Baltic Pipe for a total of 282 km of new pipeline in Denmark. In **Finland**, 157 km of pipeline is being added to the Balticconnector between Finland and Estonia.

A slew of pipelines in **Hungary** are being built or modified to flow natural gas through the member state. The Expansions Report estimates a total of 2,048 km of incremental pipeline will be added to the member states' transmission system. Projects include the Slovakia-Hungary interconnection on the Eustream system, Magyar Gaz Tranzit Zrt's Slovak-Hungarian interconnector, the Hungarian segment of the South Stream Project, the Varosfold-Ercsi-Gyor pipeline between Austria and Hungary, the Ercsi-Szazhalombatta pipeline, and the LNG main gas transit pipeline as a part of the North-South Gas Corridor.

In **Latvia**, a total of 21 km of pipeline are being added to enhance the Latvian segment of the Riga-Lecava-Lithuania pipeline. In **Portugal**, an estimated 185 km of pipeline is being added for the expansion of the Portugal-Spain interconnector at the Spanish border, Cantanhede compressor station, and between Cantanhede and Mangualde.

Greece reported 1,486 km of natural gas pipeline, in line with TYNDP's estimate of 1,291 km of pipeline. Greece also reported one pipeline project under construction with a length of 6.5 km. However, ENTSO-G's Expansions Report is tracking 1,954 km of new pipeline in the member state. The Report attributes 375 km of new pipeline to the Trans-Adriatic pipeline project that crosses through Greece, Italy, and Albania, 239 km to the Trans Anatolian pipeline project that crosses through Georgia, Turkey, and Greece, 613 km of pipeline to the ITGI Poseidon pipeline between Komotini and Thesprotia, 28 km to the Alexandroupolis Independent Natural Gas System, and 700 km to the Trans-Mediterranean Gas Pipeline crossing through Cyprus and Greece.

Ireland reported 2,467 km of natural gas pipeline, in line with TYNDP's estimated 2,585 km of pipeline. Ireland also reported one planned pipeline project with a length of 50 km. This, too, is in line with ENTSO-G's Expansions Report, which is tracking about 44 km of new pipeline in Ireland.

Lithuania reported 1,217 km of natural gas pipeline, which differs significantly from TYNDP's estimate of 2,007 km of pipeline. Platts suspects that this is a reporting error on the part of the member state. In Lithuania's 2013 reporting, it reported 1,904 km of natural gas pipeline, much more in line with TYNDP's estimate, and reported no potential decommissions within the proceeding five years. In fact, in 2013, Lithuania reported two pipeline projects with a cumulative 102 km of pipeline were under construction. Therefore, accurate reporting in 2015 would be much closer to TYNDP's estimate. Lithuania also reports one pipeline project currently under construction with a length of 110 km. ENTSO-G' Expansions Report tracks about 577 km of new pipeline from the Gas Interconnection Poland-Lithuania project and the capacity enhancement of the Klaipeda-Kiemenai pipeline in Lithuania.

Poland reported 11,007 km of natural gas pipeline, which differs significantly from TYNDP's estimate of 10,064 km of pipeline. The discrepancy is likely due to the timing of various decommissioning projects. Poland reports plans to decommission 31 natural gas pipelines, 83 km of which will be decommissioned between zero and two years and 230 km of which will be decommissioned between three and five years. Meanwhile, Poland also reported 20 new pipeline projects with a cumulative length of 1,444 km, in line with Platts's estimate of 1,518 km from ENTSO-G's Expansions Report.

Romania reported 13,235 km of natural gas pipeline, in line with TYNDP's estimate of 13,138 km. Romania also reports 15 new pipeline projects with a cumulative length of 1,147 km, which is significantly lower than Platts estimate from ENTSO-G's Expansions Report of 2,104 km of new pipeline projects. Projects tracked by ENTSO-G include the South Caucasus Pipeline expansion (625 km), the project to reverse flow on the SNTGN Transgaz pipeline between Romania and Hungary (138 km), the modification of the Romanian segment of the AGRI pipeline (425 km), the interconnection of the national transmission system with the international gas transmission pipeline to meet the South Caucasus Pipeline (200 km), the development on the Romanian territory of the National Gas Transmission System on the Bulgaria-Romania-Hungary-Austria Corridor (273 km), the development on the Romanian territory of the Southern Transmission Corridor for taking over Black Sea gas (247 km), and the bridging of the Isaccea-Horia corridor by construction of the Onesti-Bacia section (184 km).

Slovakia reported 519 km of natural gas pipeline, which differs significantly from TYNDP's estimate of 2,255 km. Platts is unable to verify the source of this discrepancy between member-state data and publically-reported data. The most likely reason for this discrepancy is that TYNDP is tracking multiple natural gas pipelines within a right-of-way. For instance, there are four operational pipelines in the ground crossing through Slovakia for a total of 2,076 km of pipelines in the ground, but the right-of-way is only about 519 km. It is likely that Slovakia is reporting the length of right-of-ways rather than the miles of natural gas pipeline in the ground. Slovakia also reports 106 km of new pipeline projects. ENTSO-G's Expansions Report tracks about 303 km of new pipeline from the Slovak-Hungarian interconnector project on the Vecses-Szada-Balassagyarmat pipeline, Poland-Slovakia interconnection project on EUstream, and the Poland-Slovakia interconnection project along the North-South corridor.

Slovenia reported 1,155 km of natural gas pipeline, in line with TYNDP's estimate of 1,121 km. Slovenia also reports one pipeline project with a total length of 20 km, while ENTSO-G's Expansions Report tracks 859 km of new pipeline. Natural gas projects in Slovenia include the Slovenia segment of the South Stream Project (266 km), the interconnection between Croatia and Slovenia on the Bosiljevo-Karlovac-Lucko-Zabok-Rogatec pipeline (200 km), a series of pipeline projects in Slovenia driven by Plinovodi (326 km), and an interconnection project at the Slovenian-Hungarian border by FGSZ (21 km).

Spain reported 10,314 km of natural gas pipeline, which differs significantly from TYNDP's estimate of 11,130 km. Platts is unable to verify the source of this discrepancy between member-state data and publically-reported data. Spain also reported one pipeline project with a length of 1,144 km. ENTSO-G's Expansions Report tracks about 523 km of new pipeline from various cross-border projects.

Conclusion

With the exception of the data reported by a portion of the member states on compressor station power capacity, the length of natural gas pipeline in Europe is publically available through the ENTSO-G. The existing member-state dataset, given the 23% reporting rate of total gas transmission infrastructure, is incomplete and proves far less useful than ENTSO-G's publically-available data.

To a certain extent, comparing member state-reported transmission line projects with that of TYNDP's project list aids in understanding which pipelines have reached FID. TYNDP does not indicate what projects have reached FID, which explains the discrepancy in the member state-reported project data and that of the benchmark.

Generally speaking, capacities of transmission line and pipelines are more useful for infrastructure analysis than the length of the pipeline alone. The length of the pipelines can inform market trends, such as identifying the countries with the most pipeline infrastructure. However, domestic capacity of natural gas pipelines could be compared to capacities of existing and planned natural gas-fired power plants to reach an understanding of which areas and countries require additional infrastructure. With the length of the pipeline alone, the data is not useful in determining where and when additional infrastructure may be necessary.

Finally, given the discrepancy between the member state-reported project data and the project information from the TYNDP, more detailed notes on the various projects that member states report would be useful in determining the accuracy of the member-state data, as well as determine which pipeline projects are most likely to proceed. The TYNDP can supplement such data to understand which planned projects that have not reached FID are most necessary or should be encouraged.

G2 – Natural Gas Cross-Border Transport

State of the European Cross-Broder Natural Gas Pipeline Infrastructure

As mentioned, Europe's natural gas market is growing, albeit slowing, as member states increase their natural gas-fired power generation. Not only do member states require additional infrastructure to connect new gas-fired generation to natural gas supply, but cross-border pipelines are vital to the European market. Cross-border pipelines allow for greater connectivity amongst the member states, allow for greater diversification of supply and, therefore, fewer price spikes, and reduce Europe's reliance on Russia for a large portion of its supply.

Figure 14: Cross Border "To" Gas Capacity

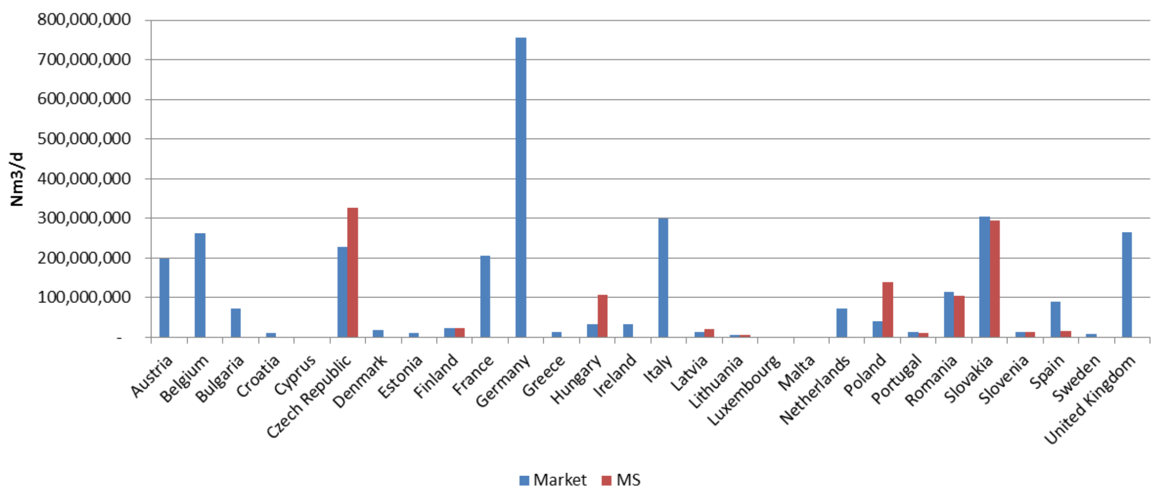


Figure 15: Cross Border "From" Gas Capacity

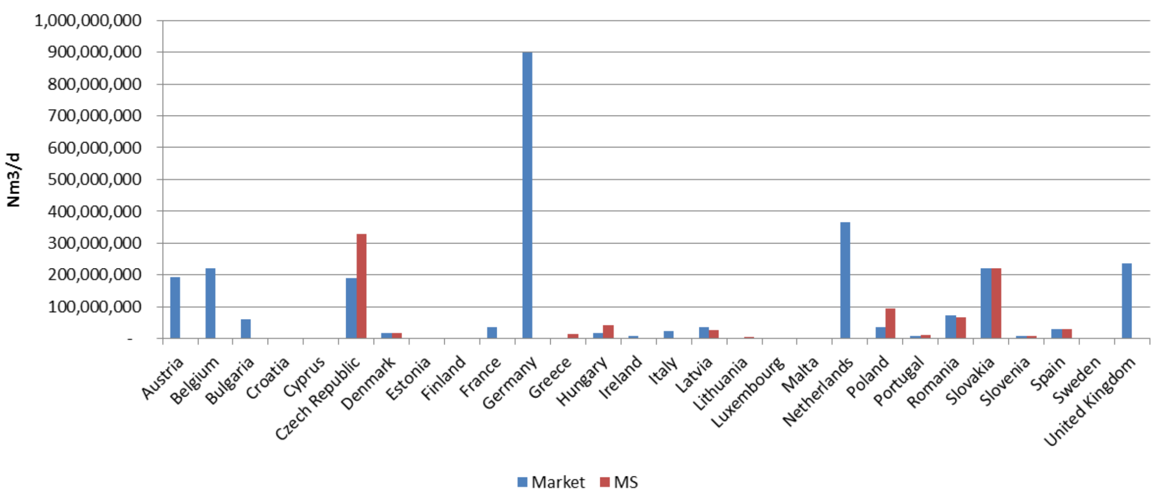


Figure 16: Cross Border "To" Gas Capacity Expansions

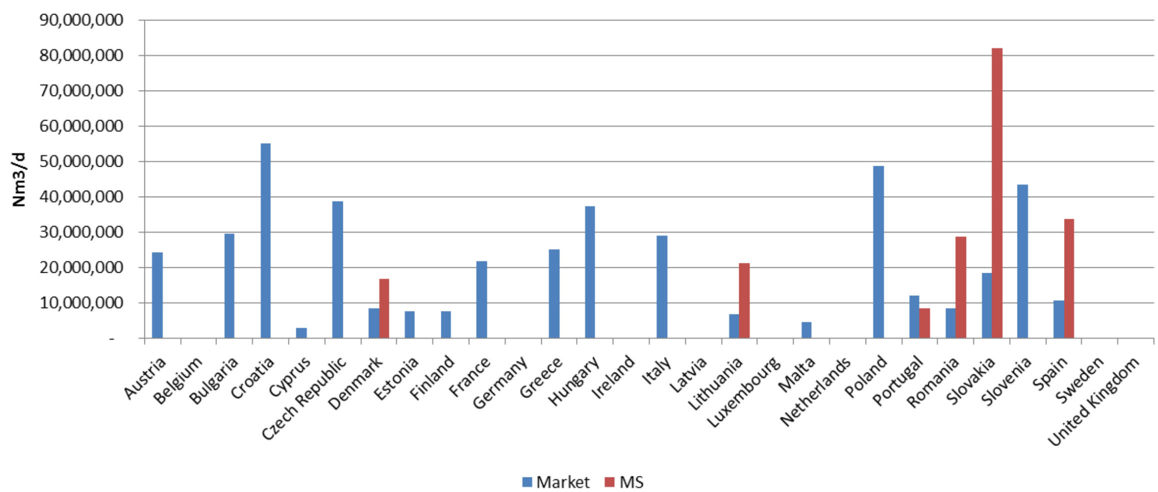
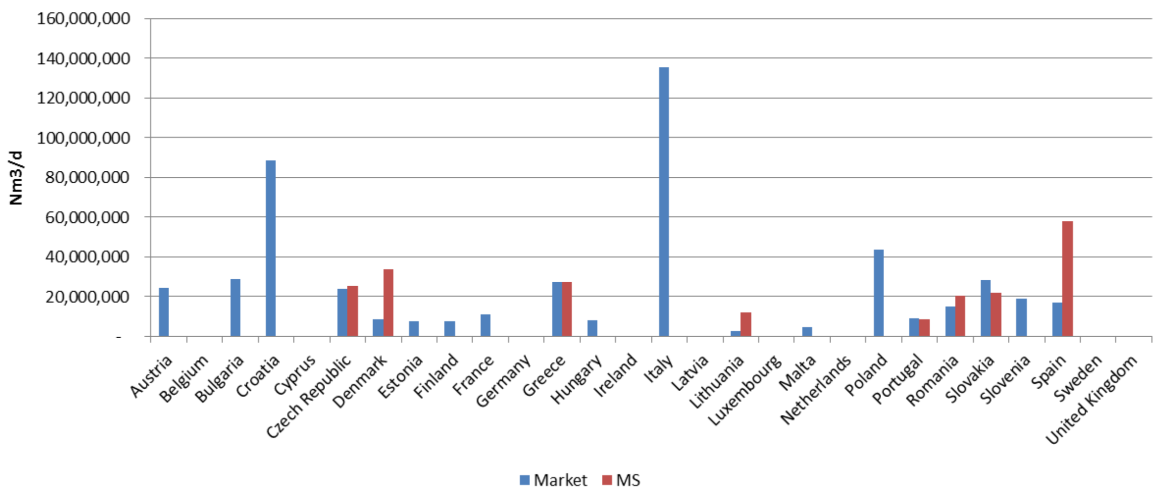


Figure 17: Cross Border "From" Gas Capacity Expansions



Comparison of Member-State Data to Third-Party Sources

Under the Regulation, member states are required to report natural gas pipelines and projects of common interest identified in the guidelines under Article 171 TFEU. Member states are to report the capacity of the cross-border pipeline in cubic metres (cm) and the point at which the pipeline crosses the border.

Fifteen of the 28 member states reported 1,895,744,742 cm of natural gas cross-border pipeline capacity. Of the member states that reported data, the reported data differed greatly when compared to the third-party source, the Ten-year Network Development Plan (TYNDP) from 2015. The TYNDP is the annual report from the European Network of Transmission System Operators for Gas (ENTSO-G) that tracks European gas infrastructure with the intent to anticipate any potential gaps in future investment. ENTSO-G also tracks new infrastructure in its Expansions Report. Platts used the TYNDP to track the length of existing pipelines.

The thirteen member states that did not report account for 2,115,413,607 cm of natural gas cross-border pipeline from Austria, Belgium, Estonia, France, Germany, Ireland, Italy, the Netherlands, and the United Kingdom, over half of total cross-border natural gas transmission capacity.

Individual Member-State Reporting

The **Czech Republic** reported their data in million cubic meters, rather than the cubic meters suggested in the Regulation. Once converted, the Czech Republic reported 327,620,000 cm of natural gas capacity flowing into the Czech Republic and 213,500,000 cm of capacity flowing out of the Czech Republic, whereas the TYNDP estimates cross-border capacity at 227,393,296 cm of capacity flowing into the Czech Republic and 2,000,000 cm of capacity flowing out of the Czech Republic.

Additionally, the Czech Republic reports 25,400,000 cm of new capacity out of the Czech Republic, which differs significantly from ENTSO-G's Expansion Report, which tracks 38,617,745 cm of new capacity into the Czech Republic and 44,830,599 cm of new capacity out of the Czech Republic. Platts cannot confirm the source of the discrepancies between member state-reported data and third-party sources. The Expansions report is tracking two projects flowing gas out of the Czech Republic expected to be completed in the next five years including Czech-Poland interconnector (18,384,015 cm) and the Reinthal Bidirectional Austrian-Czech Interconnector (23,946,358 cm), both of which increase bi-directional capacity across borders.

Bulgaria reported their data in million cubic meters, rather than the cubic meters suggested in the Regulation. Once converted, Bulgaria reports 78,550,000 cm of natural gas capacity flowing into Bulgaria from Romania and 1,000,000 cm flowing into Bulgaria from Greece. Bulgaria also reports 12,000,000 of natural gas capacity from Bulgaria into Romania, 10,270,000 cm of capacity from Bulgaria into Greece, 45,120,000 cm of capacity from Bulgaria to Turkey, and 2,580,000 cm of capacity from Bulgaria to FYROM. The TYNDP estimates cross-border capacity into Bulgaria at 73,454,039 cm and capacity flowing out of Bulgaria at 60,846,376 cm, in line member state-reported data. Bulgaria also reported 80,000 cm of incremental capacity from Romania to Bulgaria and 4,560,000 cm of incremental capacity from Bulgaria to Romania. ENTSO-G's Expansion Report is tracking an incremental 29,414,424 cm of capacity into Bulgaria and 28,973,039 cm of capacity from Bulgaria, which could include projects that have not yet reached FID.

Denmark also reported their data in million cubic meters, rather than the cubic meters suggested in the Regulation. Once converted, Denmark reports two cross-border points for a cumulative 16,900,000 cm of natural gas pipeline capacity flowing out of Denmark. However, the TYNDP reports 17,422,390 cm of cross-border capacity into Denmark and 17,808,548 cm of cross-border capacity out of Denmark. Denmark reports new cross-border capacity out of Denmark to increase 33,800,000 cm and capacity into Denmark to increase 16,800,000 cm. The reported data differs significantly form the TYNDP data which tracks an incremental 8,588,635 cm of capacity both in and out of Denmark. Platts suspects that the discrepancy in the data is a result of reporting error and incorrect entries into the various columns of the template.

Finland reported 22,500,000 cm of cross-border capacity into Finland and no cross-border projects. The TYNDP reports 7,523,305 cm of incremental cross-border capacity to and from Estonia. However, as noted in Finland's reported "supplemental notes," no final investment decisions have been made on new cross-border projects, which would explain why Finland has not yet reported the project.

Greece reported 15,100,000 cm of cross-border capacity into Greece from Bulgaria and Turkey and one cross-border project bringing 27,397,260 cm of gas into Greece. TYNDP confirms existing capacity into Greece, but also reports a small 980,481 cm of capacity out of Greece, which may not have been reported due to its small capacity or its lack of utilization. TYNDP confirms the reported cross-border project, but also tracks 27,434,607 cm of incremental capacity out of Greece from three pipeline projects planned for the next five years – TAP Pipeline, Ionic-Adriatic Pipeline, and Nea Mesimvria.

Hungary reported 106,600,000 cm of cross-border capacity into Hungary and 42,200,000 cm of cross-border capacity out of Hungary. The TYNDP, however, reports 69,036,219 cm of cross-border capacity into Hungary and 25,222,869 cm of cross-border capacity out of Hungary. The discrepancy seems to stem from lower capacity estimates in the TYNDP data than the member state-reported data. Hungary reports no cross-border projects, but the TYNDP reports 34,411,105 cm of incremental capacity into Hungary and 18,006,907 cm of incremental capacity out of Hungary.

Latvia reported their data in million cubic meters, rather than the cubic meters suggested in the Regulation. Once converted, Latvia reported 20,480,000 cm of cross-border capacity into Latvia, 25,540,000 cm of cross-border capacity out of Latvia, and no future cross-border projects. The TYNDP affirms the accuracy of this data.

Lithuania reported their data in million cubic meters, rather than the cubic meters suggested in the Regulation. Once converted, Lithuania reported 5,800,000 cm of cross border capacity into Lithuania and 6,000,000 cm of cross border capacity out of Lithuania. The TYNDP, however, reports 24,134,912 cm of cross border capacity into Lithuania and 16,649,318 cm of cross border capacity out of Lithuania. The bulk of capacity out of Lithuania is flowing to Russia and the bulk of capacity into Lithuania is flowing from Belarus. The member state-reported data appears to not account for either pipeline and may only account for cross-border pipelines that cross into or out of other European Union member states.

Lithuania does not report any cross-border projects, but indicates that though projects have been announced, the projects have not yet reached FID, which would explain why Lithuania did not report the 6,919,932 cm of planned cross-border capacity into Lithuania or the 2,884,876 cm of planned cross-border capacity out of Lithuania that was reported by the TYNDP.

Poland reported 139,725,806 cm of cross-border capacity into Poland, 95,213,543 cm of cross-border capacity out of Poland, and no future cross-border projects. The TYNDP data confirms the member state-reported data for existing cross-border pipelines. However, the TYNDP reports 39,973,449 cm of incremental cross-border capacity into Poland and 34,976,767 cm of incremental cross-border capacity out of Poland in the next five year.

Portugal reported their data in million cubic meters, rather than the cubic meters suggested in the Regulation. Once converted, Portugal reported 12,100,000 cm of bidirectional cross-border capacity and 8,400,000 cm of future bidirectional cross-border capacity. The TYNDP, however, reports 13,575,888 cm of existing cross-border capacity to Portugal and 7,542,160 cm of existing cross-border capacity out of Portugal, as well as 11,973,179 cm of future capacity to Portugal and 9,144,869 cm of future capacity from Portugal. Platts cannot confirm the accuracy of the member state-reported data or the reason for the discrepancy in the data.

Romania reported 104,225,979 cm of cross-border capacity to Romania and 67,430,557 cm of cross-border capacity out of Romania. TYNDP reports slightly higher capacities with 114,621,977 cm of cross-border capacity to Romania and 72,747,904 cm of cross-border capacity out of Romania. Platts is unable to confirm the accuracy of the data or the border-crossing points as Romania reported the cross-border points in Romanian. Additionally, Romania reports 28,706,617 cm of incremental cross-border capacity into Romania and 20,445,417 cm of incremental cross-border capacity out of Romania. The TYNDP data confirms the accuracy of the project data reported by Romania.

Slovakia reported their data in million cubic meters, rather than the cubic meters suggested in the Regulation. Once converted, Slovakia reported 294,000,000 cm of cross-border capacity into Slovakia and 220,900,000 cm of cross-border capacity out of Slovakia. TYNDP data affirms the accuracy of existing cross-border pipeline data. However, Slovakia reported 82,100,000 cm of incremental cross-border capacity into Slovakia and 22,100,000 cm of incremental cross-border capacity our of Slovakia.

The member-state data differs significantly from TYNDP-reported data, which reported 18,351,018 cm of incremental cross-border capacity into Slovakia and 28,413,202 cm of incremental cross-border capacity out of Slovakia. Platts cannot confirm the accuracy of the member state-reported data, but 82,100,000 cm is extraordinarily high for new projects. Slovakia reports a 41,900,000 cm pipeline from the Czech Republic to Slovenia that cannot be verified and could be skewing the member state-reported data.

Slovenia reported their data in million cubic meters, rather than the cubic meters suggested in the Regulation. Once converted, Slovenia reported 14,800,000 cm of cross-border capacity into Slovenia, 8,300,000 cm of cross-border capacity out of Slovenia, and no cross-border pipeline projects. TYNDP confirms the accuracy of the existing cross-border pipeline data. However, TYNDP is tracking two bi-directional cross-border pipelines from Slovenia to Hungary and Austria with a capacity of 19,138,231 cm in both directions planned for 2021.

Spain reported their data in gigawatt hours, rather than the cubic meters suggested in the Regulation. Once converted, Spain reported 15,555,765 cm of cross-border capacity into Spain and 29,603,092 cm of cross-border capacity out of Spain. Though TYNDP affirms the accuracy of the capacity out of Spain, TYNDP reports 90,034,535 cm of cross-border capacity into Spain. TYNDP includes cross-border capacity from Algeria into Spain, but it appears as though Spain only reports cross-border capacity between Spain and other European Union member states.

Additionally, Spain reports 33,751,269 cm of incremental cross-border capacity into Spain and 57,886,301 cm of incremental cross-border capacity from Spain. TYNDP reports only 10,747,578 cm of incremental cross-border capacity into Spain and 17,158,414 cm of incremental cross-border capacity from Spain in the next five years. Some of the projects that Spain reports are outside of the five-year threshold for reporting, hence the larger member state-reported estimates.

Sweden did not actually report capacity of any cross-border capacity, but did indicate there is a cross-border point from Denmark to Sweden. TYNDP confirms that this border crossing, with a capacity of 8,296,376 cm, is the only cross-border point in Sweden.

Conclusions

Much of the member state-reported data does not correspond with the benchmark data both for existing pipeline capacity and planned pipeline capacity. Some notes as reported by the member states were useful in determining the accuracy of the data, as well as useful in providing additional information on the pipelines. Project information may differ as the TYNDP reports all project, regardless of whether the pipeline project has reached FID. The member state-reported is in inconsistent measurement units and cubic meters become a cumbersome unit to measure capacity.

In its current form, with vital member states such as Germany, France, and Italy failing to report, the member-state dataset is incomplete and less useful than the publically available data from ENTSO-G. Requiring additional details on the cross-border pipelines could improve the utility of this dataset.

G3 – LNG Terminals

State of the European LNG Infrastructure

As the European power market continues to diversify away from hydrocarbons to more renewable power generation sources, demand for natural gas in Europe has grown only marginally. Slowing demand growth for natural gas coupled with copious natural gas supply from Russia has led to low utilization rates of existing liquefied natural gas (LNG) import infrastructure. LNG terminals in Europe are expected to continue to run at low utilization rates, despite global oversupply of LNG in the next five years, negating the need for any incremental LNG import capacity. However, LNG could be extremely useful in efforts to diversify supply sources away from dependence on Russia.

Comparison of Member-State Data to Third-Party Sources

Under the Regulation, member states are required to report liquefied natural gas (LNG) terminals with a gasification capacity of 1 billion cm (bcm) per year or more. The template requires the member state to report the regasification of the capacity in billion cubic meters per year (bcm) and the maximum LNG storage capacity in the member state in cubic metres (cm).

Platts utilized Gas LNG Europe (GLE) to verify member state-reported data. GLE's LNG data is publically-available data published on GLE's website as the "LNG Import Terminals Map Database." The dataset includes import capacity by LNG facility. GIE defines a project as "under construction" if the final

Figure 18: Existing LNG Regas Capacity

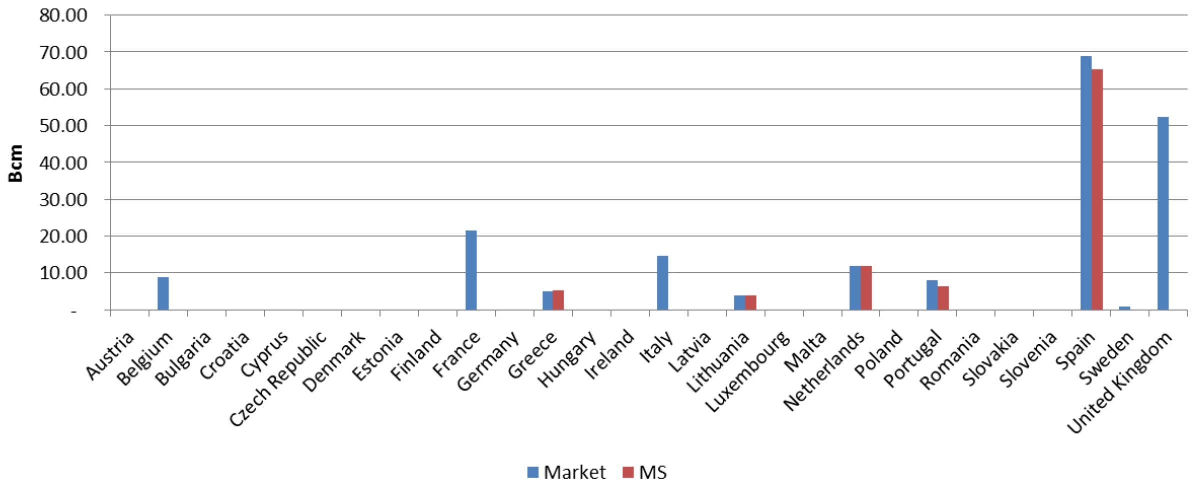
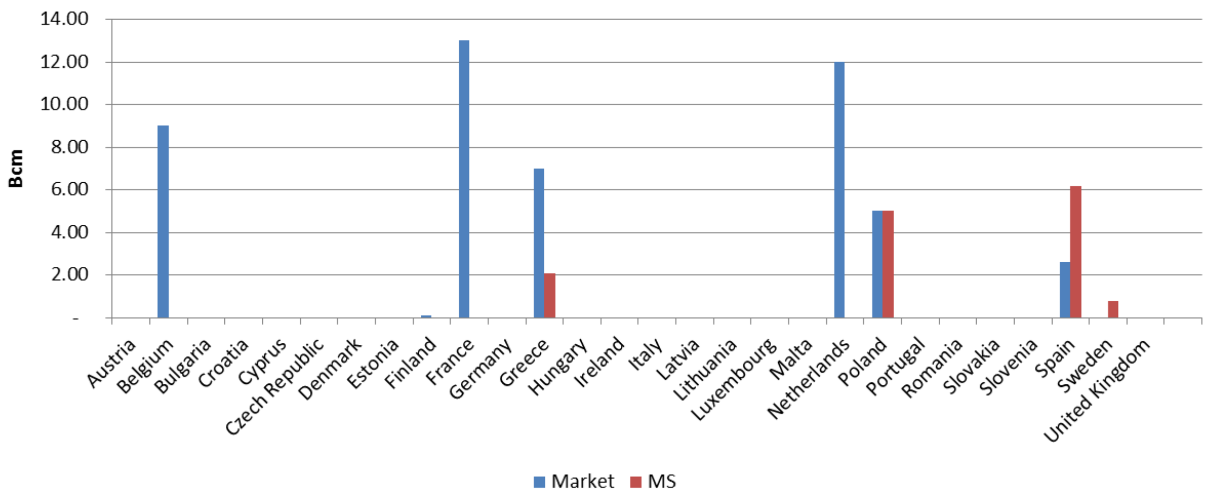


Figure 19: New LNG Regas Capacity

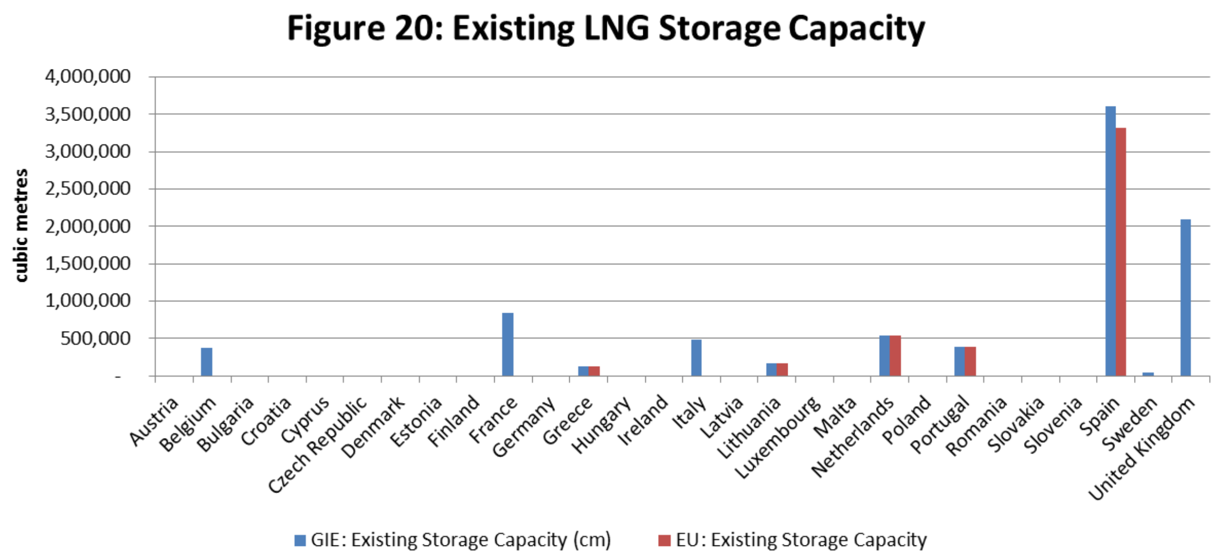


investment decision has been made and "planned" if the final investment decision has not been made, but Platts has taken into account all planned projects when comparing the data.

Ten of the 28 member states reported a total of ten terminals with a total regasification capacity of 92.77 bcm. Five of the member states that reported on LNG terminals have no LNG terminals. Only six member states reported LNG storage capacity with a total reported LNG storage capacity of 4,543,260 cm. GLE reports 24 terminals with a total regasification capacity of 196.25 bcm. Based on the benchmark data, Platts deems the LNG regasification and storage capacity to be mostly accurate.

Individual Member State Reporting

The **Czech Republic** and **Denmark** accurately reported no LNG terminals or LNG storage and no incremental LNG infrastructure.



Finland also accurately reported no LNG terminals, but also reported no incremental LNG infrastructure. However, GIE reports that the 2.5-bcm Finngulf LNG terminal is planned for 2021 with 120,000 cm of LNG storage capacity.

Greece accurately reports one LNG terminal with a capacity of 5.17 bcm, but reports only 2.07 bcm of additional capacity. GIE reports that one LNG terminal, the Revithoussa LNG Terminal, is under construction in Greece with a capacity of 7.0 bcm, and two additional LNG terminals, the Kavala LNG terminal and the Alexandroupolis LNG terminal, are planned with cumulative capacity of 11.10 bcm. Greece accurately reported 126,760 cm of existing LNG storage capacity. However, Greece only reported 95,000 cm of planned incremental storage capacity, while GIE reports incremental storage capacity of 225,000 cm.

Lithuania accurately reports one operational LNG terminal with a capacity of 4.00 bcm, but reports no incremental LNG infrastructure. GIE reports that the existing FSRU Independence terminal is undergoing a 4.00-bcm expansion, which is currently under construction. Lithuania also accurately reports 170,000 cm of LNG storage and no incremental storage capacity planned.

The Netherlands accurately reported one operational LNG terminal with a capacity of 12.00 bcm, but reports no incremental LNG infrastructure. GIE reports that the existing Gate terminal at Rotterdam is undergoing a 12.00-bcm expansion, which is currently under construction, and another planned expansion of 16.00 bcm. The Netherlands accurately reported 540,000 cm of LNG storage capacity, but no incremental storage capacity, whereas GIE tracks an incremental 540,000 cm of LNG storage capacity.

Poland accurately reported no existing LNG terminals. However, Poland reported only one new terminal project with a capacity of 5.00 bcm and no new LNG storage capacity, but GIE reports that, in addition to the new 5.00-bcm Swinoujscie LNG terminal, there is a planned expansion of the facility with a capacity of 7.50 bcm and 120,000 cm of LNG storage capacity.

Portugal accurately reported one operational LNG terminal with a capacity of 6.30 bcm and no incremental LNG infrastructure. Portugal also accurately reported 390,000 cm of existing LNG storage capacity and no planned incremental storage capacity.

Spain accurately reported six operational LNG terminals with a cumulative capacity of 65.30 bcm. However, Spain only reported 6.20 bcm of incremental capacity, while GIE reports a cumulative 47.40 bcm of expansions of existing LNG terminals and new LNG terminals. Spain reports 3,316,500 cm of existing LNG storage capacity and 800,000 cm of incremental storage capacity planned, but GIE reports 3,616,500 cm of existing storage capacity and 300,000 cm of incremental storage capacity planned.

Sweden accurately reported no existing LNG terminals and 0.80 bcm of incremental LNG terminal capacity. Sweden also reported 27,000 cm of new LNG storage capacity, but GIE reports that Sweden has 50,000 cm of operational LNG storage capacity.

Conclusions

Four of the member states that did not report on LNG terminals have 11 existing LNG terminals with a cumulative capacity of 97.65 bcm, or about half of existing LNG regasification capacity, and 3,800,000 cm of LNG storage capacity. Belgium has one terminal with a capacity of 9.00 bcm, France has three terminals with total capacity of 21.65 bcm, Italy has three terminals with a total capacity of 14.70 bcm, and the United Kingdom has four terminals with a cumulative capacity of 52.30 bcm. The GIE reports that there is a cumulative 16.50 bcm of projects planned and under construction in these four member states, as well as 950,000 bcm of new LNG storage capacity.

GIE reports LNG terminal projects Croatia, Estonia, Germany, Ireland, Latvia, Malta, and Romania with a cumulative capacity of 24.50 bcm. Austria, Bulgaria, Cyprus, Hungary, Luxembourg, Slovakia, and Slovenia did not report, but have no existing or planned LNG infrastructure.

The majority of the member state-reported data required by the Regulation template is already published publically by GLE, but with less detail, since GLE reports data by facility and not at the member-state aggregate level. The benchmark data from GLE reports all projects that have been planned.

Given the comprehensive reporting of existing and projected capacity reported by the GLE, there remains little need for the member state-reported data. Additionally, non-reporting member states account for 50% of total LNG import capacity in Europe, making the current dataset largely incomplete without reported data from Belgium, France, Italy, and the United Kingdom.

Finally, tracking regasification capacity alone fails to encompass major trends in the LNG market by not reporting export capacity in addition to import capacity. Cyprus' Vassilikos LNG terminal, for example, is planned for 4.5 t/year of LNG exports by 2022 and four export terminals are currently operating in Norway with an export capacity of 4.82 t/year. As the global LNG market continues to evolve, it is vital to track export terminals as well as import terminals in Europe.

G4 – Gas Storage

State of the European Gas Storage Infrastructure

Natural gas storage utilization in Europe has continued to climb in the last two years, primarily due to the abundance of natural gas in the global market and mild weather in Western Europe. At the same time, European countries have increased power generation capacity from renewable sources, reducing natural gas demand in the region. Given the reliability of natural gas and the easy access to supply both from Russia and in the form of LNG, European countries will continue to rely on natural gas storage to meet their power demand needs when renewable energy-powered generation is unable to meet demand. Given the decreasing demand for natural gas, there should be limited build out of new natural gas storage capacity, but increasing amounts of investment are being allotted toward increasing natural gas storage capacity, likely in conjunction with new natural gas-fired power plants.

Comparison of Member-State Data to Third-Party Sources

Under the regulation, member states are required to report natural gas storage installations connected to the transport pipelines. The template requires member states to report total storage capacity in billion cubic metres (bcm), working gas capacity in billion cubic metres (bcm), maximum withdrawal capacity in million cubic metres per day (mcm/d), and maximum injection capacity in million cubic metres per day (mcm/d).

Platts utilized Gas Storage Europe (GSE) gas to verify the accuracy of member state-reported data. The publically available data is published as the Storage Map Database and tracks existing storage facilities, as well as storage projects planned and under construction. The data includes the type of facility (aquifer, salt cavern, depleted field, other), working gas capacity, and maximum withdrawal and

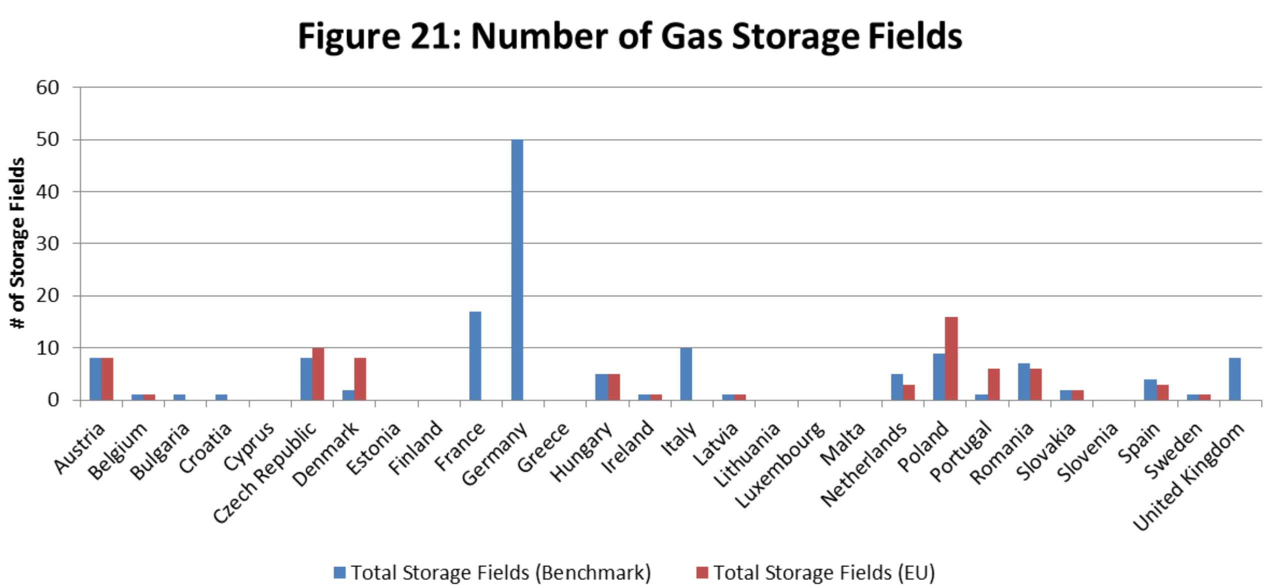


Figure 22: Capacity of Existing Gas Storage Fields

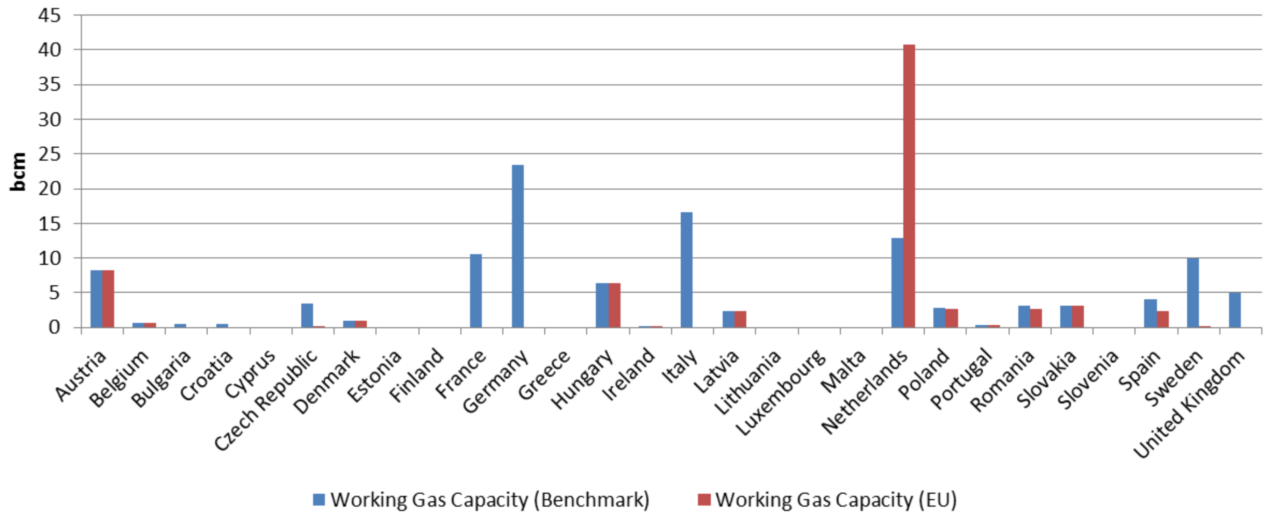
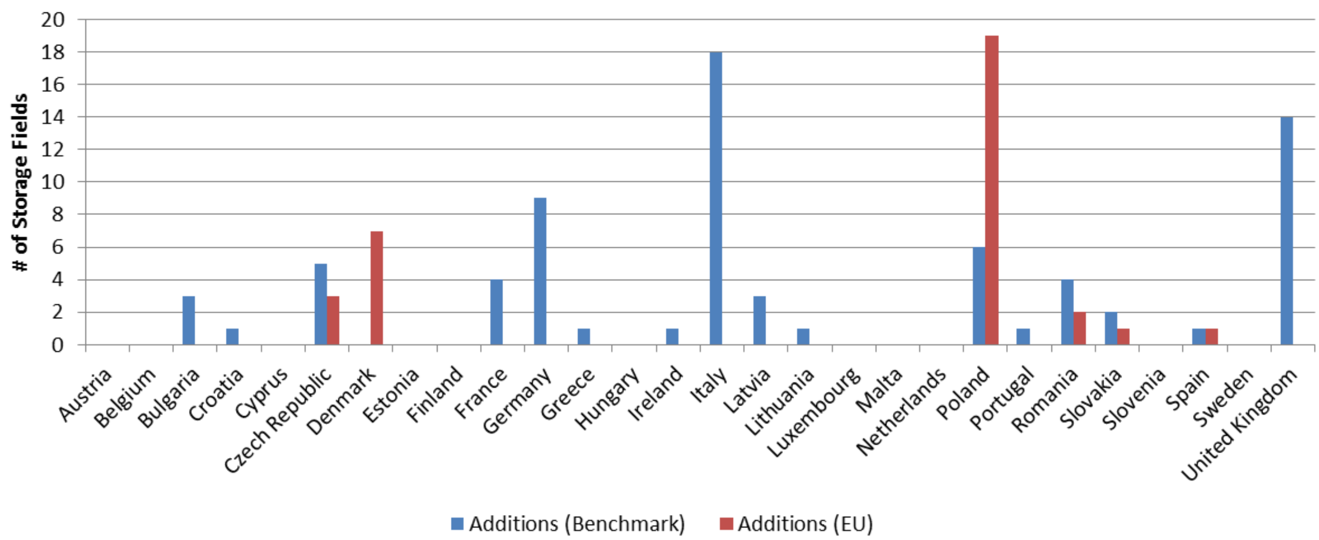
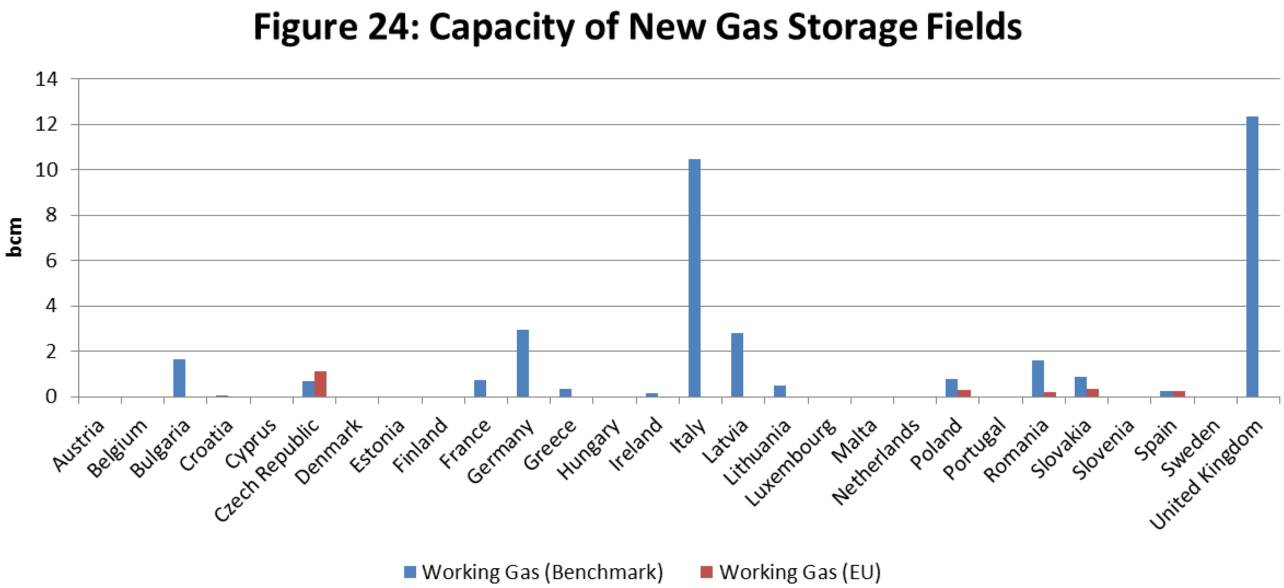


Figure 23: Number of Gas Storage Additions



injection capacity by storage facility. When compared to GSE data, the member state-reported data was relatively accurate with the exception of some errors in data-reporting.

Sixteen of the 28 member states reported 17.40 bcm of aquifer storage capacity, 2.0 bcm of salt cavern storage capacity, 39.00 bcm of storage from depleted fields, no above ground storage, and 0.01 bcm of line rock storage. Non-reporting member states account for approximately 11.10 bcm of aquifer storage capacity, 15.20 bcm of salt cavern storage capacity, 29.90 bcm of storage from depleted fields, no above ground storage. Member states that reported data reported 16 new storage facilities with a cumulative capacity of 6.10 bcm, while GSE tracks 52 new storage facilities in non-reporting member states with a cumulative capacity of 30.10 bcm.



Individual Member-State Reporting

Austria reported eight storage facilities, all of which were aquifer storage, with total capacity of 8.20 bcm. According to GSE, however, Austria's storage facilities are all depleted fields. Austria's reported total working capacity and maximum injection and withdrawal rates matched that of the GSE data.

Belgium reported one aquifer storage facility with a capacity of 0.70 bcm. Belgium's reported total working capacity and maximum injection and withdrawal rates matched that of the GSE data.

Bulgaria reported one storage facilities at a depleted field with a capacity of 1.30 bcm and no planned storage facilities. Bulgaria's reported total working capacity and maximum injection and withdrawal rates matched that of the GSE data.

The **Czech Republic** reported one aquifer storage facility with a capacity of 0.17 bcm, one salt cavern with a capacity of 0.06 bcm, and five depleted field storage facilities with a total capacity of 2.46 bcm. Because the Czech Republic likely reported its storage capacity in incorrect units, it is difficult to judge the accuracy of the reported data. GSE reports three operational storage facilities at depleted fields with a total capacity of 3.50 bcm and differing estimates on maximum injection and withdrawal rates. The Czech Republic also reports three new storage facilities with a total capacity of 1.10 bcm, while GSE reports five new storage facilities with a total capacity of 0.70 bcm.

Denmark reported one aquifer storage facility with a capacity of 0.60 bcm and seven salt caverns with a total capacity of 0.50 bcm. However, the GSE only reports one operational salt cavern with a capacity of 0.50 bcm. Belgium's reported total working capacity and maximum injection and withdrawal rates mostly matched that of the GSE data. Denmark also reported seven new salt cavern storage facilities, but reported no information on the facilities, while GSE reported no new storage projects in Denmark.

Hungary reported five storage facilities at depleted fields with a total capacity of 6.33 bcm. GSE verifies that Hungary's member-state data is accurate.

Ireland reported one depleted field storage facility with a total capacity of 0.23 bcm. GSE verifies Ireland's member-state data is accurate. Ireland reports no new storage facilities, but GSE tracks one new offshore depleted field storage facility with a capacity of 0.20 bcm.

Latvia reported one aquifer storage facility with a capacity of 2.30 bcm. GSE verifies Latvia's member-state data is accurate. Latvia reports no new storage facilities, but GSE tracks three new aquifer storage facilities with a cumulative capacity of 2.8 bcm.

The Netherlands reported three depleted field storage facilities with a total capacity of 40.7 bcm. GSE, however, reports a total working gas capacity of 12.8 bcm from five storage facilities at depleted fields and one salt cavern storage facility. The inaccurate capacity estimate was likely a reporting error, given the disproportionate size of the reported capacity to the number of storage facilities.

Poland reported 11 salt cavern storage facilities with a total capacity of 0.52 bcm and five depleted field storage facilities with a total capacity of 2.2 bcm. GSE, however, only tracks two operational salt cavern storage facilities with a capacity of 0.50 bcm and tracks 7 operational depleted field storage facilities with a total capacity of 2.3 bcm. Poland is likely not accurately accounting for the number of operating storage facilities as the capacities for the two types of storage facilities appear accurate based on GSE data.

Additionally, Poland reports 15 new salt cavern storage facilities with a cumulative capacity of 0.30 bcm and four new depleted field storage facilities with 0.00 bcm of capacity. GSE only reports two new salt cavern storage facilities with a cumulative capacity of 0.60 bcm and four new depleted field storage facilities with a cumulative capacity of 0.20 bcm. Notes reported by the member state were in Polish and could not be analyzed.

Portugal reported six salt cavern storage facilities with a total capacity of 0.31 bcm and reports new salt cavern storage capacity without indicating a capacity estimate. GSE, however, only reports one salt cavern storage facility with comparable capacity. Spain accurately reported a new salt cavern storage facility and GSE also does not report the capacity of the new storage facility.

Romania reported six depleted field storage facilities with a cumulative capacity of 2.67 bcm and four new depleted field storage facilities with a capacity of 0.63 bcm. GSE reports seven depleted field storage facilities with a cumulative capacity of 3.10 bcm and three new depleted field storage facilities with a cumulative capacity of 1.40 bcm.

Slovakia reported two depleted field storage facilities with a total capacity of 3.20 bcm and one new depleted storage facility planned in the next five years with a capacity of 0.34 bcm. GSE confirms the accuracy of the member state-reported data for existing storage facilities, but tracks two new depleted storage facilities with a total capacity of 0.90 bcm.

Spain reported one aquifer storage facility with a capacity of 1.05 bcm and two depleted storage facilities with a total capacity of 2.39 bcm. However, the GSE reports three operational depleted field storage facilities with a total capacity of 3.10 bcm.

Sweden reported one line rock cavern storage facility with a capacity of 0.01 bcm. GSE confirms the facilities, but estimates working gas capacity at 10.00 bcm.

The **United Kingdom** only supplied information on decommissioning projects as the existing and planned storage data is covered by ENTSO-G. The decommissioning projects are not tracked by any independent, third-party source and, therefore, cannot be verified. The United Kingdom is only retiring one small above-ground storage facility with a capacity of 0.08 bcm, which is largely inconsequential to the understanding of gas storage infrastructure in Europe.

Conclusions

The majority of the member state-reported data required by the Regulation template is already published publically by GSE, but with less detail, since GSE reports data by storage facility and not only at the member-state aggregate level. Similarly, the data reporting required by the Regulation includes information that may not be useful to the overarching understanding of infrastructure, such as the total storage capacity or the maximum injection and withdrawal capacity. Also, given the comprehensive reporting of existing and projected capacity reported by the GSE, there remains little need for the member state-reported data, with the exception of decommissioning data reported by member states.

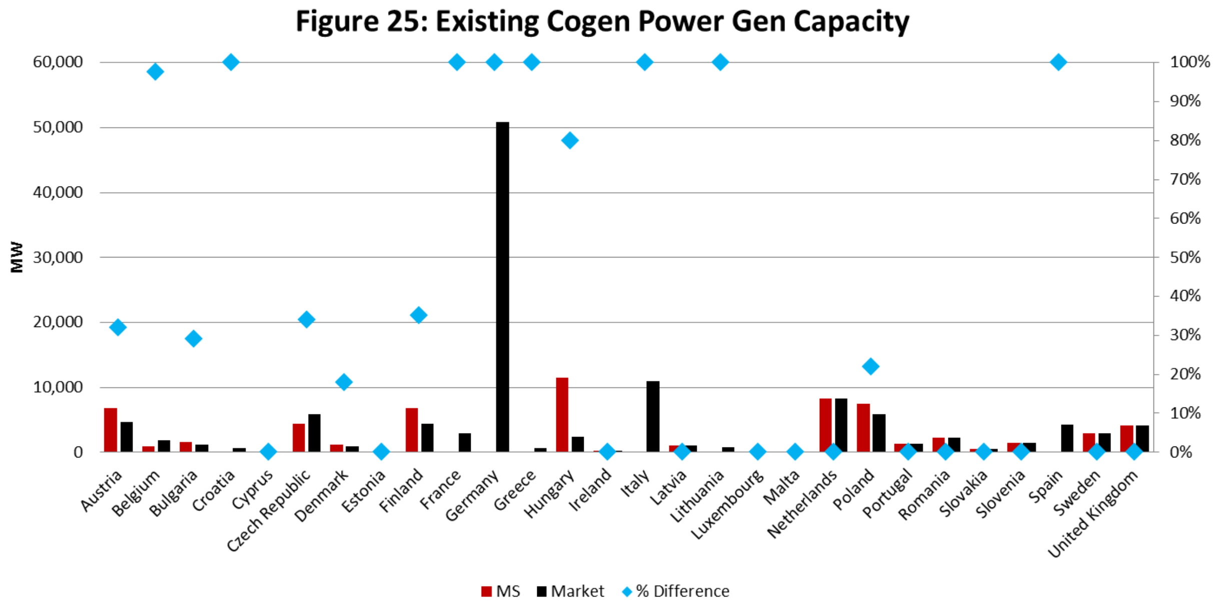
The value of the member state-reported data is drastically affected by the number and importance of member states that did not report information. The majority of new storage facilities and 50% of existing storage capacity reside in the 13 member states that did not report natural gas storage data. The bulk of European natural gas storage is located in Germany, France, and Italy where storage capacity is estimated at 23.50 bcm, 10.50 bcm, and 16.60 bcm, respectively. Without data from these member states, the dataset is complete and not entirely useful in understanding European infrastructure.

E1 – Electricity Production

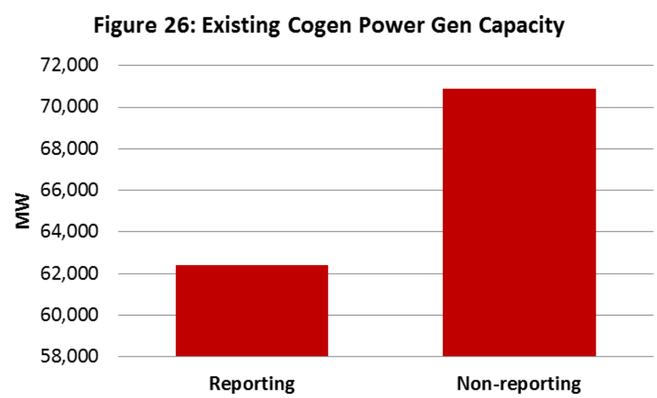
State of the European Electricity Production Infrastructure

The European power market has become increasingly diversified as renewable energy sources account for a greater share of total power generation capacity. Member states endeavor to diversify their power sources domestically and, in most cases, seek to transition reliance away from hydrocarbons. Such goals have led to a build-out of new infrastructure, an increasing amount of power generation capacity fueled by renewable energy sources, and retirements of inefficient or hydrocarbon-intensive power plants. Economic growth in Europe could also drive continued investment in incremental power generation facilities.

Comparison of Member-State Data to Third-Party Sources



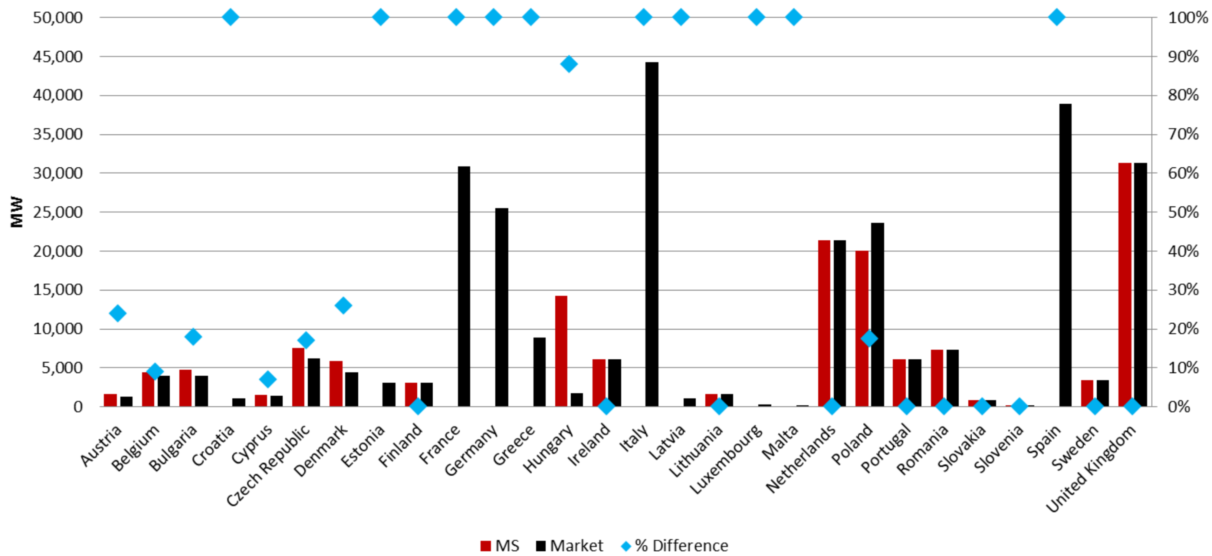
Platts utilized Platts' Powervision to determine the accuracy of member state-reported data. Powervision tracks installed and planned generation capacity in the European power sector. It builds on over ten years of continuous research by a dedicated product team which reviews company reports and releases, official government gazettes and filings, tender postings, and local press, and makes direct enquiries with utilities and developers.



Constantly updated and released monthly, Platts Powervision's European power plant data is cross-referenced to publicly available inventories and benchmarked to aggregate statistics. In addition to comprehensive monitoring of available information sources, the product team carries out proactive research guided by internal metrics on project development timelines.

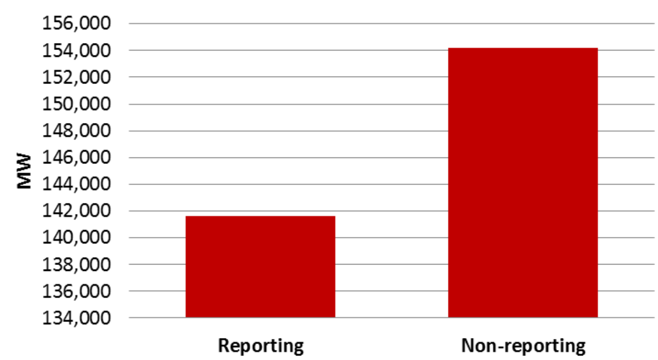
Member states are required to report electricity production capacity in megawatts (MW) by type of power generation. The types of electricity production to be reported include thermal and nuclear power generation (generators with a capacity of 100 MWe or more), biomass/bioliquids/waste power generation installations (with a capacity of 20 MW or more), power stations with cogeneration of electricity and useful heat (installations with an electrical capacity of 20 MW or more), hydro-electric power stations (installations having a capacity of 30 MW or more), wind power farms with a capacity of 20 MW or more, concentrated solar thermal and geothermal installations (with a capacity of 20 MW of more), and photovoltaic installations (with a capacity of 10 MW or more).

Figure 27: Existing Conventional Power Gen Capacity



Member state-reported power plant capacity differs, on average, about 5% from third-party source-reported capacity. In Platts's comparison between member state-reported data and Platts' Powervision, Platts assumed that the member-state data was accurate if the capacities were within a 5% margin of error. Powervision perpetually overestimates incremental capacity, because it tracks all announced, proposed, and considered projects, and does not note if projects have reach FID.

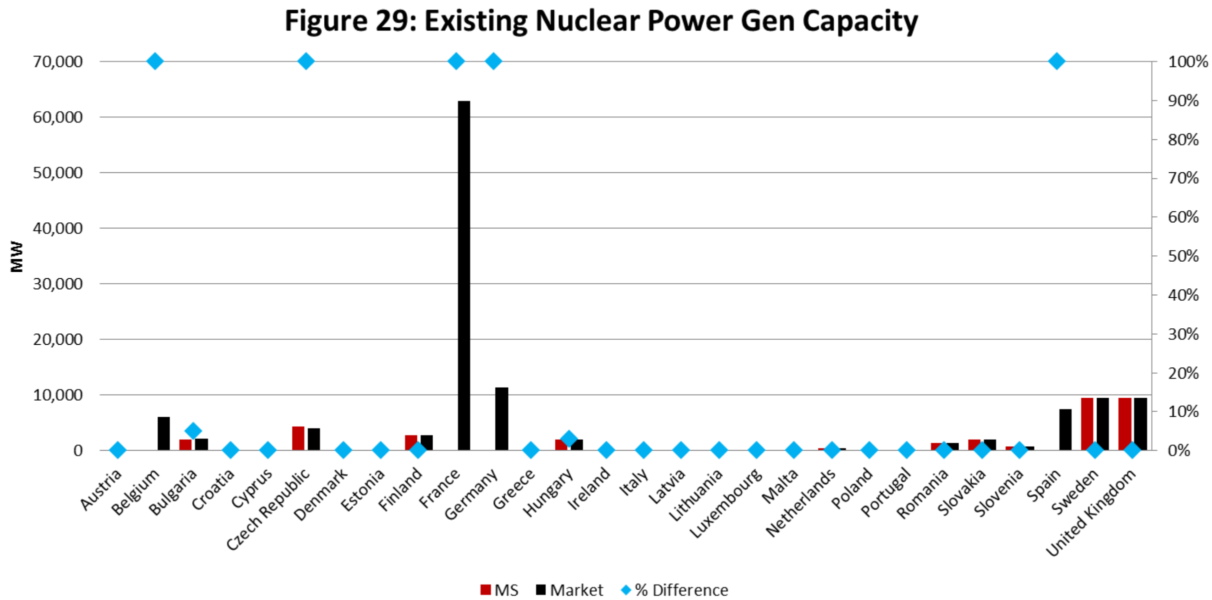
Figure 28: Existing Conventional Power Gen Capacity

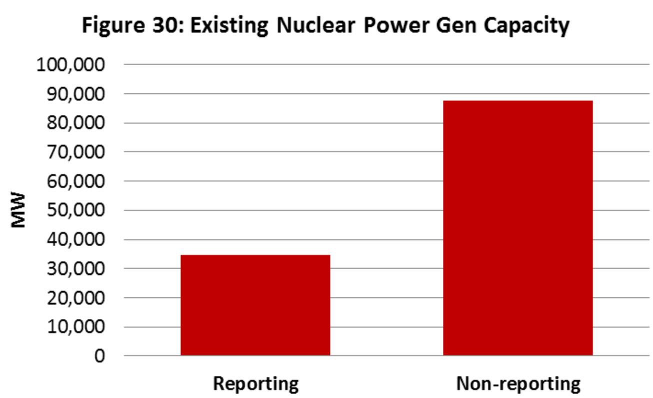


Nineteen of the 28 member states reported 330,465 MW of existing electricity production capacity, 6,994 MW of production capacity planned or under construction, and 31,375 MW of capacity slated for retirement. Of the member states that did not report, Powervision tracks 478,628 MW of electricity production capacity, 84,394 MW of production capacity planned in the next five years or under construction, and 26,454 MW of capacity slated for retirement in the next five years.

Individual Member-State Reporting

Austria reports 1,650 MW of conventional thermal power burning capacity and aggregates capacity into an "other" category. Platts' Powervision tracks about 1,255 MW of conventional power plant capacity including 250 MW of oil-fired generation, 505 MW of gas-fired generation, and 500 MW of generation using two or more sources. Austria also reports 377 MW of biomass generation and no waste or bioliquid generation over >20 MW. Powervision, however, only tracks about 141 MW of biomass power generation.

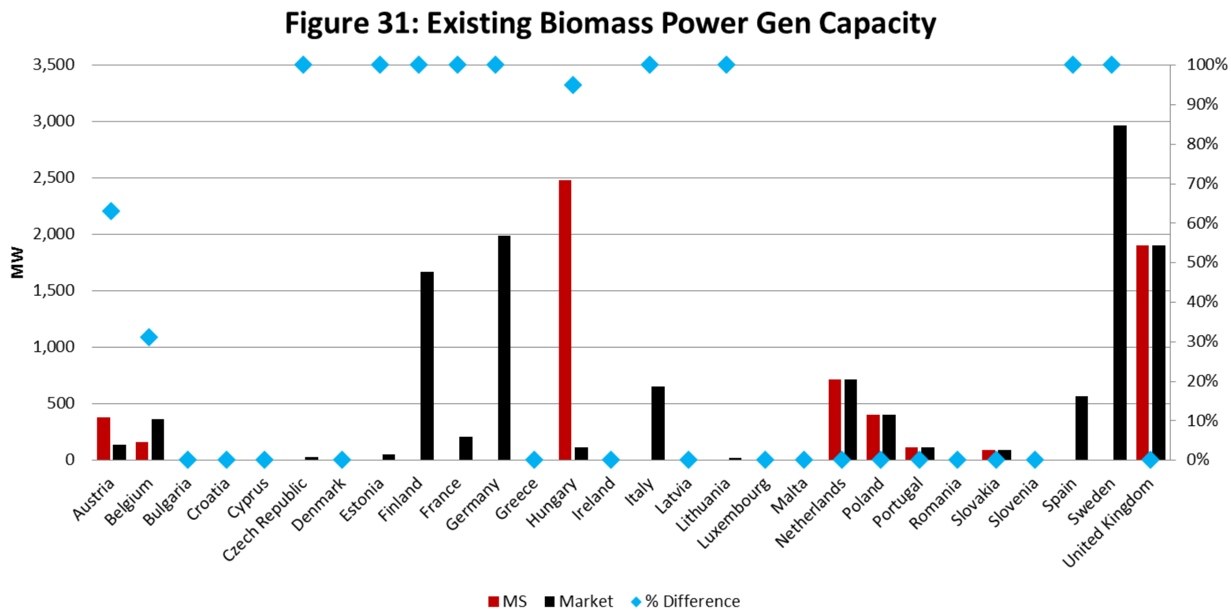




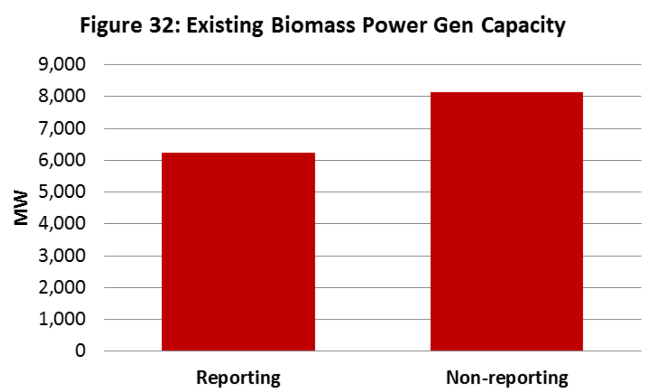
Austria reports 6,782 MW of total power generation capacity with cogeneration capabilities, but does not track the source of generation from cogen plants. Powervision tracks about 4,619 MW of cogeneration capacity. Austria reports 12,230 MW of hydroelectric power generation. Powervision tracks about 11,548 MW of hydroelectric power generation. Austria reports 1,069 MW of onshore wind generation capacity. Powervision is currently tracking about 2,157 MW of wind generation capacity. Part of this discrepancy likely stems from the 728 MW of wind capacity that was added in 2014 and 2015. Austria does not report any PV installation capacity, but Powervision tracks 746 MW of PV installation capacity with a capacity greater than 20 MW.

Of the power generation projects reported, Austria reported 879 MW of hydroelectric generation under construction, 127.5 MW of wind power under construction, and 86.2 MW of wind power planned in the next five years. Powervision does not track any wind power projects, but is tracking about 1,011 MW of hydroelectric projects currently under construction and 1,830 MW of hydroelectric projects planned or proposed for the next five years, as well as one proposed coal plant with a capacity of 800 MW.

Belgium reports 4,410 MW of conventional thermal power burning capacity, 3,940 MW of which is gas-fired and 470 MW of which is coal- and biomass-fired. Powervision tracks about 3,995 MW of conventional power generation, in line with member state-reported data. However, Powervision only tracks 1,819 MW of gas-only power generation. Powervision confirms the 470 MW coal- and biomass-



fired Langerlo power plant. Belgium also reports 158 MW of waste power generation, while Powervision tracks 365 MW of power generation from biomass, waste, and wood.

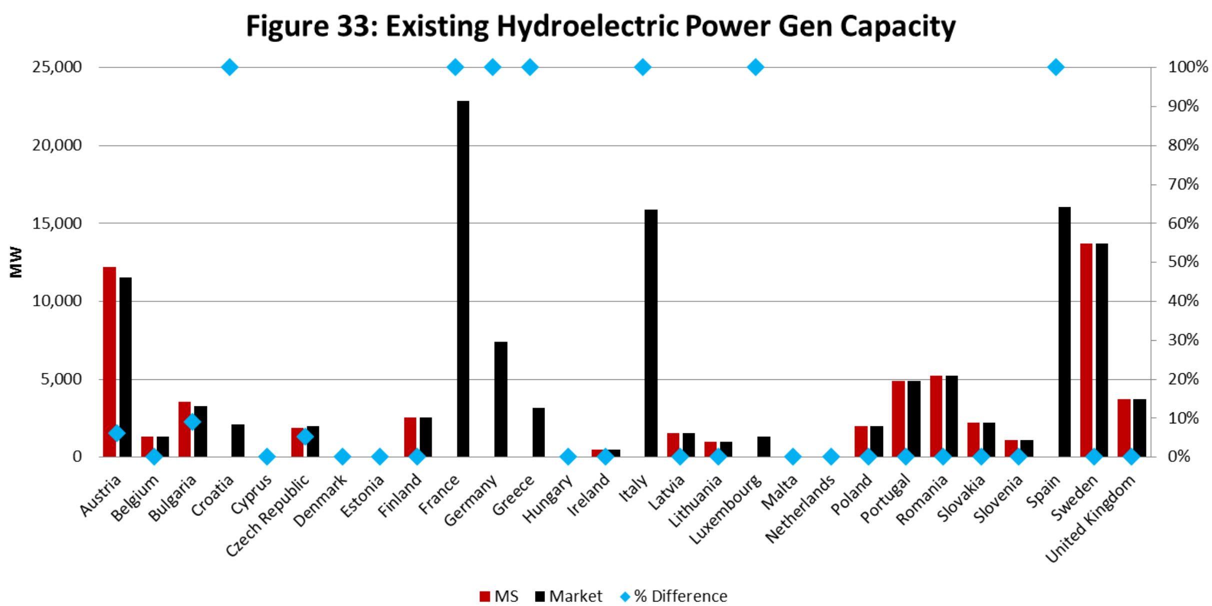


Belgium reports 960 MW of total power generation capacity with cogeneration capabilities from gas and waste, while Powervision reports 1,897 MW of cogen capacity. The bulk of the plants deemed to be cogeneration facilities are gas-fired. Platts suspects that some of the gas-fired plants reported in conventional power generation could actually be cogeneration plants as defined by Powervision.

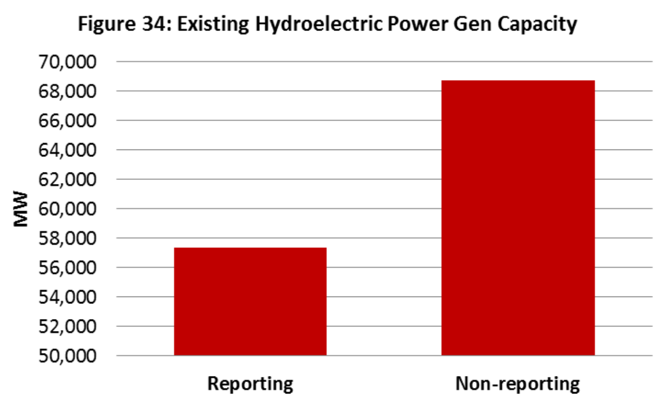
Belgium also reports 1,307 MW of hydroelectric power generation. Powervision confirms the hydroelectric power generation capacity from the Coo and Plate Taille plants.

Finally, Belgium reports 105 MW of wind-powered generation from onshore installations with a capacity greater than 25 MW and 133.89 MW from onshore installations with a capacity greater than 25 MW, as well as 712 MW of wind-powered generation from offshore wind farms. Powervision tracks 929 MW of wind-powered generation from installations with a capacity greater than 20 MW, in line with the 817 MW reported by Belgium.

Platts cannot confirm the 817 MW of non-operational geothermal capacity. However, Belgium failed to report any PV installation capacity, while Powervision tracks 3,079 MW of PV installations with a capacity of greater than 20 MW. Similarly, Belgium failed to report its nuclear power plants. Belgium is home to the Doel and Tihange nuclear power plants with a cumulative capacity of 6,043 MW. The plants



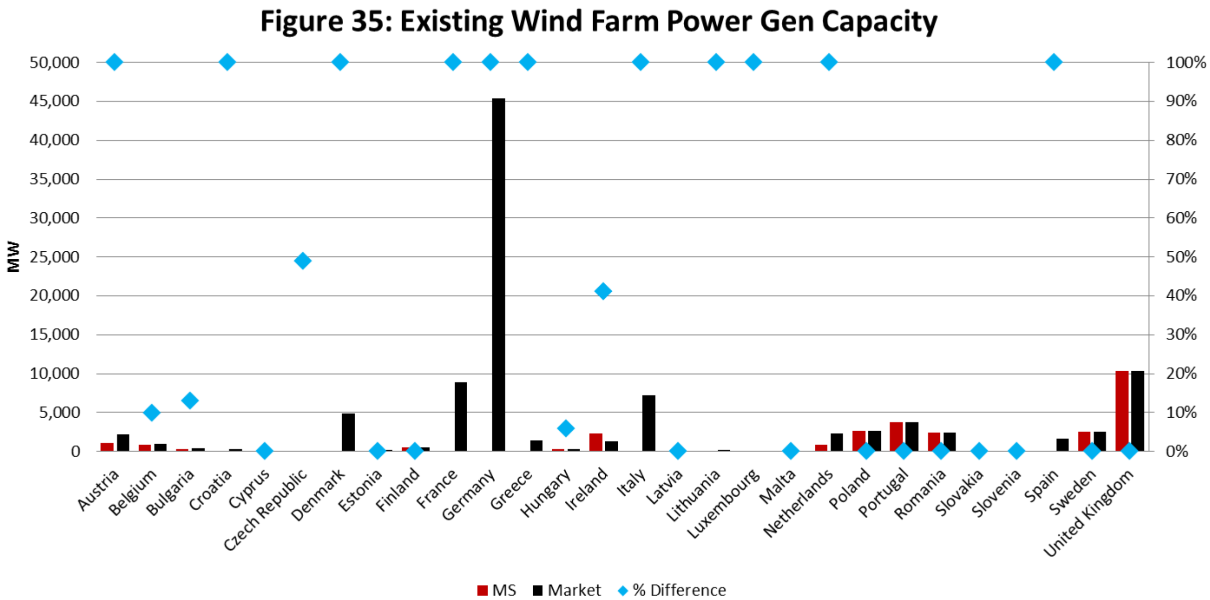
are slated for retirement between 2022 and 2025, but should continue to be reported as operational until retirement.



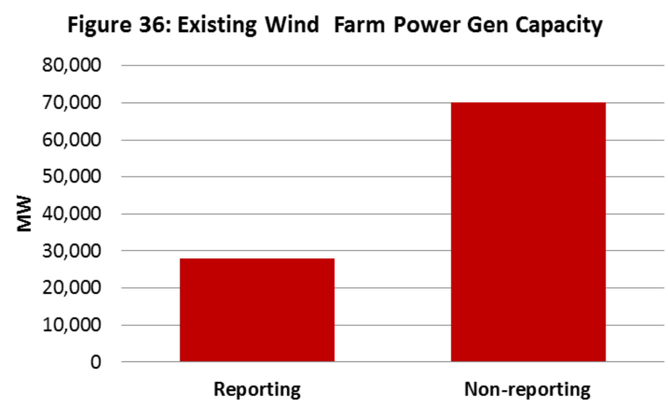
The only projects reported by Belgium were six new planned wind farm installations with a cumulative capacity of 448 MW. However, Powervision is tracking 1,856 MW of wind farm installation, 240 MW of which are onshore and planned for completion before 2017, and 1,616 MW of offshore wind farm installations planned in the next five years. Powervision is also tracking the 400 MW proposed Antwerp Biomass plant, 3,060 MW of natural gas-fired conventional power plants, a 20 MW offshore hydroelectric power plant, and a 215 MW waste plant, none of which has been reported by Belgium.

Bulgaria reports 4,814 MW of operational coal-fired conventional power generation and 320 MW of non-operational coal-fired conventional power generation, as well as 630 MW of coal- and gas-fired conventional generation. Bulgaria's reporting is in line with Powervision, which reports 3,958 MW of operational coal-fired conventional power generation, but Powervision indicates that all coal- and gas-fired conventional power plants were retired as of 2014.

Bulgaria reports 2,000 MW of operational nuclear power plant capacity and 1,760 MW of non-operational nuclear power plant capacity. Bulgaria's reporting is in line with Powervision, which reports 2,100 MW of capacity from the Kozloduy plant, which added 100 MW of capacity in 2015 since the member state last reported.



Bulgaria reports about 1,618 MW of operational power plants with cogeneration capabilities and 239 MW of non-operational capacity. Powervision only track 1,151 MW of cogen capacity, of which 905 MW is coal-fired, 125 MW is gas-fired, and 121 MW is fired by both gas and oil.



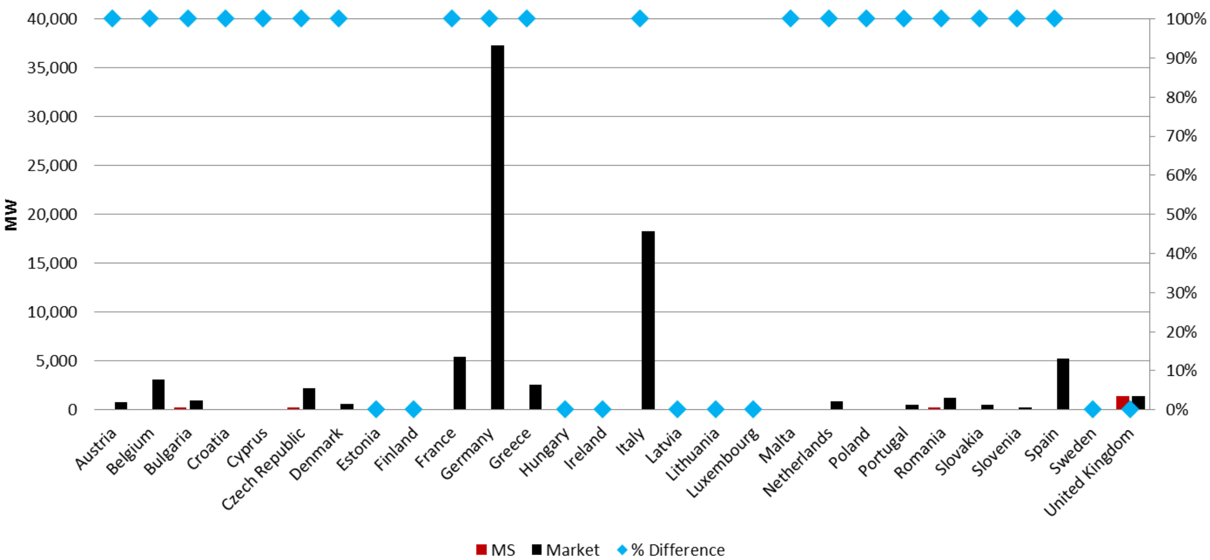
Bulgaria reports 3,571 MW of hydroelectric power generation capacity, in line with Powervision's estimate of 3,267 MW of capacity. Bulgaria reports 323 MW of wind farm power generation capacity, in line with Powervision's estimate of 365 MW of capacity.

Though Bulgaria does report PV installation capacity of 240 MW, Powervision indicates that Bulgaria under-reports its PV installation capacity which Powervision reports at 992 MW.

Bulgaria reports a slew of power plant projects, including a planned 210 MW coal-fired conventional power plant, two nuclear plants with a capacity of 2,000 MW currently under construction and another 1,000 MW of nuclear capacity planned, four natural gas cogeneration plants planned and under construction with a cumulative capacity of 107 MW. Powervision is only tracking 1,000 MW of new nuclear power plant capacity, 956 MW of hydroelectric plant projects, and 985 MW of new wind farm capacity.

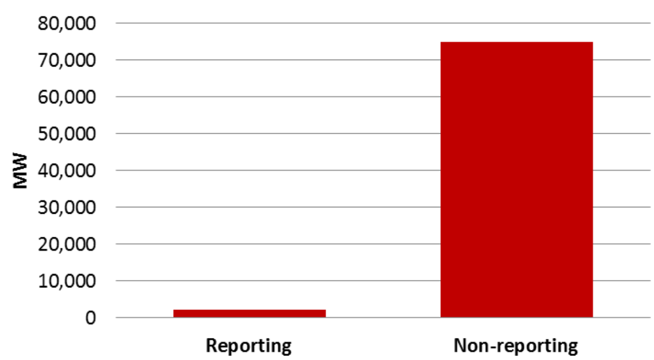
Bulgaria also reports the decommissioning of four nuclear plants with a cumulative capacity of 1,760 MW and the decommissioning of four natural gas-fired cogeneration plants with a cumulative capacity of 135 MW. Powervision, on the other hand, only tracks the retirement of a 120-MW coal-fired conventional power plant.

Figure 37: Existing PV Installation Power Gen Capacity



Cyprus reports 1,478 MW of conventional power plant capacity, which is line with Powervision's estimate of 1,378 MW of capacity, comprised of 1,158 MW of oil-fired capacity and 220 MW of gas-fired capacity. Powervision also tracks 32 MW of power generation capacity from PV installations not reported by Cyprus. Neither the member-state data nor Powervision tracks any power plant projects in Cyprus.

Figure 38: Existing PV Installation Power Gen Capacity



The **Czech Republic** reports 7,582 MW of conventional power burning capacity, 4,290 MW of nuclear power plant capacity, 4,325 MW of power plants with cogeneration capabilities, 1,869 MW of hydroelectric generation capacity, 83 MW of wind farm installation capacity, and 242 MW of PV installation capacity. Powervision tracks 6,263 MW of conventional power burning capacity and 5,790 MW of power plants with cogeneration capacity. Cumulatively, hydrocarbon power burn is very close, indicating that the discrepancy lies in the definition of a cogeneration plant and that the Czech Republic data is mostly accurate.

The Czech Republic failed to report the 30 MW Houdin biomass power plant as a biomass power generation source. Additionally, Powervision tracks only 42 MW of wind farm installations, which is significantly lower than the member-state data. However, the bulk of the wind farm installations are of 20 MW capacity or lower. To include the smaller farms, total wind farm installation capacity is estimated at 223 MW. The discrepancy in the member-state data and third-party data is likely due to the 20 MW reporting threshold. Finally, Powervision tracks 2,230 MW of PV installation capacity, much greater than the member state-reported data. The Czech Republic included useful notes, but were not helpful in resolving the data discrepancies.

The Czech Republic only reported four new coal-fired power plants currently under construction with a total capacity of 1,410 MW. Powervision tracks two coal-fired power plants with a cumulative capacity of 780 MW that are currently under construction. Another two power plants are planned for the end of the decade with a capacity of 1,860 MW. Powervision also tracks 84 MW of new wind farm installations, which is not reported by the member state.

Denmark reports 5,896 MW of conventional power burning capacity and 1,169 MW of power plants with cogeneration capabilities. Denmark employed unique reporting tactics that hinder the full understanding and analysis of the member state-reported data. Powervision tracks 2,601 MW of coal-fired cogeneration plant capacity, which Denmark likely attributes to conventional power generation. Despite the discrepancies related to the definition of a cogeneration plant, Platts affirms the accuracy of the reported data.

Denmark, like many member states, failed to report its PV installation capacity, which Powervision estimates at 595 MW. Due to reporting errors, Platts is unable to establish the reported capacity for wind farm installations. Powervision reports 7,066 MW of wind farm installation capacity, 2,183 MW of which was added in 2015.

Denmark reported one new cogeneration plant using two or more sources currently under construction, 170 MW of planned biomass power plant capacity, and a 39 MW planned waste power plant. However, Powervision is tracking 1,284 MW of new biomass plant capacity, 791 MW of which are restarts. Denmark-reported data is mostly accurate, but Denmark did not report the 1,025 MW of new offshore wind farm installation capacity planned in the next five years.

Finland reports 3,074 MW of conventional power burning capacity, 2,752 MW of nuclear power plant capacity, 6,760 MW of power plants with cogeneration capabilities, 2,537 MW of hydroelectric generation capacity, and 551 MW of wind farm installation capacity. Powervision affirms the accuracy of conventional power burning capacity, nuclear plant capacity, hydroelectric capacity, and wind farm installation capacity.

Powervision tracks 4,411 MW of power plants with cogeneration capabilities, which is significantly lower than the member state-reported data. Additionally, Powervision tracks 1,668 MW of biomass, waste, and wood-fired power plant generation capacity. Combined, these two capacities are near that of the 6,760 MW of cogeneration capacity reported by Finland, indicating that Finland likely lumped biomass plants into total cogeneration capacity.

Of the power plant projects planned in Finland, Finland reported one nuclear power plant under construction with a capacity of 1,600 MW, one planned biomass- and coal-fired cogeneration plant with a capacity of 145 MW, one planned hydroelectric plant with a capacity of 38 MW, and 11 planned wind farm installations with a cumulative capacity of 378 MW. Powervision affirms the accuracy of these projects except for the wind farm projects which cumulatively account for 4,569 MW of incremental power capacity in the next five years, 2,981 MW of which is planned for offshore. Finland is likely only reporting wind farm installation projects planned for 2016, which total about 462 MW. Additionally, Finland reports that 370 MW of oil-fired convention power plant capacity are slated for retirement.

Powervision confirms this data, but cannot confirm the 160 MW of wind farm installation capacity that Finland reports will be decommissioned.

Hungary reports 14,235 MW of conventional power burning capacity, 2,000 MW of nuclear power plant capacity, 2,483 MW of biomass power generation capacity, 11,518 MW of power plants with cogeneration capabilities, and 254 MW of wind farm installation capacity. Platts believes the data reported by the member state is largely incorrect and far overestimating power generation capacity. The member state data for gas-fired generation and multiple source generation nearly doubled between reporting periods and total power generation capacity increased substantially from 14,217 MW in 2013 to 30,490 MW in 2015.

Powervision reports power generation capacity in Hungary to consist of 1,722 MW of conventional power burning capacity, 2,054 MW of nuclear power plant capacity, 115 MW of biomass power generation capacity, 2,303 MW of power plants with cogeneration capabilities, and 269 MW of wind farm installation capacity. Platts does not have an explanation as to how or why Hungary has overestimated its capacity, but Platts affirms that the data is incorrect.

Hungary reports only one power generation project – a 2,400 MW planned nuclear power plant. Platts affirms that there is a 2,400-MW expansion planned at the Paks nuclear plant to begin operations in 2025, which is outside the range of the reporting threshold. However, there are other projects tracked by Powervision, including 94 MW of biomass power generation capacity, a 435-MW geothermal plant, 2,260 MW of natural gas-fired power plant additions, and 596 MW of new wind farm installations.

Ireland reports 6,139 MW of conventional power burning capacity, 162 MW of power plants with cogeneration capabilities, 508 MW of hydroelectric capacity, and 2,300 MW of wind farm installation capacity. Powervision confirms the accuracy of all this data with the exception of wind farm installation capacity. Powervision tracks 1,351 MW of wind farm installation capacity from plants with a capacity greater than 20 MW. Powervision tracks about 795 MW of planned wind farm projects through 2012 that had been put “on hold,” which may explain the discrepancy in the reported data.

Ireland reports two power plant projects, a planned 61 MW biomass plant and a planned 42 MW biomass plant with cogeneration capabilities, as well as 20 wind farm installations totaling 700 MW currently under construction. Powervision confirms the new biomass capacity and also tracks 2,505 MW of proposed natural gas-fired power generation capacity, 430 MW of proposed hydroelectric capacity, and an incremental 2,100 MW of wind farm installations. Ireland reports no planned decommissioning projects, but Powervision anticipates 937 MW of conventional power plant capacity to be retired in the next five years.

Latvia reports 1,090 MW of power plants with cogeneration capabilities, 1,536 MW of hydroelectric capacity, and 40 MW of wind farm installation capacity. Powervision affirms the accuracy of this data. Lativa reports only two new hydroelectric projects with a cumulative capacity of 52 MW. Platts cannot confirm the accuracy of Latvia’s project data. However, Powervision does track a 400 MW coal- and biomass-fired power plant planned for 2020 and 50 MW of wind farm installation by 2017.

Lithuania reports 1,645 MW of power plants of conventional power burning capacity and 1,000 MW of hydroelectric power generation. Powervision affirms the accuracy of the reported data, but also tracks 20 MW of biomass power generation capacity, 698 MW of power plants with cogeneration capabilities, and 153 MW of wind farm installation capacity. Latvia reports one new planned hydroelectric plant with a capacity of 225 MW. Powervision confirms the accuracy of this project data, but also tracks a planned nuclear power plant with a capacity of 1,300 MW, a planned hydroelectric power plant with a capacity of 250 MW, 203 MW of new onshore wind farm capacity, and a 400-MW offshore wind farm project. Lithuania also reports the retirement of its natural gas-fired conventional power capacity and Powervision confirms the accuracy of this retirement data.

The Netherlands reports 21,394 MW of conventional power burning capacity, 486 MW of nuclear power plant capacity, 720 MW of biomass power generation capacity, 8,221 MW of power plants with cogeneration capabilities, and 903 MW of wind farm installation capacity. Powervision confirms the accuracy of the data provided by the Netherlands with the exception of wind farm installation capacity. Powervision tracks 2,277 MW of wind farm installation capacity. Additionally, Powervision is tracking 888 MW of PV installation capacity, which is not reported in the member-state data.

The Netherlands reports three new biomass power plants with a cumulative capacity of 175 MW. In addition, Powervision tracks a 1,100 MW coal-fired power plant currently under construction, 2,550 MW of new natural gas-fired power plant capacity, and 744 MW of planned wind farm installation capacity. Additionally, the Netherlands reports six coal-fired power plant retirements in the next years with a cumulative capacity of 2,826 MW, as well as two natural gas-fired power plant retirements with a cumulative capacity of 377 MW. Powervision confirms member state-reported retirement data.

Poland reports 20,082 MW of conventional power burning capacity, 400 MW of biomass power generation capacity, 7,473 MW of power plants with cogeneration capabilities, 1,965 of hydroelectric power generation, and 2,618 MW of wind farm installation capacity. Poland reports its information in Polish, making it difficult to decipher its reporting of power plants with two or more sources.

Of Poland's reported conventional power burning capacity, 100% is generated by coal-fired plants. Powervision only tracks 18,455 MW of conventional coal-fired power plants with a capacity above 100 MW, as the Regulation suggests. Powervision also tracks about 5,131 MW of conventional power plants that burn both coal and biomass. A portion of these power plants are likely accounted for in Poland's reporting of cogeneration plants, but a portion is also seemingly not reported by Poland. Additionally, Powervision tracks the 400 MW oil-fired Patnow plant. Powervision confirms Poland's reporting of hydroelectric power generation, biomass power generation, and wind farm installation capacity. However, Poland did not report the 27 MW of PV installation capacity in the member state.

Poland reports a slew of new power plant projects including 4,503 MW of conventional coal plants under construction and 4,654 MW of planned conventional coal plants, an 88-MW biomass project under construction, 2,146 MW of new power stations with cogeneration capabilities under construction and 3,535 MW of new planned power stations with cogeneration capabilities, and finally, 6,789 MW of wind farm installation capacity. Powervision confirms Poland's coal, biomass, wind, and cogeneration plant projects. However, Powervision is also tracking a 80 MW hydroelectric plant in Poland, which is not reported by the member state.

Poland reports a number of plant retirements, including eight conventional coal plants with a cumulative capacity of 2,924 MW and a cumulative 3,852 MW of cogeneration capacity. However, Powervision only tracks 2,636 MW of coal plant retirements in the next five years, though an additional 480 MW of coal-fired generation were retired in 2015.

Portugal reports 6,072 MW of conventional power burning capacity, 400 MW of biomass power generation capacity, 1,273 MW of power plants with cogeneration capabilities, 4,915 of hydroelectric power generation, 3,704 MW of wind farm installation capacity, and 82 MW of PV installation capacity. Powervision affirms the accuracy of the member state-reported data with the exception of PV installation capacity, which Powervision estimates at 466 MW.

Portugal reports a slew of power plant projects including 3,828 MW of new hydroelectric power generation, 608 MW of new wind farm installations, and 340 MW of new PV installation capacity, as well as the retirement of a 1,180 MW coal-fired power plant. Powervision tracks 2,642 MW of new hydroelectric power generation, 189 MW of new wind farm installation, and 1,600 MW of new natural-gas-fired power plant capacity. Though Powervision does not track any new PV installation capacity, the Portugal-reported data is likely included in Powervision as existing PV installation capacity.

Romania reports 7,286 MW of conventional power burning capacity, 1,413 of nuclear power generation, 2,183 MW of power plants with cogeneration capabilities, 5,217 MW of hydroelectric power generation, 2,460 MW of wind farm installation capacity, and 222 MW of PV installation capacity. Powervision affirms the accuracy of the member state-reported data with the exception of PV installation capacity, which Powervision estimates at 1,219 MW.

Romania reports 930 MW of new coal-fired power generation, 1,440 MW of new nuclear power generation, 241 MW of new natural gas-fired power generation, 539 MW of new wind farm installation capacity, and 60 MW of new PV installation capacity. Powervision affirms the accuracy of the member state-reported project data with the exception of the new hydroelectric power generation and new PV installation capacity, which Powervision estimates at 2,077 MW and 2,735 MW, respectively. Additionally, Romania reports the decommissioning of 2,574 MW of conventional power burning capacity within the next five years, or 35% of total conventional power burning capacity.

Slovakia reports 880 MW of conventional power burning capacity, 1,940 of nuclear power generation, 88 MW of biomass power generation capacity, and 439 MW of power plants with cogeneration capabilities, and 2,197 MW of hydroelectric power generation. Powervision affirms Slovakia's nuclear, biomass, and hydroelectric power generation. However, Powervision tracks the retirement of nearly all of Slovakia's coal-fired generation capacity in 2014 and 2015. Slovakia also failed to report 524 MW of existing PV installation capacity.

Slovakia reports five power plant projects with 471 NW of nuclear capacity currently under construction, a 60-MW oil-fired cogeneration plant under construction, a 25-MW planned oil-fired cogeneration plant, and a 55 MW planned cogeneration plant fueled by two or more sources. Platts cannot confirm the accuracy of the project data, but Powervision reports 880 MW of new nuclear capacity, 195 MW of new gas-fired generation capacity, 648 MW of new hydroelectric capacity, and 60 MW of new wind farm installations. Powervision also tracks a 55-MW gas plant retirement in the next five years, which is not reported by the member state.

Slovenia reports 228 MW of conventional power burning capacity, 696 of nuclear power generation, 1,371 MW of power plants with cogeneration capabilities, and 1,095 MW of hydroelectric power generation. Powervision affirms the accuracy of the member state-reported data. Slovenia reports four power plant projects: a 45-MW hydroelectric plant under construction, two planned hydroelectric plants with a cumulative capacity of 470 MW, and the retirement of a 275-MW coal plant. Powervision confirms these projects, but also tracks 100 MW of new natural gas-fired power generation capacity and 158 MW of incremental wind farm installation capacity. Like many other member states, Slovenia failed to report 212 MW of PV installation capacity.

Sweden reports 3,465 MW of conventional power burning capacity, 9,528 MW of nuclear power generation, 2,888 MW of power plants with cogeneration capabilities, 13,694 MW of hydroelectric power generation, and 2,522 MW of wind farm installation capacity. Powervision affirms the accuracy of most of the member state-reported data. Powervision is tracking 2,964 MW of biomass-fired power plants that Platts suspects Sweden has included in its oil- and gas-fired cogeneration capacity. This is likely a reporting error in which the data for biomass and waste plants were entered into the incorrect rows.

The only projects that Sweden reports is 350 MW of incremental nuclear power capacity. Powervision confirms this project, but is also tracking 180 MW of new biomass capacity, of which one project is currently under construction, and 180,997 MW of offshore wind farm installation capacity planned in the next five years. Additionally, Sweden reports no planned retirements, but Powervision is tracking plans to retire nearly half the capacity of the Ringhals nuclear plant and 465 MW of capacity of Oskarshamn nuclear plant.

The **United Kingdom** reports 31,300 MW of conventional power burning capacity, 9,408 MW of nuclear power generation, 1,900 MW of biomass power generation capacity, 4,170 MW of power plants with cogeneration capabilities, 3,716 MW of hydroelectric power generation, 10,297 MW of onshore and offshore wind farm capacity, and 1,440 MW of PV installation capacity. Powervision confirms that United Kingdom member state-reported data is mostly accurate. The United Kingdom reports 34,740 MW of new power plants that are under construction or planned for the next five years, 17,811 MW of new wind farm capacity planned and under construction, and 7,720 MW of hydrocarbon-fired and nuclear plant retirements. Powervision confirms the accuracy of the project data.

Conclusions

This dataset is useful in tracking themes and trends in the power stack of individual member states that reported. **Austria** plans to increase its reliance on hydroelectric and wind power. **Belgium** plans to retire all its nuclear power. Though Belgium did not report any new projects, Powervision indicates a slew of announced natural gas-fired power plant projects. **Bulgaria** will increasingly rely on natural gas-fired cogeneration plants and nuclear power in the wake of retiring coal and gas power plants.

Cyprus is not planning for any increase in power demand. The **Czech Republic** power consumption is highly diversified, but still relies on coal for over half of its power generation. **Denmark** plans to retire conventional plants in favor of biomass- and waste-powered plants and could benefit immensely from offshore wind farm installations.

Finland relies on biomass as its back-up fuel source, as well as other non-hydrocarbon fuel sources such as nuclear, wind, and water. **Ireland** will continue to rely on wind power generation. **Latvia** will continue to rely on hydroelectric power generation.

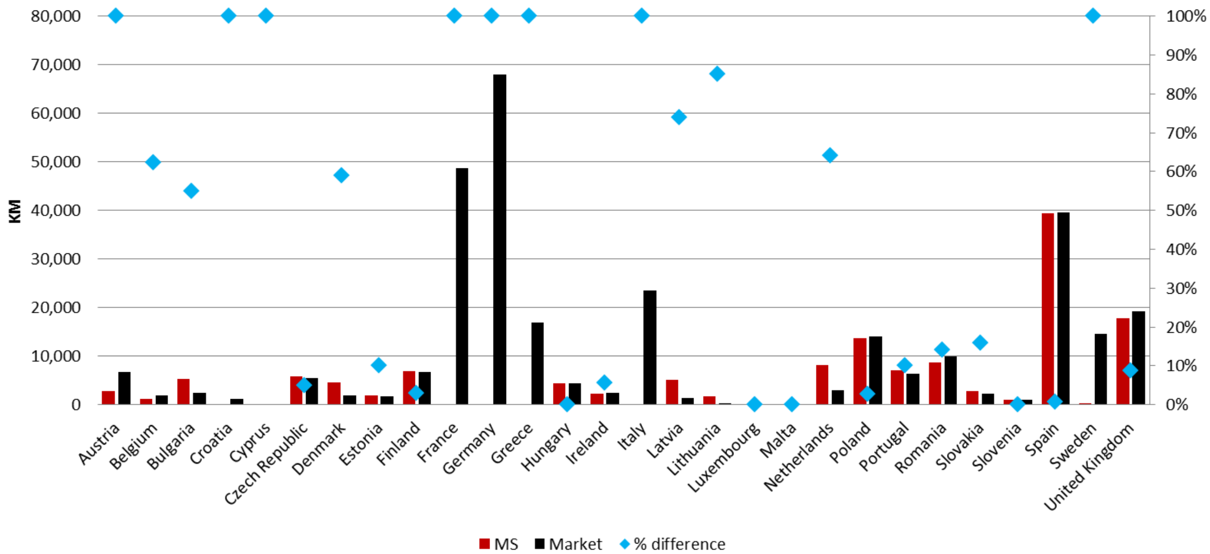
Lithuania plans to reduce its total power generation capacity, but rely on hydroelectric power generation. The **Netherlands** maintains a diversified power generation stack, but aspires to reduce its dependence on coal. **Portugal** is increasing its wind- and hydro-fired power generation and decreasing its reliance on hydrocarbons. **Poland** is ambitious in its plans for new power generation, but will continue to rely on coal for 80% of its power generation.

Romania is increasing its wind- and water-fired power generation and decreasing its reliance on hydrocarbons. **Slovakia** has very little dependence on hydrocarbons and instead relies on nuclear and hydroelectric power generation. **Slovenia** is reducing its reliance on hydrocarbons in favor of hydroelectric generation. **Sweden** relies primarily on nuclear and hydroelectric power generation but, according to Powervision, could rely less on nuclear power and more on offshore wind generation in the future.

As to the accuracy of the reported data, however, nearly every member state reported incomplete data, failing to report a type of power plant or a portion of its power generation stack. The data almost entirely failed to track PV installations, as most member states did not report PV installation capacity or an incorrect capacity when compared to the benchmark data. Wind capacity was largely underestimated in part due to the Regulation’s suggestion to report only capacity from installations with a capacity greater than 20 MW.

As a comprehensive dataset, the electricity production is largely incomplete with nine member states failing to report data. France, Germany, and Italy, in particular account for a vast share of total power generation capacity in Europe at 78,088 MW, 179,901 MW, and 97,979 MW, respectively. These countries, along with Spain at 96,729 MW are the largest producers of electricity in Europe. Without the participation of these vital member states in the data-reporting process, the utility of the dataset is minimal, particularly when analyzing the ability of the electricity being produced to be transported to areas that are experiencing growing electricity demand.

Figure 39: Length of Electricity Transmission Lines

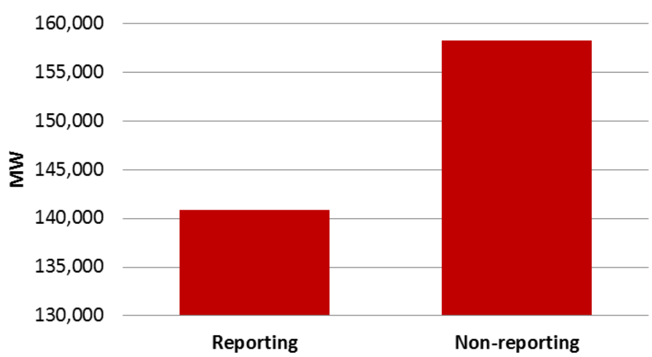


E2 – Electricity Transmission

State of the European Electricity Transmission Infrastructure

While Europe embarks on an endeavor to increase connectivity between member states, infrastructure needs within member states continue to grow, especially as populations grow and disperse further from large cities. Bottlenecks within member states are creating electricity price imbalances and hinder full utilization of power generation facilities.

Figure 40: Length of Electricity Transmission Lines



Comparison of Member-State Data to Third-Party Sources

Platts' utilized ENTSO-E data to judge the accuracy of the member state-reported data. The data is publically available and accessible through ENTSO-E's website. The dataset defined as "Information upon the lengths of circuits (in km)" tracks the length of alternating current (AC), an electric current in which the flow of electric charge periodically reverses flow, circuit transmission lines of varying voltage for each country. ENTSO-E reports the circuit length of an electrical line or cable as the actual length of each of its conductors or the mean of the lengths of the conductors, if there is an appreciable difference in their lengths. Based on the discrepancies in the data, ENTSO-E appears to only track aboveground AC circuit lines. Platts, therefore, based the accuracy of member state-reported data on the reported aboveground AC circuit transmission lines alone. To judge the accuracy of the member state-reported data, Platts utilized ENTSO-E's 2016 TYNDP Project List as a benchmark for comparing the projects reported by the member states.

Member states are required to report the length of electricity transmission pipelines in kilometres at varying degrees of voltage and if the lines are AC or DC. They are to report overhead transmission lines, if they have been designed for voltage commonly used at the national level for the interconnection lines, and provided they have been designed for a voltage of 220 kV or more, as well as underground and submarine transmission cables, if they have been designed for a voltage of 150 kV or more.

Twenty-one of the 28 member states reported 134,992 km of transmission line and 23,507 km of new transmission line under construction or planned in the next five years. Though electricity transmission information was the member state-reported data's most comprehensive dataset, the seven non-reporting member states account for 122,760 km of existing transmission line and 35,500 km of new transmission line under construction or planned in the next five years, which accounts for 48% of the existing transmission line and 60% of planned infrastructure.

Individual Member-State Reporting

Austria reported 1,612 km of AC circuit transmission line with 220-299 kV and 1,243 km of AC circuit transmission line with 360-499 kV, as well as 220 km of new AC transmission line projects. ENTSO-E, on the other hand, tracks 3,686 km of circuit transmission line with 220-299 kV and 3,043 km of AC circuit transmission line with 360-499 kV. ENTSO-E does report 1,418 km as the length of routes of AC circuit transmission line with 360-499 kV, as opposed to the length of the actual cable, which is closer in line with Austria's member state-reported data for 360-499 kV of transmission line. This indicates that Austria may be reporting route length rather than the actual length of transmission cable.

Though Austria reports four new transmission projects, the TYNDP only reports one internal transmission project deemed the "East of Austria" project intended to increase the capacity of the northeast region of Austria to absorb planned renewable energy generation. TYNDP does report five additional projects that increase connectivity between Austria, Italy, and Germany.

Belgium reported 297 km of aboveground AC circuit transmission line with 220-299 kV, 891 km of aboveground AC circuit transmission line with 260-499 kV, and 470 km of underground transmission line. Belgium also reports 42 transmission line projects for a cumulative 770 km of new transmission lines and one 27.6-km transmission line retirement.

ENTSO-E reports 491 km of circuit transmission line with 220-299 kV and 1,438 km of circuit transmission line with 360-499 kV in total for 2015. In 2014, transmission length for the two circuit strength category totaled 434 kV and 1,326 kV, respectively, indicating that some of the projects reported as under construction in Belgium in 2014 may have been completed in 2015.

The TYNDP reports at least five new domestic transmission line projects in Belgium that will increase electricity transmission capacity by 8,600 MW, as well as ten additional transmission lines that will increase connectivity with France, Luxembourg, Germany, the United Kingdom and the Netherlands and an incremental 8,600 MW of electricity transmission capacity.

Bulgaria reported 2,704 km of AC circuit transmission line with 220-299 kV and 2,571 km of AC circuit transmission line with 360-499 kV, as well as four planned transmission line projects with a cumulative 350 km of new transmission line. ENTSO-E reports 1,525 km of circuit transmission line with 220-299 kV and 865 km of circuit transmission line with 360-499 kV in total for 2015.

The TYNDP reports one domestic transmission line project in Bulgaria that will increase electricity transmission in the country by 648 MW. Another three projects increase Bulgaria's connectivity to Greece, Macedonia, Albania, and Serbia.

Cyprus reported 44 km of AC circuit transmission line 220-299 kV. ENTSO-E reports no information for Cyprus.

The **Czech Republic** reported 1,909 km of AC circuit transmission line with 220-299 kV and 3,912 km of AC circuit transmission line with 360-499 kV, as well as an indeterminate number of planned transmission line projects with a cumulative 215 km of new transmission line. ENTSO-E reports 1,909 km of circuit transmission with 220-299 kV and 3,617 km of circuit transmission with 360-499 kV in total for 2015.

The TYNDP reports one large domestic transmission project in the Czech Republic intended to increase the capacity of electricity transmission by 1,250-1,750 MW between West and East Czech Republic. An additional three projects are planned to increase connectivity between the Czech Republic and Germany.

Denmark reported 3,171 km of aboveground AC circuit transmission line with 132-220 kV, 56 km of aboveground AC circuit transmission line with 220-299 kV, 1,362 km of aboveground AC circuit transmission line with 360-499 kV, 906 km of underground AC transmission line with 132-199 kV, 60 km of underground AC transmission line with 220-299 kV, and 109 km of underground AC transmission line with 360-499 kV. Denmark also reports 247 km of AC submarine transmission line and 32 km of DC submarine transmission line.

Denmark reports 30 new transmission line projects with a cumulative length of 872 km. The bulk of the projects are underground AC transmission lines, but the new projects include aboveground AC transmission line and AC submarine transmission lines. Additionally, Denmark reports substantial decommissioning projects with a total of 606.4 km of aboveground AC transmission slated for decommissioning in the next five years.

ENTSO-E reports 140 km of transmission line of circuit transmission with 220-299 kV and 1,500 kV of circuit transmission with 360-499 kV in total for 2015

The TYNDP tracks three domestic transmission line projects in Denmark with a total capacity of 1,700 MW, but these projects are slated for completion beyond the five-year time frame. Other projects in Denmark include increased interconnectivity with its European neighbors.

Estonia reported 158 km of aboveground AC circuit transmission line with 220-299 kV, 1,697 km of aboveground AC circuit transmission line with 300-359 kV, 14 km of aboveground DC circuit transmission line, 44 km of aboveground DC circuit transmission line, and 219 kV of submarine DC circuit transmission line. Aside from the aboveground AC circuit transmission line, the transmission lines reported by Estonia are shorter than the threshold of 150 kV for reporting and, therefore, did not need to be reported. Estonia reports seven new transmission line projects for a cumulative 900 km of new transmission line. Estonia also reports 4 km of transmission line slated for decommissioning.

ENTSO-E reports 158 km of transmission line of circuit transmission with 220-299 kV and 1,534 km of circuit transmission with 360-499 kV. The TYNDP only reports one new transmission line project increasing connectivity between Estonia and Latvia.

Finland reported 2,225 km of aboveground AC circuit transmission line with 220-299 kV, 4,607 km of AC circuit transmission line with 360-499 kV, 81 km of aboveground DC circuit transmission line, 22 km of underground DC circuit transmission line, and 302 km of DC submarine transmission line. With the exception of the aboveground AC circuit transmission line, the transmission lines reported by Finland are shorter than the threshold of 150 kV for reports and, therefore, did not need to be reported. Finland reported four aboveground AC circuit transmission line for a cumulative of 409 km of new transmission line. Finland also reported 44 km of transmission line slated for decommissioning.

ENTSO-E reports 2,125 of transmission line of circuit transmission with 220-299 kV and 4,565 km of circuit transmission with 360-499 kV. The TYNDP reports two domestic transmission line projects in Finland, but they are expected to be completed outside the five-year time frame.

Hungary reported 1,393 km of aboveground AC circuit transmission line with 220-299 kV and 2,978 km of aboveground AC circuit transmission line with 360-499 kV, as well as three projects that Hungary reports will increase transmission length by 1.29 km.

ENTSO-E reports 1,394 km of transmission line of circuit transmission with 220-299 kV and 2,978 km of circuit transmission with 360-499 kV. The TYNDP only reports one project in the five-year period that increases connectivity between Hungary and Slovenia and increases transmission capacity to 1,700 MW.

Ireland reported 1,790 km of aboveground AC circuit transmission line with 220-299 kV, 439 km of aboveground AC circuit transmission line with 360-499 kV, 116 km of underground AC circuit transmission line, and 11 km of AC transmission line. Ireland reports six projects with a cumulative of 443 km of new transmission line, the bulk of which is aboveground AC transmission lines.

ENTSO-E reports 1,917 km of AC transmission line with 220-299 kV and 439 km of circuit transmission with 360-499 kV. The TYNDP does not track any domestic transmission projects in Ireland, but does track four projects to be implemented in the next five years that would increase transmission capacity between Ireland and the United Kingdom by 4,600 MW.

Latvia reported 3,820 km of aboveground AC circuit transmission line with 100-150 kV, 1,368 km of aboveground AC circuit transmission line, and 85 km of underground AC circuit transmission. Latvia also reports five new transmission projects, the bulk of which is aboveground AC transmission lines, with a total length of 899 km.

ENTSO-E reports no AC transmission lines with 220 kV as of 2014, but did report 3,939 km of AC transmission lines with 220 kV in 2011, in line with the data reported by Latvia for the length of transmission lines with 100-150 kV, indicating that Latvia's reporting is correct, but that ENTSO-E no longer reports transmission lines with a voltage less than 220 kV. ENTSO-E reports 1,360 km of transmission line with 260-449 kV. The TYNDP does not report any domestic transmission line projects in Latvia, but does report two projects that increase the connectivity between Latvia, Estonia, and Montenegro but 1,545 MW.

Lithuania reported 1,760 km of AC circuit transmission line with 300-359 kV and one transmission project that will add 53 km of new transmission line. ENTSO-E reports 260 km of AC circuit transmission line with 220 kv voltage. The TYNDP reports one project, intended to increase connectivity between Poland and Lithuania that will add 500-1,000 MW of capacity.

The Netherlands reported 1,859 km of aboveground AC circuit transmission line with 110-149 kV, 3,426 km of aboveground AC circuit transmission line with 150-199 kV, 733 km of aboveground AC circuit transmission line with 220-299 kV, 2,178 km of aboveground AC circuit transmission line with 360-499 kV, and 1,090 of underground AC circuit transmission line with a voltage greater than 150 kV. The Netherlands reports 58 projects, adding a total of 1,408 km of new aboveground and underground transmission line in the next five years.

ENTSO-E reports 742 km of AC circuit transmission line with 220 kV and 2,232 km of AC circuit transmission line with 400 kV, in line with the data reported by The Netherlands. Given that ENTSO-E does not report transmission lines with voltage less than 220 kV, much of the Netherlands' transmission data cannot be verified. The TYNDP does not report any domestic transmission line projects in the Netherlands, but does report four projects that increase the transmission capacity between the Netherlands and Germany by 2,000 MW and between Denmark and Belgium by 1,600 MW.

Poland reported 7,985 km of aboveground AC circuit transmission with 220-299 kV, 5,382 km of aboveground AC circuit transmission line with 360-499 kV, 114 km of aboveground transmission line with 750 kV, and 127 km of aboveground DC transmission. Poland reported 24 new transmission line projects for a total length of 5,319 km. Poland also noted that some transmission lines were no longer operational, but did not provide the length of transmission line that is no longer operational.

ENTSO-E reports 7,784 km of AC circuit transmission line with 220 kV, 6,092 km of AC circuit transmission line with 360 kV, and 114 km of AC circuit transmission line with 750 kV, indicating that the Poland-reported data is accurate. The TYNDP does not track any domestic transmission line projects in Poland, but does track two projects intended to increase connectivity between Poland, Germany, and Lithuania that will add 500-2,500 MW of additional transmission capacity in the next five years.

Portugal reported 3,506 km of aboveground AC circuit transmission with 220-299 kV, 2,467 km of aboveground AC circuit transmission with 360-499 kV, and 95.2 km of underground AC circuit transmission. Portugal also reported 12 new transmission line projects for total length of 1,073 km and 55 km of transmission line slated for decommissioning.

ENTSO-E reports 3,515 km of AC circuit transmission line with 220 kV and 2,467 km of 360 kV of AC circuit transmission line with 260 kV, indicating that the data reported by Portugal is accurate. The TYNDP reports one large domestic transmission line project in Portugal that is intended to increase transmission capacity by 1,200-1,600 MW, as well as two projects intended to increase the connectivity between Spain and Portugal.

Romania reported 3,875 km of AC circuit transmission with 220-299 kV, 2,856 km of AC circuit transmission with 360-499 kV, and 3 km of AC circuit transmission with 750 kV. Romania reports nine new transmission projects with a cumulative length of 983 km and plans to decommission 140 km of existing transmission line.

ENTSO-E reports 4,893 km of AC circuit transmission like with 220 kV, 5,068 km of AC transmission line with 360 kV, and 4.1 km of AC transmission line with 750 kV. The TYNDP reports one domestic transmission line project in Romania intended to increase electricity transmission capacity by 1,260 MW, as well as another transmission line project increased connectivity between Romania and Serbia.

Slovakia reported 826 km of aboveground AC circuit transmission line with 220-299 kV and 1,953 km of aboveground AC circuit transmission line with 360-499 kV. Slovakia also reports five new transmission line projects with a total of 404 km and 393 km of transmission line slated for decommissioning. ENTSO-E reports 685 km of AC circuit transmission line with 220 kV and 1,647 km of AC circuit transmission line with 400 kV, confirming the accuracy of the member state-reported data on existing transmission infrastructure. The TYNDP only reports one project slated for the next five years increasing interconnectivity between Slovakia and Hungary.

Slovenia reported 328 km of AC circuit transmission line with 220-299 kV and 669 km of AC circuit transmission line with 360-499 kV. Slovenia also reports four new transmission projects, adding a total of 554 km of new transmission lines. ENTSO-E reports 328 km of AC circuit transmission line with 220 kV and 669 km of AC circuit transmission line with 400 kV, confirming the accuracy of Slovenia-reported data. The only project that TYNDP reports for Slovenia is a new transmission line from Hungary to Slovenia expected online in 2021 that will add 1,700 MW of cross-border capacity.

Spain reports 18,357 km of aboveground AC circuit transmission line with 220-299 kV, 20,977 km of aboveground AC circuit transmission line with 360-499 kV, 402 km of underground AC circuit lines, 76 km of underground DC circuit lines, 29 km of AC submarine transmission lines, and 474 km of DC submarine transmission lines. Spain reports 1,872 km of new transmission line, the bulk of which is aboveground AC circuit transmission line.

ENTSO-E reports 18,496 km of AC circuit transmission line with 220 kV and 21,117 km of aboveground AC circuit transmission line with 400 kV, confirming the accuracy of a portion of the member state-reported data. In the next five years, the TYNDP reports 100-2,900 MW of new domestic transmission line in Spain, along with a number of other projects increasing cross-border capacity to Portugal, France, and Great Britain.

Sweden reported information in Swedish and was difficult to decipher. The reported data included unconventional noting and letters that were not defined by the member state. From what could be understood, Sweden reported 4,187 km of aboveground AC circuit transmission like with 220-299 kV, 160 km of AC circuit transmission, 160 km of aboveground DC circuit transmission, 17.4 km of underground transmission lines, 6.3 km of AC submarine transmission lines, and 460 km of DC submarine transmission lines. Sweden also reported approximately 18 projects that will add 1,193 km of new transmission line.

ENTSO-E reports 3,579 km of AC circuit transmission with 220 kV and 10,988 km of AC circuit transmission with 400 kV. The TYNDP reports no new transmission line projects in Sweden within the five-year time frame.

The **United Kingdom** reported 5,979 km of aboveground AC circuit transmission line with 220-299 kV, 11,750 km of aboveground AC circuit transmission line with 360-499 kV, 730 km of underground AC circuit transmission line, 16 km of underground DC circuit transmission line, 298 km of AC submarine transmission lines, and 107 km of DC submarine transmission line. The United Kingdom reports 661 km of new aboveground transmission line, 158 km of new underground transmission line, and 5,364 km of new submarine transmission line.

ENTSO-E reports 7,160 km of AC circuit transmission line with 220 kV and 12,123 km of aboveground AC circuit transmission line with 400 kV, confirming the accuracy of a portion of the member state-reported data. The TYNDP tracks one domestic transmission line project in the United Kingdom, intended to increase transmission capacity between Scotland and England by 4,200 MW. Other projects include increasing connectivity to Ireland and France.

Conclusion

The reported data, when reported and accurate, is more detailed than the information that is publically available from ENTSO-E. The voltage, type of current, and indication of aboveground, underground, or submarine line is useful additional data that can be utilized to indicate infrastructure trends in Europe. For instance, coastal member states rely more on underground and submarine transmission lines and Western Europe tends to have lower voltage transmission systems than Eastern Europe. Additionally, the decommissioning information is useful in that such data is not publicly available and not easily attainable through primary research.

The Regulation requires member states to report aboveground transmission line with a 220-kV minimum. However, the bulk of transmission capacity within Denmark, Latvia, and the Netherlands is of voltage less than 220 kV. These member states still reported transmission lines with voltage less than 220 kV, but the Regulation's reporting template creates distortion in the data. Lowering the threshold for reporting will help to develop a more comprehensive understanding of domestic transmission systems in each member state.

Generally speaking, infrastructure capacity, rather than the length, is largely more useful in fully understanding any infrastructure gaps. The data itself fails to capture some of the important gaps in domestic infrastructure systems. For example, the member state-reported data does not in any way indicate the need for additional capacity connecting England and Scotland in the United Kingdom, where an increase in wind-farm electricity generation fails to reach the southern portion of the member state due to a lack of transmission infrastructure. To efficiently capture this gap in reported data, member states would need to report more granular regions, such as Northern Italy and Southern Italy, as reported by ENTSO-E, or submit the locations of the transmission lines.

Finally, the dataset as a whole remains incomplete given the seven non-reporting member states. Germany and France account for the largest transmission systems in Europe with 34,615 km and 48,723 km of transmission line, respectively. Germany has the most new transmission line under construction or planned for the next five years at 33,300 km of transmission line. Another important gap in domestic infrastructure occurs in Italy, where there is insufficient connectivity between Northern Italy and Southern Italy, creating price imbalances in the member state, but no data at all is reported by this member state vital to understanding the need for electricity transmission infrastructure.

E3 – Electricity Cross-Border Connections

State of the European Electricity Cross-Border Connections Infrastructure

The European Union is currently endeavoring to increase electricity connectivity among member states and there continues to be bottlenecks along the European transmission network that are hindering efficient distribution of power. Insufficient connection between countries is creating pockets in Europe where electricity prices are much higher than in the rest of Europe, from negative electricity prices in Germany to extremely high prices in Italy and the United Kingdom. These bottlenecks coupled with EU incentives will drive an increase in cross-border projects, as the member-state data confirms, and Europe is unlikely to experience large-scale retirement of existing transmission lines.

Comparison of Member-State Data to Third-Party Sources

Platts' utilized ENTSO-E's 2014 TYNDP market modelling data to judge the accuracy of the member state-reported data. The data is publically available and accessible through ENTSO-E's website. The dataset defined as "Basic Reference transmission capacities" tracks the existing cross-border capacities amongst European Union countries and to some non-EU countries, with the exception of Russia and Moldova. Platts utilized ENTSO-E's TYNDP 2016 Project List to judge the accuracy of member state-reported projects. The Project List includes transmission projects and project details, as well as ENTSO-E's expectations for cross-border capacities by 2020. In its electricity cross-border analysis, Platts refers to the projects from the Project List as reported by TYNDP and ENTSO-E's 2020 estimate as ENTSO-E reported data.

The member states are required to report the voltage in kilovolts (kV) and the transmission capacities in megawatts (MW) of cross-border transmission lines, as well as the border crossing point and the adjacent substation.

Figure 41: Existing Cross-Border Electricity Capacity

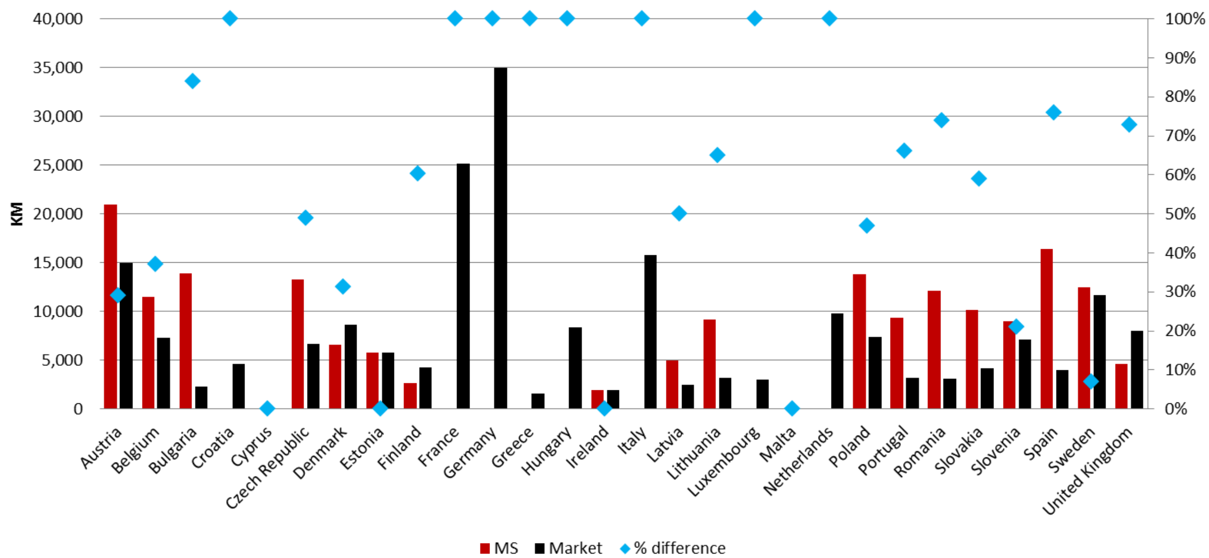
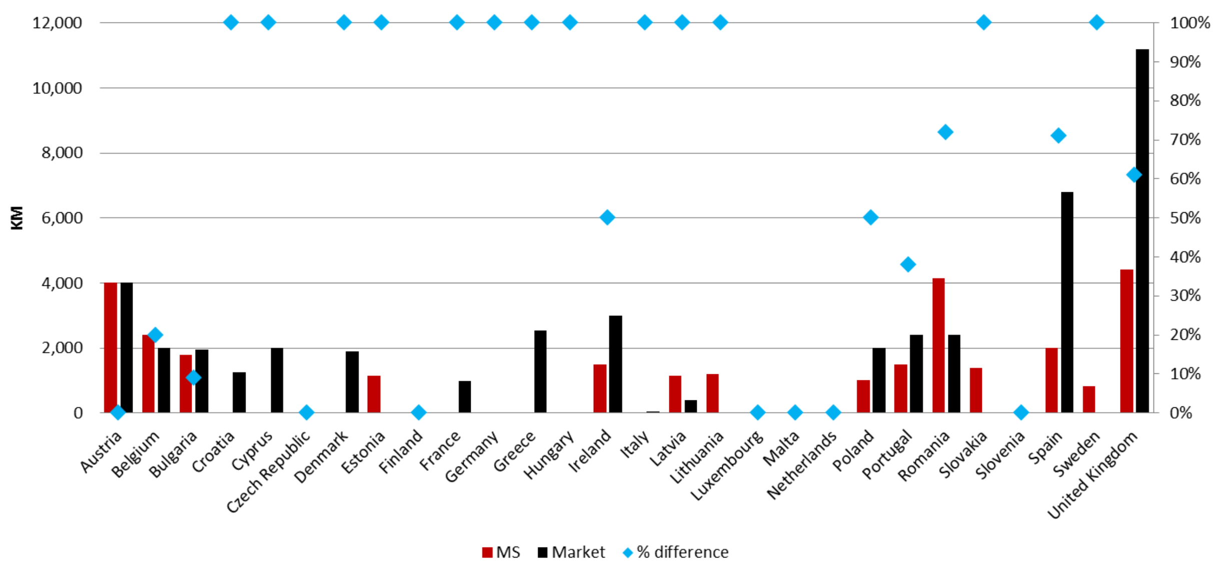


Figure 42: New Cross-Border Electricity Capacity



ENTSO-E reports only the cross-border capacity between two countries. It does not track the cross-border points, the length of the cross-border transmission lines, or the voltage. Therefore, Platts judges the accuracy of the member state-reported data on the cumulative cross-border capacities between two countries. Platts compared TYNDP's Project List of projects with an expected in-service date between now and 2021. However, the TYNDP includes projects that may have not yet reached FID, leading to a discrepancy in the member state-reported data and TYNDP's total project capacity.

Seventeen of the 28 member states reported cross-border capacity for a cumulative cross-border capacity of 178,515 MW and 28,411 MW of new cross-border transmission capacity. ENTSO-E estimates that there exists another 103,395 MW of operational cross-border capacity from the 11 non-reporting countries and 6,814 MW of new cross-border transmission projects.

Individual Member-State Reporting

Austria reported 8,751 MW of cross-border capacity with Germany, 3,464 MW of cross-border capacity with the Czech Republic, 3,090 MW of cross-border capacity with Hungary, 2,879 MW of cross-border capacity with Slovenia, 278 MW of cross-border capacity with Italy, and 2,528 MW of cross-border capacity with Switzerland. ENTSO-E confirms Austria reported cross-border capacity with Switzerland, Italy, Germany, but reports significantly less cross-border capacity to Hungary at 1,200 MW, the Czech Republic at 1,000 MW, and Slovenia at 1,200 MW.

Austria reports 4,000 MW of additional capacity between Austria and Germany. TYNDP confirms the increased connectivity between Austria and Germany, but ENTSO-E expects cross-border capacity from Austria to Switzerland and from Austria to Germany to actually decline by 800 MW and 2,500 MW, respectively.

Belgium reported 6,070 MW of cross-border capacity with The Netherlands and 5,451 MW of cross-border capacity with France. Belgium also reported a number of transmission line projects including an aboveground 400-MW connection to Luxemburg, an underground 1,000-MW DC circuit connection to Germany, a TEN-E project that has yet to reach FID, an underground 1,000-MW DC circuit connection to the United Kingdom.

ENTSO-E confirms none of the member state-reported data, instead reports 2,400 MW of cross-border capacity to The Netherlands and 2,800 MW of cross-border capacity to France. Additionally, ENTSO-E reports 1,000 MW of cross-border capacity to the United Kingdom and 1,080 MW of cross-border capacity to Luxembourg. ENTSO-E reports no cross-border capacity projects. However, the TYNDP tracks a 1,000-MW project from Belgium to the Netherlands, as well as the 1,000-MW planned connection to the United Kingdom.

Bulgaria reported 6,260 MW of cross-border capacity with Romania, 1,550 MW of cross-border capacity with Serbia, 1,630 MW of cross-border capacity with FYROM, 1,350 MW of cross-border capacity with Greece, and 3,130 MW of cross-border capacity with Turkey. Bulgaria also reports a 1,780-MW cross-border capacity project to Greece, a TEN-E project. ENTSO-E confirms Bulgaria's existing capacity with Greece, but only tracks 300 MW of capacity to FYROM, 200 MW of capacity to Romania, and 400 MW of capacity to Serbia.

ENTSO-E tracks expansions to all four countries in the next five years: 328 MW of additional capacity to Greece, 230 MW of additional capacity to FYROM, 1,200 MW of additional capacity to Romania, and 200 MW of additional capacity to Serbia. The TYNDP, on the other hand, reports only the additional project to Greece, but indicates that there may be interconnectivity to FYROM, Serbia, and Romania, as well, accounting for a portion of the total capacity number.

The **Czech Republic** reported 5,680 MW of cross-border capacity with Denmark, 3,700 MW of cross-border capacity with Austria, 3,650 MW of cross-border capacity with Poland, and 221 MW of cross-border capacity with Slovakia. ENTSO-E reports very different data, indicating a potential reporting error by the member state. ENTSO-E reports 2,600 MW of cross-border capacity with Denmark, 1,200 MW of cross-border capacity with Austria, 800 MW of cross-border capacity with Poland, and 2,100 MW of cross-border capacity with Slovakia.

The Czech Republic does not report any new cross-border transmission projects. ENTSO-E is actually expecting declining cross-border capacity between the Czech Republic and Denmark and Poland of 500 MW and 300 MW, respectively. Meanwhile, the TYNDP is tracking one project between Czech Republic and Germany with a capacity up to 500 MW in the next five years.

Denmark reported 4,805 MW of cross-border capacity with Sweden and 1,780 MW of cross-border capacity with Germany. Denmark reports no new cross-border capacity projects. ENTSO-E reports 4,100 MW of cross-border capacity with Germany, 2,440 MW of cross-border capacity with Sweden, 700 MW of cross-border capacity with the Netherlands, and 1,700 MW of cross-border capacity with Norway.

ENTSO-E reports 500 MW of incremental cross-border capacity between Denmark and Germany, 1,400 MW of incremental cross-border capacity with the United Kingdom, and 60 MW less of cross-border capacity between Denmark and Norway. The TYNDP tracks four new cross-border transmission projects from Denmark: two cross-border projects adding an incremental 1,120 MW to Germany, 700 MW of incremental capacity to the Netherlands, and 1,400 MW of new capacity to the United Kingdom.

Estonia reported 2,752 MW of cross-border capacity with Russia, 1,996 MW of cross-border capacity with Latvia, and 1,000 MW of cross-border capacity with Finland in the form of underground and submarine transmission lines. Estonia reports one 1,143-MW transmission line project between Estonia and Latvia and the decommissioning of some pipeline between Estonia and Finland. Though ENTSO-E does not track cross-border capacity with non-member states, ENTSO-E confirms Estonia data for cross border capacity with Latvia and Finland.

Finland reports 1,200 MW of cross-border capacity with Sweden, 1,000 MW of cross-border capacity with Estonia, 350 MW of cross-border capacity with Russia, and 100 MW of cross-border capacity with Norway. ENTSO-E reports 3,150 MW of cross-border capacity with Sweden, 1,000 MW of cross-border capacity with Estonia, and 100 MW of cross-border capacity with Norway. Finland does not report any cross-border transmission projects, ENTSO-E expects cross-border capacity with Norway and Sweden to decline 100 MW and 900 MW, respectively, by 2020.

Hungary reported cross-border points and the voltage at those points, but did not report transmission capacity.

Ireland reported 1,920 MW of cross-border capacity with the United Kingdom. ENTSO-E confirms the accuracy of this data. Ireland reports one cross-border transmission project with a capacity of 1,500 MW with the United Kingdom. ENTSO-E does not report this project, but the TYNDP is tracking 3,000 MW of new capacity between Ireland and the United Kingdom.

Latvia reported 1,124 MW of cross-border capacity to Estonia, 3,132 MW of cross-border capacity to Lithuania, and 730 MW of cross-border capacity to Russia. Latvia also reports a 1,143-MW project to increase cross-border capacity between Latvia and Estonia. ENTSO-E reports 1,200 MW of cross-border capacity to Estonia and 1,300 MW of cross-border capacity to Lithuania. ENTSO-E also reports 400 MW of additional capacity between Latvia and Estonia in the next five years. The TYNDP does not track any incremental projects.

Lithuania reported 3,156 MW of cross-border capacity with Latvia, 4,407 MW of cross-border capacity with Belarus, and 1,578 MW of cross-border capacity with Russia. Lithuania also reports two cross-border transmission projects: a 500-MW connection between Lithuania and Poland and a 700-MW of cross-border underground and submarine connection with Sweden. ENTSO-E reports 1,500 MW of cross-border capacity with Latvia, 1,000 MW of cross-border capacity with Poland, and 700 MW of cross-border capacity with Sweden. Neither ENTSO-E nor the TYNDP track any new cross-border projects.

The Netherlands reported cross-border points, voltage, and length of transmission line, but did not report transmission capacity.

Poland reported 4,508 MW of cross-border capacity with Germany, 3,462 MW of cross-border capacity with the Czech Republic, 2,708 MW of cross-border capacity with Slovakia, 2,330 MW of cross-border capacity with the Ukraine, 229 MW of cross-border capacity with Belarus, and 600 MW of cross-border capacity with Sweden. Poland reports 1,000 MW of new cross-border capacity with Lithuania.

ENTSO-E reports 3,000 MW of cross-border capacity with Germany, 1,800 MW of cross-border capacity with the Czech Republic, 990 MW of cross-border capacity with Slovakia, 600 MW of cross-border capacity with Sweden, and an existing 1,000 MW of cross-border capacity with Lithuania. In the next five years, ENTSO-E expects no incremental cross-border capacity, but does expect cross-border capacity between Poland and the Czech Republic to decline 1,200 MW. The TYNDP tracks 500-1,000 MW of incremental cross-border capacity with Lithuania and up to 1,500 MW of incremental cross-border capacity with Germany in the next five years.

Portugal reported 9,315 MW of cross-border capacity with Spain and one new transmission line with a capacity of 1,499 MW. ENTSO-E reported 3,200 MW of cross-border capacity with Spain and an incremental 500 MW of cross-border in the next five years. The TYNDP reports one new cross-border project between Spain and Portugal with a capacity of 1,900 MW.

Romania reported 2,492 MW of cross-border capacity with Hungary, 1,219 MW of cross-border capacity with Serbia, 3,874 MW of cross-border capacity with Bulgaria, 4,278 MW of cross-border capacity with Ukraine, and 215 MW of cross-border capacity with Moldova. Romania reported two cross-border projects: 2,760 MW of new cross-border capacity with Serbia and 1,380 MW of new cross-border capacity with Moldova.

ENTSO-E reports 300 MW of cross-border capacity with Bulgaria, 1,400 MW of cross-border capacity with Serbia, and 1,400 MW of cross border capacity with Hungary. ENTSO-E anticipates an incremental 1,200 MW of cross-border capacity with Bulgaria and 50 MW of cross-border capacity with Serbia. The TYNDP tracks one 1,157-MW project that increases interconnectivity between Romania, Serbia, and Bulgaria.

Slovakia reported 4,487 MW of cross-border capacity with the Czech Republic, 2,078 MW of cross-border capacity with the Ukraine, 831 MW of cross-border capacity with Poland, and 2,772 MW of cross-border capacity with Hungary. Slovakia also reported one new cross-border transmission project with a capacity of 1,386 MW. ENTSO-E reports 1,200 MW of cross-border capacity with the Czech Republic, 2,000 MW of cross-border capacity with Hungary, and 990 MW of cross border capacity with Poland. The TYNDP tracks no new transmission projects in Slovakia.

Slovenia reported 4,132 MW of cross-border capacity with Croatia, 2,648 MW of cross-border capacity with Austria, and 2,180 MW of cross-border capacity with Italy. Slovenia indicates there are two planned cross-border transmission projects to Italy and one to Hungary, but does not indicate the capacity of these projects.

ENTSO-E reported 1,500 MW of cross-border capacity with Croatia, 1,200 MW of cross-border capacity with Austria, 2,000 MW of cross-border capacity with Hungary, and 2,400 MW of cross-border capacity with Italy. ENTSO-E also reported an incremental 500 MW of transmission capacity from Slovenia to Croatia and a decrease in cross-border transmission capacity of 870 MW from Slovenia to Italy in the next five years. The TYNDP tracks no cross-border projects for Slovenia in the next five years.

Spain reported 6,269 MW of cross-border capacity with France, 9,380 MW of cross-border capacity with Portugal, and 715 MW of submarine cross-border capacity with Morocco. Spain also reports one 1,990-MW cross-border transmission project to Portugal. ENTSO-E reports 4,000 MW of cross-border capacity with France, but ENTSO-E may not be accounting for the 2,000-MW underground transmission line between Spain and France, and 3,200 MW of cross-border capacity between Spain and Portugal. ENTSO-E anticipates an incremental 1,000 MW of cross-border transmission capacity to both France and Portugal. The TYNDP tracks three transmission projects: 500 MW from Spain to France, 1,900 MW from Spain to Portugal, and 2,400 MW from Spain to the United Kingdom.

Sweden reported 3,608 MW of cross-border capacity with Finland, 8,051 MW of cross-border capacity with Norway, and 830 MW of cross-border capacity with Denmark. ENTSO-E reports 1,200 MW of cross-border capacity with Germany, 2,000 MW of cross-border capacity with Denmark, 3,150 MW of cross-border capacity with Finland, 700 MW of cross-border capacity with Lithuania, 3,995 MW of cross-border capacity with Norway, and 600 MW of cross-border capacity with Poland.

Sweden also reports an 830-MW cross-border transmission project with Lithuania that may have already been completed given that the first 700-MW phase has been reported as existing in the ENTSO-E data. The TYNDP reports no planned cross-border transmission projects in Sweden and the ENTSO-E reports that cross-border transmission capacity is expected to fall to Germany by 585 MW, to Denmark by 60 MW, and to Finland by 750 MW.

The **United Kingdom** reports 1,631 MW of cross-border capacity with Ireland, 2,000 MW of submarine transmission line capacity with France, and 1,000 MW of submarine transmission line capacity with the Netherlands. The United Kingdom also reports 1,400 MW of new cross-border transmission capacity to Norway, 1,000 MW of new cross-border transmission to Belgium, and 2,000 MW of new cross-border transmission capacity to France.

ENTSO-E reports 1,600 MW of cross-border capacity with Ireland, 3,000 MW of cross-border capacity with France, and 1,000 MW of cross-border capacity with the Netherlands. ENTSO-E reports 1,400 MW of existing cross-border capacity with Norway and 1,000 MW of existing cross-border capacity with Belgium, both of which likely only came online recently. ENTSO-E reports an incremental 1,400 MW of cross-border capacity between the United Kingdom and Denmark and an incremental 5,400 MW of cross-border capacity between the United Kingdom and France in the next five years. The TYNDP tracks a 1,400-MW cross-border transmission project with Norway, a 1,500-MW cross-border transmission project with Ireland, and a 1,500-MW cross-border transmission project with France.

Conclusion

The member state-reported data includes greater deatil than publically available information from ENTSO-E. The voltage of cross-border transmission lines is not available in any publically available publications, but the voltage information reported by member states can be useful for understanding where improvements either need to be made or can be made to improve cross-border capacity and efficiency. Additionally, combined with the individual member-state data reporting transmission lines by voltage, the member state-reported data can aid in the understanding of the capacity of individual member states to connect with interstate transmission lines. For example, much of the cross-border capacity from Austria is of relatively low voltage and the Czech Republic has relatively high cross-border voltage with Denmark and Poland.

ENTSO-E also does not report the cross-border points at which transmission lines cross as do the member states. On one hand, this data is useful to understanding the extent to which cross-border transmission lines permeate a member state's border, though coordinates of the border points would be more useful. If plotted, these points would visually illustrate areas without sufficient connectivity within member states.

On the other hand, the system of reporting border points leads to double-counting in the dataset, making it difficult to sum the reported volumes without overestimating cross-border capacity. For example, Estonia reports two border points from Tartu, Estonia, and Tsirguliina, Estonia, that correspond with the same destination point of Valmiera, Latvia. Estonia reported a capacity of 998 MW for both segments, but when summed, these two capacities far exceed ENTSO-E's reported capacity, which appears to reflect the capacity of just one border point.

Given the inability to match TYNDP and ENTSO-E data with the individual projects reported by the member states, member state-reporting on the length of new transmission lines cannot be fully validated. For example, Austria reports an increase of 2,000 MW of cross-border transmission capacity, but also notes that the incremental length of the transmission is only 3 km, indicating that the increase in capacity stems from an upgrade or enhancement to an existing line or a short connection to existing transmission lines.

Countries like Belgium, Hungary, Ireland, Lithuania, Poland, and Slovenia included notes relating to existing and planned infrastructure that are useful in the analysis of European infrastructure. Other useful information includes cross-border capacity with countries outside the ENTSO-E member states, such as Belarus, Moldova, and Russia.

Finally, the member-state data reports AC and DC circuits, which informs how much capacity is bi-directional and in what areas electricity can only flow one direction. Whether the transmission line is an AC or DC circuit is not reported by public publications. For example, Finland reports 2,200 MW of cross-border DC submarine line to Sweden and Estonia, indicating that Finland exports more electricity than it could import.

As to the accuracy of the reported data, the data generally matches with the benchmark data when taking into account the double-counting that may be occurring by summing reported capacities. The most marked difference is that ENTSO-E expects substantial decreases in cross-border capacities between certain member states, which is not reflected in the member state-reported decommissions or included in any notes in the member state-reported data.

The member state-reported data as a collective dataset, however, ultimately fails to be useful with 11 non-reporting member states, given that the non-reporting member states account for over 40% of total cross-border transmission capacity. Germany and France are overwhelmingly the largest exporters of electricity with 35,000 MW and 25,160 MW of cross-border capacity, respectively. Additionally, given the central location of the non-reporting member states, understanding the connectivity to bordering states is important to understand the cross-border transmission infrastructure in Europe.

B1 – Biofuels Refining

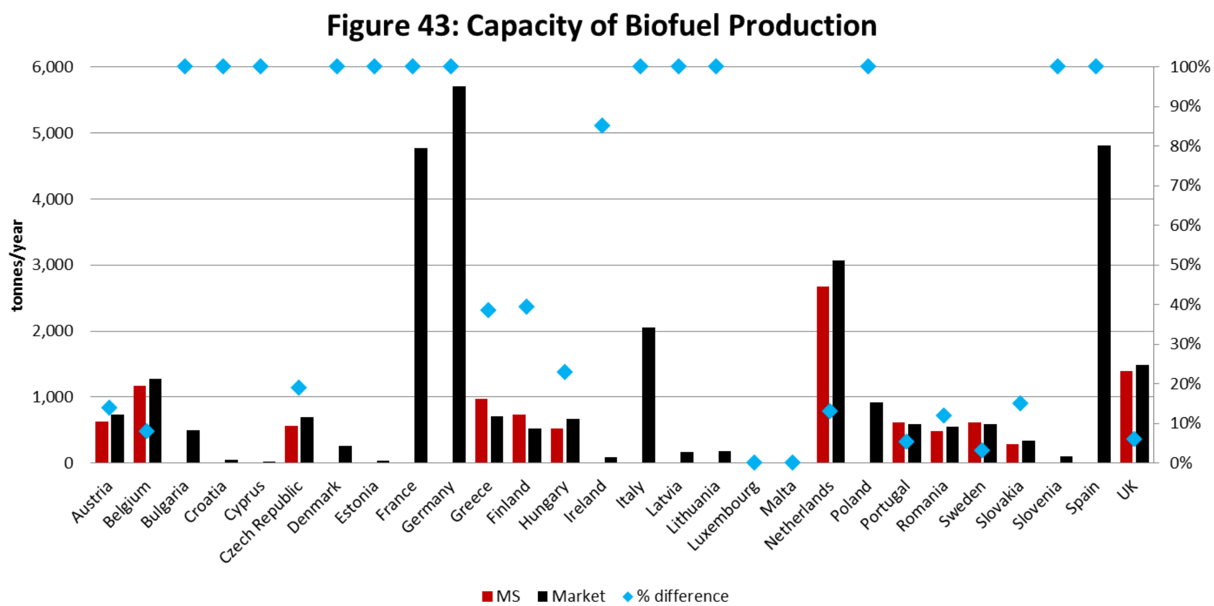
State of the European Biofuels Infrastructure

In comparison to prior reporting years, there are substantially more biofuel capacity projects planned and proposed in the European Union. The member states that reported information on biofuel production capacity reported a total of 10 new biofuel projects, three of which increase biodiesel production capacity and seven of which increase ethanol production capacity. Total and Eni have also announced plans to convert their Le Mede and Porto Marghera crude refineries into biorefineries, indicating a renewed interest in biofuel production.

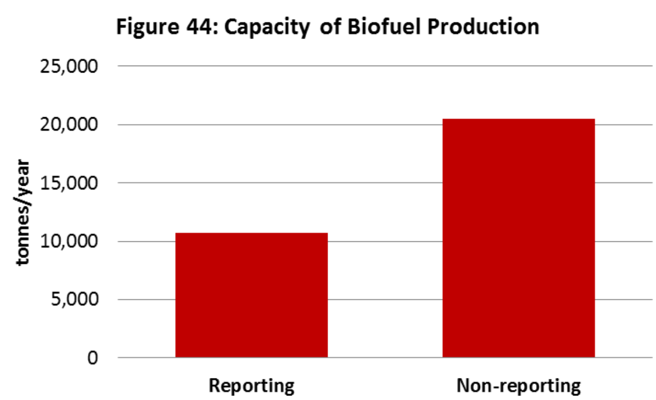
However, recent reports that biofuel may have emissions similar to that of hydrocarbons as well as opposition to imported oils in the biofuel consumption process may limit the amount of incremental capacity or utilization of that capacity in the reporting period. On the other hand, biofuels have been touted as a means to reducing emissions and as a boon for rural economies, particularly in central and eastern Europe.

Comparison of Member-State Data to Third-Party Sources

The Regulation requires member states to report biofuel production installations that are able to produce or refine bio-fuels with a capacity of 50,000 tonnes/year or more. The reporting template requires member states to report various types of installations in tonnes/year: un-processed refined oil, or pure plant oil, biofuel from oil crops (FAME, FAEE, oils, other), biofuel from sugar and starch crops



(ethanol, ETBE, other), biofuel from lignocellulosics (ethanol, synthetic biofuel, other), and methane installations from biogas. The data is to be reported in thousands of tonnes of capacity. The template also leaves space for the member state to supply supplementary information, which many member states submitted. The supplementary proved useful to understanding the biofuel infrastructure.



In order to verify the accuracy of the member-state date, Platts used publicly-available data from the European Biodiesel Board (EBB), an organization that aims to promote the use of biodiesel in the European Union and tracks various biofuels statistics. EBB, in particular, reports biodiesel production capacity, which roughly correlates with member-state data reported as production capacity from pure plant oil installations and production capacity from oil crops.

Platts also used publicly-available data and information from ePure to verify the member-state data. ePure is the European renewable ethanol association that represents the interests of European renewable ethanol producers, promotes the beneficial uses of ethanol throughout Europe, and collects various statistics on ethanol production. In particular, ePURE tracks ethanol production capacity, which roughly corresponds with the member-state data reported as biofuel installations from sugar and starch crops. The correlation is rough and varies on average by about 30% from the member state-reported data. Platts supplemented the two publically-available sources with primary research and analyst expertise.

Thirteen member states reported a cumulative 10,675 tonnes/year of biofuel production capacity, accounting for about a third of total biofuel production capacity in Europe. Non-reporting states, including Bulgaria, Croatia, Denmark, Cyprus, Estonia, France, Germany, Italy, Latvia, Lithuania, Slovenia, and Poland, accounted for the majority of Europe's biofuel production capacity at 20,496 tonnes/year.

Individual Member-State Reporting

Austria reported 445 kt of pure plant oil biofuel production and 190 kt of biofuel production capacity from ethanol. With the use of EBB and ePure, Platts is able to confirm the relative accuracy of the member state-reported data. ePURE tracks 240 kt of ethanol capacity and EBB tracks 495 kt of biodiesel capacity.

Belgium reported 750 kt of biofuel production from oil crops and 219 kt of ethanol production capacity. With the use of EBB and ePure, Platts is able to confirm the relative accuracy of the member state-reported data. ePURE tracks 532 kt of ethanol capacity and EBB tracks 741 kt of biodiesel capacity.

The **Czech Republic** reported 410 kt of operational biofuel production capacity from oil crops and 70 kt of non-operational capacity. The Czech Republic also reports 158 kt of non-operational biofuel production capacity from sugar and starch crops. Platts is unable to verify the accuracy of non-operational capacity, but confirms biodiesel production capacity is in-line with EBB's 503 kt of biodiesel capacity. Though the Czech Republic reported 158 kt of ethanol capacity non-operational, ePURE reports 199 kt of ethanol capacity currently in operation. Platts suspects that the Czech Republic misreported this capacity as non-operational.

Finland reports 500 kt of biofuel production capacity from oil crops, 183 kt of biofuel production capacity from sugar and starch crops, and 50 kt of biofuel production capacity from lignocellulosics. The EBB reports 500 kt of biodiesel production capacity and ePURE reports 233 kt of ethanol capacity for a total capacity of 733 kt of biofuel production capacity, in-line with the 733 kt of cumulative capacity as reported by Finland. Finland also reports two new ethanol production projects currently under construction with capacities of 150 kt and 84 kt. Through primary research, Platts is able to confirm biofuel projects in Finland.

Greece reports 973 kt of biodiesel production capacity, while the EBB reports 702 kt. Platts is unable to identify the cause of the discrepancy, but given the margin of error is within 30%, Platts deems the member state-reported data to be accurate.

Hungary reports 150 mt of biodiesel production capacity and 368 mt of ethanol production capacity. Platts confirms the accuracy of the existing biofuel installations with the EBB reporting 158 mt of biodiesel production capacity and 517 mt of ethanol production capacity. Hungary also reports one new ethanol production project with a capacity of 160 mt of production capacity. Platts confirms the project as an expansion of the existing Dunafoldvar corn-ethanol plant in Hungary.

Ireland reports some biofuel capacity from oil crops (28 kt) and from sugar and starch crops (13 kt), but these projects are smaller than the 50 kt threshold for reporting biofuel production installations.

Additionally, Ireland reports that there is currently no ethanol being manufactured for use as biofuel in Ireland. Platts confirms the accuracy of the ethanol production capacity as reported by the member state, but also notes that the EBB reports 73 kt of biodiesel production capacity in Ireland. Platts cannot identify the source of the discrepancy.

The Netherlands reports no pure plant oil installations with a capacity greater than 50 kt, 2,097 kt of biofuel production capacity from oil crops, 562 kt of biofuel production capacity from sugar and starch crops, and 43 kt of biofuel production from lignocellulosics, which is below the threshold for reporting installations. Platts confirms the relative accuracy of the member state-reported data. The EBB reports 2,505 kt of biodiesel production capacity and ePURE reports 565 kt of ethanol production capacity. The Netherlands also reports five new biofuel projects with a cumulative capacity of 387 kt. Platts confirms the accuracy of the member state-reported project information.

Portugal reports 621 kt of operational biodiesel production capacity and 100 kt of non-operational biodiesel production capacity. Platts confirms the accuracy of this data, as the EBB reports 590 kt of biodiesel production capacity.

Romania reports 400 kt of biodiesel production capacity and 80 kt of ethanol production capacity. Platts confirms the accuracy of the reported data. The EBB reports 407 kt of biodiesel production capacity and ePURE reports 137 kt of ethanol production capacity.

Slovakia reports 185 kt of biodiesel production capacity and 105 kt of ethanol production capacity. Platts confirms the accuracy of the reported data. The EBB reports 158 kt of biodiesel production capacity and ePURE reports 185 kt of ethanol production capacity.

Spain reports no biofuel production capacity, however the EBB tracks 4,194 kt of biodiesel production capacity and ePURE tracks 618 kt of ethanol production capacity.

Sweden reports 290 kt of biofuel production capacity from oil crops, 175 kt of biofuel production capacity from sugar and starch crops, 25 kt of biofuel production capacity from lignocellulosics, below the threshold of 50 kt for reporting, and 121 kt of methane installations from biogas. The member state-reported data is mostly in-line with market sources. EBB and ePURE combined track 592 kt of biofuel production capacity in Sweden, just shy of the member state-reported capacity of 586 kt of biofuel production capacity in the member state. Sweden reports one new lignocellulosics project with a capacity of 60 kt. Platts confirms the member state-reported project information.

The **United Kingdom** reported 675 kt of biodiesel production capacity and 719 kt of ethanol production capacity, which is in-line with publically available information. The EBB reports 505 kt of biodiesel production and ePURE reports 985 kt of ethanol production capacity. The United Kingdom reports one new planned biodiesel production installation with a capacity of 77 kt. Platts confirms the accuracy of this reported information. The United Kingdom also reports the retirement of one biodiesel production installation. Though Platts cannot confirm the accuracy of this information and the capacity of the plant is smaller than the threshold for reporting, decommissioning information is usual in the analysis of energy infrastructure in the European Union and will likely prove useful in the future.

Conclusion

EBB and ePURE report very limited data on ethanol production capacity and biodiesel production capacity, but there are no publically available sources that track the type of installations like that of the member state-reported data. The very descriptive categories of biofuel capacity track important information that is not tracked by any publically available sources. However, these descriptive categories may contribute little in terms of infrastructure analysis. A more simplistic approach in biofuels, distinguishing between biodiesel and ethanol production may be sufficient in understanding existing capacity, the need for additional capacity, and investment trends in the industry.

No publically available data source tracks the retirement of biofuel production capacity. This data will remain useful to the greater understanding of energy infrastructure in Europe, but the reported data cannot be verified against another market source and public information on the retirements are limited.

The benchmark data differs slightly from reported data, but the discrepancy appears to stem from the definition of biodiesel versus ethanol production. The cumulative capacities of biofuel production installations coincide with the cumulative capacities reported by EBB and ePure, suggesting that the member state-reported data on biofuel production capacity is very accurate. Ultimately, the data, as currently reported by the member states is insufficient, given that non-reporting member states account for the majority of biofuels capacity. Like the bulk of the member state-reported data, more widespread participation in the reporting, particularly from the energy-intensive states of Germany, France, and Italy, is vital for the utility of the data.

C1/C2 – CO2 Transport and Storage

State of the European Carbon Transport and Storage Infrastructure

The capture and storage of carbon was once an innovative plan to incentivize energy market participants to reduce carbon emissions. Such infrastructure was economic when the value of European carbon offsets was high, but since the carbon offset price has fallen, the massive start-up costs of both carbon transport and storage are no longer viable. CO2 pipelines could be built in order to transport CO2 to production sites where the CO2 could be used for Enhanced Oil Recovery (EOR). However, current depressed crude oil prices and a future of easy-to-access to crude in North America, EOR in Europe is no longer the most economic endeavor. Though CO2 recovery can aid in CO2 reduction targets, no incremental infrastructure can be expected in the next five years, nor is any infrastructure necessary to the functioning of the European energy market.

Comparison of Member-State Data to Third-Party Sources

Platts utilized internal expertise and knowledge of our analyst team focused on carbon infrastructure and prices, supplemented by primary research, to verify the member state-reported data, which reported no existing CO2 storage or transportation. Member states are required to report the capacities, in kilotonnes (kt) of carbon dioxide pipelines and storage installations with a capacity greater than 100 kt.

Individual Member-State Reporting

The **Czech Republic** and **Denmark** all accurately reported no existing or planned carbon transportation or storage capacity.

The **United Kingdom** accurately reports no existing carbon infrastructure. However, through primary research, Platts has found plans for the 116-km Peterhead CO2 pipeline and the 165-km White Rose CO2 pipeline. These projects may not have yet reached FID, which would imply that the United Kingdom is accurate.

The **Netherlands** also reports no existing CO2 transportation, but OCAP currently sources CO2 from the Shell and Abengoa refineries in Rotterdam to supply a number of major greenhouse areas to the port of Amsterdam. The OCAP pipeline transports about 400 kt/year of CO2 and is 97 km in length. The Netherlands also reports plans for one 25 km CO2 pipeline to be commissioned in the next three to five years. Platts confirms that the ROAD project is planned for the Netherlands with a capacity of 5,000 kt/year.

Germany and France did not report data, but France is home to the existing 27-km Lacq CO2 pipeline. In Germany, the 52-km Janschwalde is in the planning stages.

Conclusion

The list of CO2 transport and storage infrastructure and number of future CO2 transport and storage infrastructure projects are small and inconsequential to the goals of the European Union in enacting the reporting Regulation. Economics will likely continue to deter investment in such projects. Platts deems continued reporting of CO2 transport and storage infrastructure unnecessary.

RECOMMENDATIONS AND CONCLUSIONS BY CONSULTANT

The greatest impediment of the utility of the member-state data as reported is the participation rate. Though participation in the survey was higher this year than previous reporting years, the member states that did not report account for an overwhelming portion of Europe's energy infrastructure. The energy infrastructure in the non-reporting states has a substantial effect on the infrastructure of surrounding member states. Without full participation in the survey, the aggregated data cannot be fully utilized by the European Union for its intended purposes: to obtain an overall picture of the development of investment in energy infrastructure in order to develop the European Union's energy policy.

In terms of the reporting template and the required reporting parameters, Platts offers various suggestions in each reporting sector and summarized below.

European **refinery data (O1)** is currently not publically available information, in particular the operating capacities of a refineries' various units. Therefore, the member-state data is useful. However, a number of steps can be taken to increase the utility of the member state-reported data. The states are not required to report the number of operating refineries. The discrepancies in the benchmark data and the member state-reported data in Greece or the United Kingdom, for example, could be explained with an indication of the number of operating refineries included in the cumulative capacity estimate. Similarly, refinery-by-refinery information would prove the most useful and can enhance the understanding of the location of the refining capacity relative to pipelines, seaways, and populations.

The refinery units for which the member states are encouraged to report capacities by the Regulation's reporting template are not comprehensive of refineries and can be ambiguous. The reporting can be improved with more clearly defined parameters for what constitutes the various categories of refining units. Desulphurization units and reforming capacity are difficult to compare to Platts' refinery database information, for example. The ability to report various units as the refineries define the units would result in a more comprehensive view of refinery capabilities in each member state, especially if this data was reported on a refinery-by-refinery basis.

For the purpose of better understanding the crude markets in Europe and the need for additional infrastructure, particularly additional units at existing refineries, the Commission may consider expanding its reporting requirements to include the type or origination of the crude oil consumed at Europe's refinery.

Publically available data on **crude oil pipelines (O2)** is scarce and the data provided by member states under the Regulation could prove useful to understanding European infrastructure. A number of modifications could be made in order to increase the utility of member state-reported liquids pipeline data. The number of operating pipelines would be useful in addition to the total length of the pipeline. More clearly defined parameters for what constitutes a product pipeline and what product the pipeline is designed to transport would aid the reporting of all liquids pipelines and proper understanding of the movement of products around Europe. Given the discrepancy in the member state-reported data and the benchmark data, it appears likely that member states, such as Denmark and the United Kingdom, are not reporting offshore pipelines. An additional category for offshore pipelines would encourage member states to report this data in additional to onshore pipelines.

The capacity of crude oil and product pipelines, rather than the length of pipeline would better aid in identifying any additional need for pipeline infrastructure between supply and demand sources, as well as estimated origins and destinations. Such data could be paired with refinery capacity data reported by the member states to provide a comprehensive understanding of flows, required infrastructure, and where potential investments could be made to increase optionality of supply.

Crude and product movements in Europe are not exclusive to pipelines. In fact, large volumes of crude and product are imported into Europe or transported throughout Europe via waterways and import terminals. To fully understand the movement of crude and product and the bottlenecks that may exist in Europe, the Commission may consider including data reporting requirements for import and export terminals in Europe. Data on the number of terminals, the total capacity for imports and exports, and the type of crude or product typically handled at the terminals.

As mentioned, the European oil market is relatively established and few **pipelines cross borders (O3)** given the location and dynamics of the supply and demand for crude oil and refined products.

Therefore, this particular dataset does not appear to be useful in the analysis of infrastructure in Europe. The utility of the dataset is further hindered by its inaccuracy and multilingual reporting. Origins and destinations of the pipeline would be of greater use for analysis purposes than simply the admission of cross-border pipelines.

Given the lack of publicly available data on **crude oil and refined product storage (O4)** in Europe, this data could be extremely useful if the data could be proven accurate. Currently, the member-state data is deemed mostly inaccurate or incomplete and is, therefore, not useful. Aside from better accuracy, the data could be utilized more efficiently if the data was reported in barrels rather than cubic meters, which is more in line with industry standards of reporting crude oil and refined product inventories and capacities. Additionally, like product pipelines, it would be useful for product storage to be reported by the product stored, in order to inform if there is a lack of or an excess of storage capacity for a particular product.

With the exception of the data reported by a portion of the member states on compressor station power capacity, the length of **natural gas pipelines (G1)** in Europe is publically available through the ENTSO-G. The existing member-state dataset, given the 23% reporting rate of total gas transmission infrastructure, is incomplete and proves far less useful than ENTSO-G's publically-available data.

To a certain extent, comparing member state-reported transmission line projects with that of TYNDP's project list aids in understanding which pipelines have reached FID. TYNDP does not indicate what projects have reached FID, which explains the discrepancy in the member state-reported project data and that of the benchmark.

Generally speaking, capacities of transmission line and pipelines are more useful for infrastructure analysis than the length of the pipeline alone. The length of the pipelines can inform market trends, such as identifying the countries with the most pipeline infrastructure. However, domestic capacity of natural gas pipelines could be compared to capacities of existing and planned natural gas-fired power plants to reach an understanding of which areas and countries require additional infrastructure. With the length of the pipeline alone, the data is not useful in determining where and when additional infrastructure may be necessary.

Much of the member state-reported data for **cross-border natural gas pipelines (G2)** does not correspond with the benchmark data both for existing pipeline capacity and planned pipeline capacity. Some notes as reported by the member states were useful in determining the accuracy of the data, as well as useful in providing additional information on the pipelines. Project information may differ as the TYNDP reports all project, regardless of whether the pipeline project has reached FID. The member state-reported data could be better aggregated in larger units than cubic meters and requiring additional details on the cross-border pipelines could improve the utility of this dataset.

The majority of the member state-reported data on **LNG terminals (G3)** required by the Regulation template is already published publically by GLE, but with less granularity, since GLE reports data by facility and not at the member-state aggregate level. The benchmark data from GLE reports all projects that have been planned. Given the comprehensive reporting of existing and projected capacity reported by the GLE, there remains little need for the member state-reported data.

Finally, tracking regasification capacity alone fails to encompass major trends in the LNG market by not reporting export capacity in addition to import capacity. Cyprus' Vassilikos LNG terminal, for example, is planned for 4.5 t/year of LNG exports by 2022 and four export terminals are currently operating in Norway with an export capacity of 4.82 t/year. As the global LNG market continues to evolve, it is vital to track export terminals as well as import terminals in Europe. The Commission may consider modifying the requirement to include regasification capacity, as well.

The majority of the member state-reported data for **natural gas storage (G4)** required by the Regulation template is already published publically by GSE, but with less granularity, since GSE reports data by storage facility and not only at the member-state aggregate level. Similarly, the data reporting required by the Regulation includes information that may not be useful to the overarching understanding of infrastructure, such as the total storage capacity or the maximum injection and withdrawal capacity. Also, given the comprehensive reporting of existing and projected capacity reported by the GSE, there remains little need for the member state-reported data, with the exception of decommissioning data reported by member states.

The **electricity production (E1)** dataset is useful in tracking themes and trends in the power stack of individual member states that reported. However, nearly every member state reported incomplete data, failing to report a type of power plant or a portion of its power generation stack. The data almost entirely failed to track PV installations, as most member states did not report PV installation capacity or an incorrect capacity when compared to the benchmark data. Wind capacity was largely underestimated in part due to the Regulation's suggestion to report only capacity from installations with a capacity greater than 20 MW. If the dataset could be deemed accurate, the granular nature of the reporting requirements would prove extremely useful to understanding power generation needs and trends in Europe.

The reported data on **electricity transmission (E2)**, when reported and accurate, is more detailed than the information that is publically available from ENTSO-E. The voltage, type of current, and indication of aboveground, underground, or submarine line is useful additional data that can be utilized to indicate infrastructure trends in Europe. For instance, coastal member states rely more on underground and submarine transmission lines and Western Europe tends to have lower voltage transmission systems than Eastern Europe. Additionally, the decommissioning information is useful in that such data is not publicly available and not easily attainable through primary research.

The Regulation requires member states to report aboveground transmission line with a 220-kV minimum. However, the bulk of transmission capacity within Denmark, Latvia, and the Netherlands is of voltage less than 220 kV. These member states still reported transmission lines with voltage less than 220 kV, but the Regulation's reporting template creates distortion in the data. Lowering the threshold for reporting will help to develop a more comprehensive understanding of domestic transmission systems in each member state.

Generally speaking, infrastructure capacity, rather than the length, is largely more useful in fully understanding any infrastructure gaps. The data itself fails to capture some of the important gaps in domestic infrastructure systems. For example, the member state-reported data does not in any way indicate the need for additional capacity connecting England and Scotland in the United Kingdom, where an increase in wind-farm electricity generation fails to reach the southern portion of the member state due to a lack of transmission infrastructure. To efficiently capture this gap in reported data, member states would need to report more granular regions, such as Northern Italy and Southern Italy, as reported by ENTSO-E, or submit the locations of the transmission lines.

The member state-reported data on **cross-border electricity transmission (E3)** includes greater granularity than publically available information from ENTSO-E. The voltage of cross-border transmission lines is not available in any publically available publications, but the voltage information reported by member states can be useful for understanding where improvements either need to be made or can be made to improve cross-border capacity and efficiency. Additionally, combined with the individual member-state data reporting transmission lines by voltage, the member state-reported data can aid in the understanding of the capacity of individual member states to connect with interstate transmission lines. For example, much of the cross-border capacity from Austria is of relatively low voltage and the Czech Republic has relatively high cross-border voltage with Denmark and Poland.

ENTSO-E also does not report the cross-border points at which transmission lines cross as the members atate On one hand, this data is useful to understanding the extent to which cross-border transmission lines permeate a member state's border, though coordinates of the border points would be more useful. If plotted, these points would visually illustrate areas without sufficient connectivity within member states.

On the other hand, the system of reporting border points leads to double-counting in the dataset, making it difficult to sum the reported volumes without overestimating cross-border capacity. For example, Estonia reports two border points from Tartu, Estonia, and Tsirguliina, Estonia, that correspond with the same destination point of Valmiera, Latvia. Estonia reported a capacity of 998 MW for both segments, but when summed, these two capacities far exceed ENTSO-E's reported capacity, which appears to reflect the capacity of just one border point.

Given the inability to match TYNDP and ENTSO-E data with the individual projects reported by the member states, member state-reporting on the length of new transmission lines. For example, Austria reports an increase of 2,000 MW of cross-border transmission capacity, but also notes that the incremental length of the transmission is only 3 km, indicating that the increase in capacity stems from an upgrade or enhancement to an existing line or a short connection to existing transmission lines.

Countries like Belgium, Hungary, Ireland, Lithuania, Poland, and Slovenia included notes relating to existing and planned infrastructure that are useful in the analysis of European infrastructure. Other useful information includes cross-border capacity with countries outside the ENTSO-E member states, such as Belarus, Moldova, and Russia.

Finally, the member-state data reports AC and DC circuits, which informs how much capacity is bi-directional and in what areas electricity can only flow one direction. Whether the transmission line is an AC or DC circuit is not reported by public publications. For example, Finland reports 2,200 MW of cross-border DC submarine line to Sweden and Estonia, indicating that Finland exports more electricity than it could import.

As to the accuracy of the reported data, the data generally matches with the benchmark data when taking into account the double-counting that may be occurring by summing reported capacities. The most marked difference is that ENTSO-E expects substantial decreases in cross-border capacities between certain member states, which is not reflected in the member state-reported decommissions or included in any notes in the member state-reported data.

In terms of **biofuel production (B1)** reporting, EBB and ePURE report very limited data on ethanol production capacity and biodiesel production capacity, but there are no publically available sources that track the type of installations like that of the member state-reported data. The very descriptive categories of biofuel capacity track important information that is not tracked by any publically available sources. However, these descriptive categories may contribute little in terms of infrastructure analysis. A more simplistic approach in biofuels, distinguishing between biodiesel and ethanol production may be sufficient in understanding existing capacity, the need for additional capacity, and investment trends in the industry.

No publically available data source tracks the retirement of biofuel production capacity. This data will remain useful to the greater understanding of energy infrastructure in Europe, but the reported data cannot be verified against another market source and public information on the retirements are limited.

The benchmark data differs slightly from reported data, but the discrepancy appears to stem from the definition of biodiesel versus ethanol production. The cumulative capacities of biofuel production installations coincide with the cumulative capacities reported by EBB and ePure, suggesting that the member state-reported data on biofuel production capacity is very accurate.

The list of **CO2 transport and storage infrastructure (C1/C2)** and number of future CO2 transport and storage infrastructure projects are small and inconsequential to the goals of the European Union in enacting the reporting Regulation. Economics will likely continue to deter investment in such projects. Platts deems continued reporting of CO2 transport and storage infrastructure unnecessary.

APPENDIX I – New Power Generation Projects and Associated Costs

Power Plant Projects by Status and Type

Platts Powervision tracks over 900 power plant projects of various types that have been publically announced in European Union member states in which the latest publically recorded announcement indicated that the project would reach completion in the 0-5 year time frame used in this study. Figures 1-7 track the cumulative capacity of new projects in each country filtered by the project status. Projects deemed **under construction** are projects in which ground has been broken on construction of the project and are the projects least at risk of cancellation or delays beyond the five year time frame. Platts estimates that there is currently 1,963 MW of biomass power plant capacity, 5,307 MW of cogeneration power plant capacity, 8,260 MW of conventional power plant capacity, 61 MW of geothermal power plant capacity, 2,753 MW of hydroelectric power plant capacity, 2,530 MW of nuclear power plant capacity, and 6,030 MW of wind farm power plant capacity under construction in the European Union.

Projects that are defined as **advanced development** are projects in which the developer has applied for the necessary permits to begin construction and the permits have been granted by the appropriate government entity. Projects in advanced development are likely to begin construction in the short-term and at little risk of cancellation or delays beyond the five-year period. Platts estimates that there is currently 4,656 MW of biomass power plant capacity, 8,925 MW of cogeneration power plant capacity, 41,147 MW of conventional power plant capacity, 228 MW of geothermal power plant capacity, 4,187 MW of hydroelectric power plant capacity, 1,420 MW of nuclear power plant capacity, and 36,460 MW of wind farm power plant capacity is currently in an advanced development stage in the European Union.

Projects that are defined as **early development** are projects in which the developer has applied for the necessary permits to begin construction, but the permits have yet to be granted. Platts estimates that there is currently 668 MW of biomass power plant capacity, 3,665 MW of cogeneration power plant capacity, 32,468 MW of conventional power plant capacity, 200 MW of geothermal power plant capacity, 5,297 MW of hydroelectric power plant capacity, and 13,556 MW of wind farm power plant capacity is currently in an advanced development stage in the European Union.

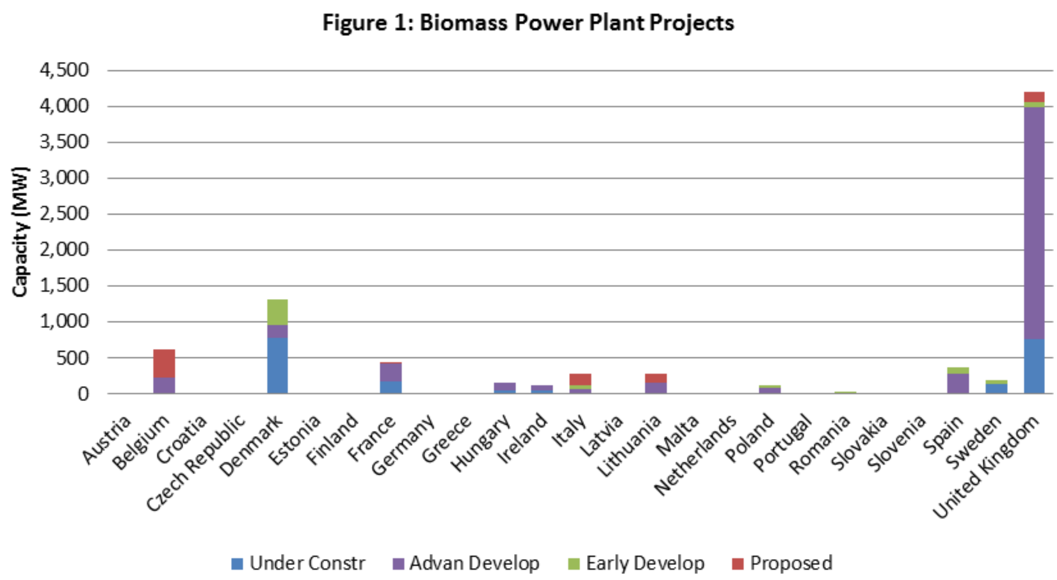
Projects that are defined as **proposed** are projects in which the developer has announced the intention to develop a power plant project. Developers of these projects have not publically announced concrete development plans nor have they applied for permits needed for construction. These projects are the most uncertain, and are potentially at risk of cancellation or delays beyond that of the five year time frame. Platts estimates that there is currently 842 MW of biomass power plant capacity, 5,177 MW of cogeneration power plant capacity, 11,348 MW of conventional power plant capacity, 564 MW of geothermal power plant capacity, 5,907 MW of hydroelectric power plant capacity, and 6,000 MW of wind farm power plant capacity proposed in the European Union.

Figure 8 tracks power plant projects by fuel type and status for projects in the 0-5 year time frame and Figure 9 tracks the cumulative capacity of power plant projects for each member state, filtered by the fuel type of the announced power plant project.

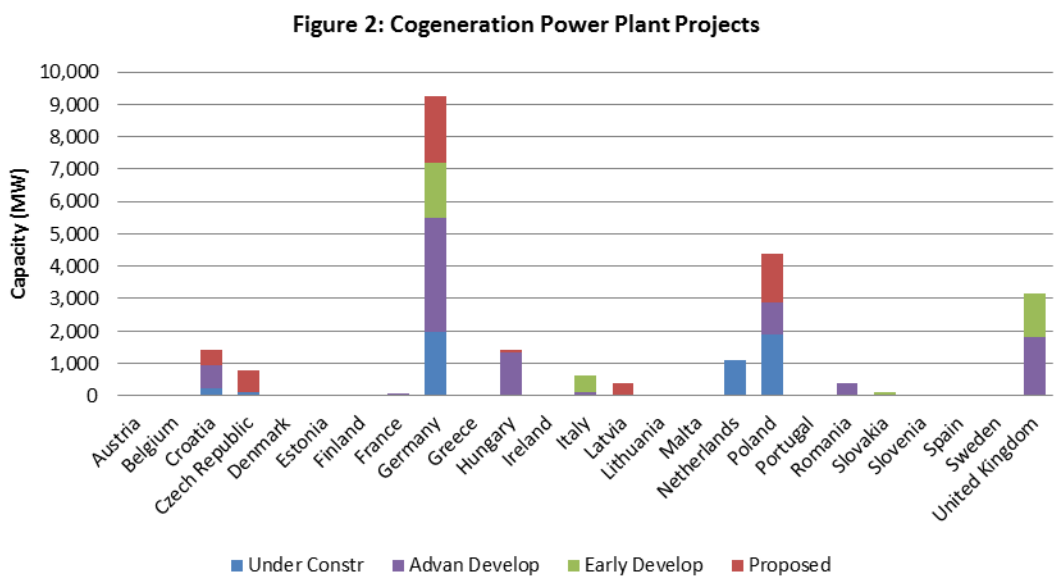
Estimated Cost of Electricity Generation Projects

Though Platts' Powervision does not track the cost associated with announced power plant projects, Platts has utilized primary research to track announced investment costs for power plant projects. Platts was able to collect publically announced capital investment estimates for approximately 50% of the total capacity of new power plant projects. For the remainder of the announced projects, Platts assumed a cost per MW of capacity, estimated using the capital investment data that was publically available. Figure 10 summarizes Platts' findings in terms of announced capital investment in new power plant projects, as well as Platts' estimations of capital investment requirements in lieu of publically available information. Platts estimates that capital investment for the construction of the power plants Platts tracks cumulatively represent €436 billion of investment in new power generation. The bulk of this investment stems from planned wind farm plants, which account for €229 billion of capital investment, or 42% of total estimated capital investment in power generation. Platts estimates that there is €25 billion of capital investment planned for biomass power plant projects, €29 billion for cogeneration power plant projects, €116 billion for conventional power plant projects, €6 billion for thermal and geothermal power plant projects, €19 billion for hydroelectric power plant projects, and €14 billion for nuclear power plant projects.

Platts' collected data on 89% of the announced biomass power plant project capacity and assumed the remaining capacity would incur a cost of M€5.19 per MW of capacity. Platts' collected data on 61% of the announced cogeneration power plant project capacity and assumed the remaining capacity would incur a cost of M€1.83 per MW of capacity. Platts' collected data on 38% of the announced conventional power plant project capacity and assumed the remaining capacity would incur a cost of M€1.39 per MW of capacity. Platts' collected data on 22% of the announced thermal and geothermal power plant project capacity and assumed the remaining capacity would incur a cost of M€5.81 per MW of capacity. Platts' collected data on 35% of the announced hydroelectric power plant project capacity and assumed the remaining capacity would incur a cost of M€1.04 per MW of capacity. Platts' collected data on 100% of the announced nuclear power plant project capacity. Platts' collected data on 59% of the announced wind farm power plant project capacity and assumed the remaining capacity would incur a cost of M€3.85 per MW of capacity.

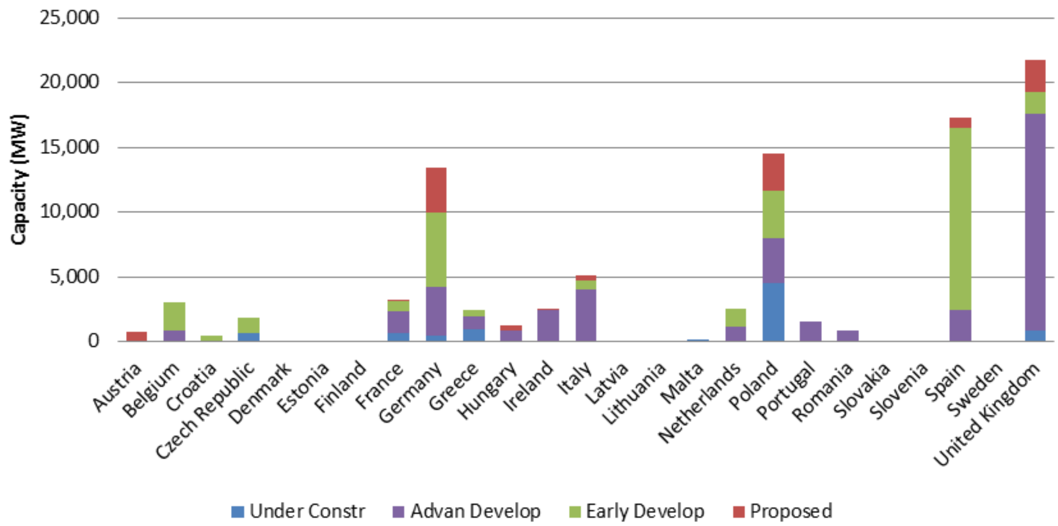


Source: S&P Global Platts Powervision



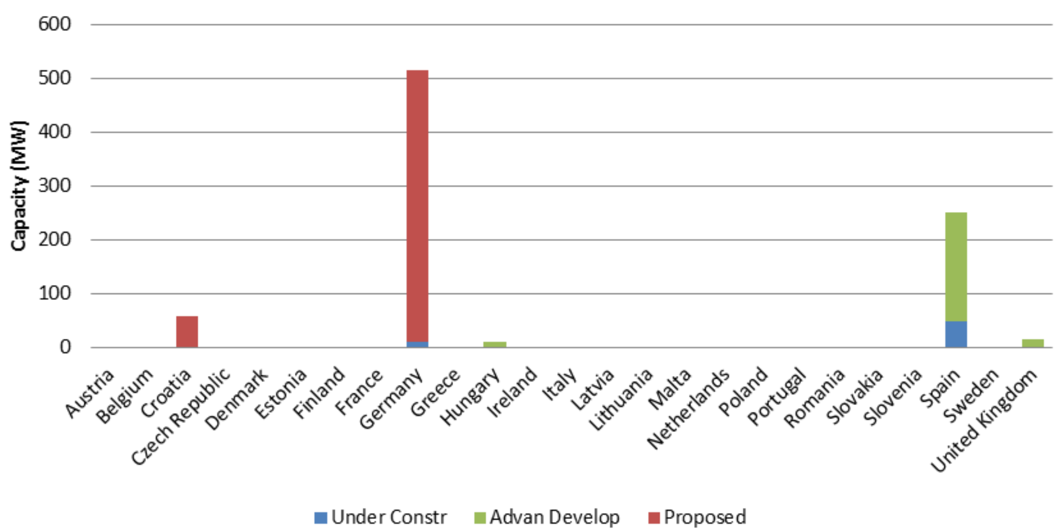
Source: S&P Global Platts Powervision

Figure 3: Conventional Power Plant Projects



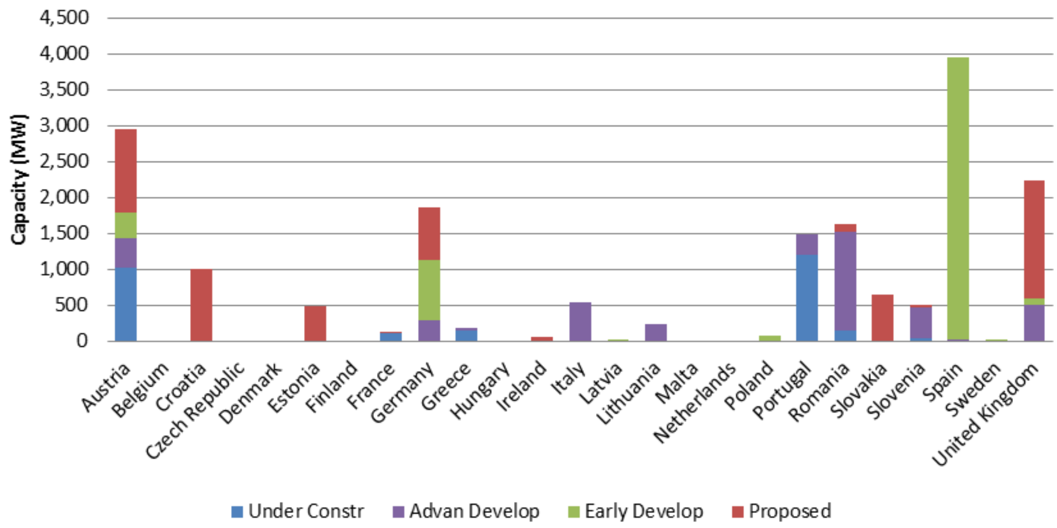
Source: S&P Global Platts Powervision

Figure 4: Geothermal Power Plant Projects



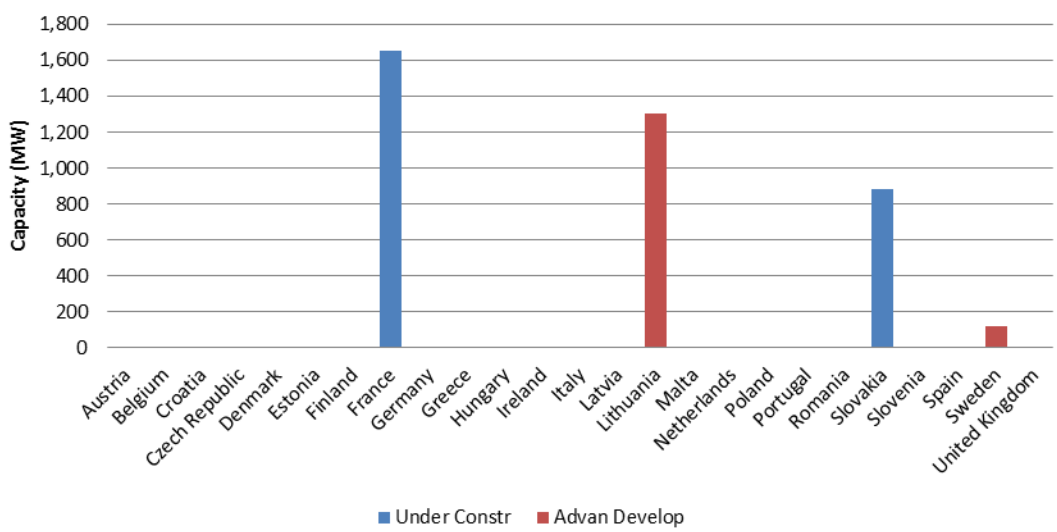
Source: S&P Global Platts Powervision

Figure 5: Hydroelectric Power Plant Projects



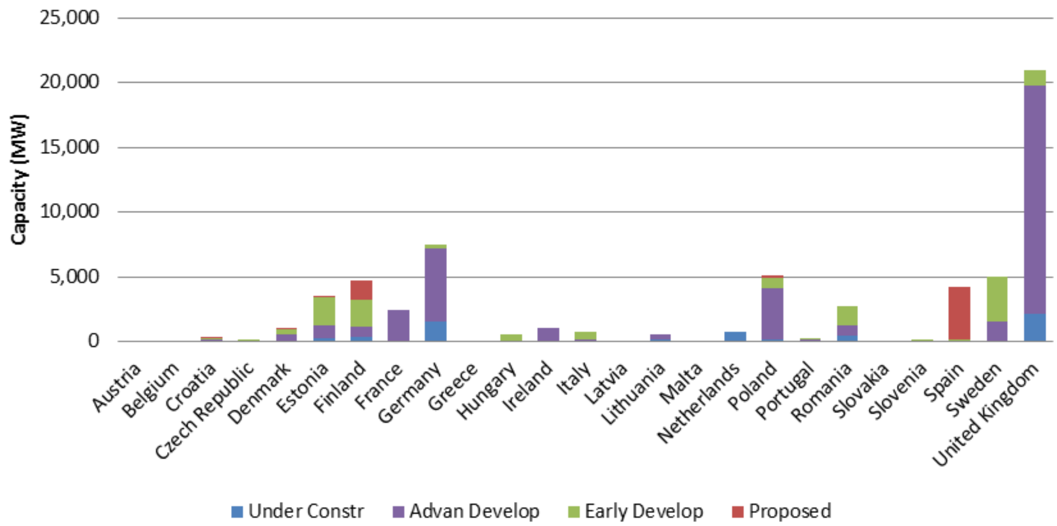
Source: S&P Global Platts Powervision

Figure 6: Nuclear Power Plant Projects



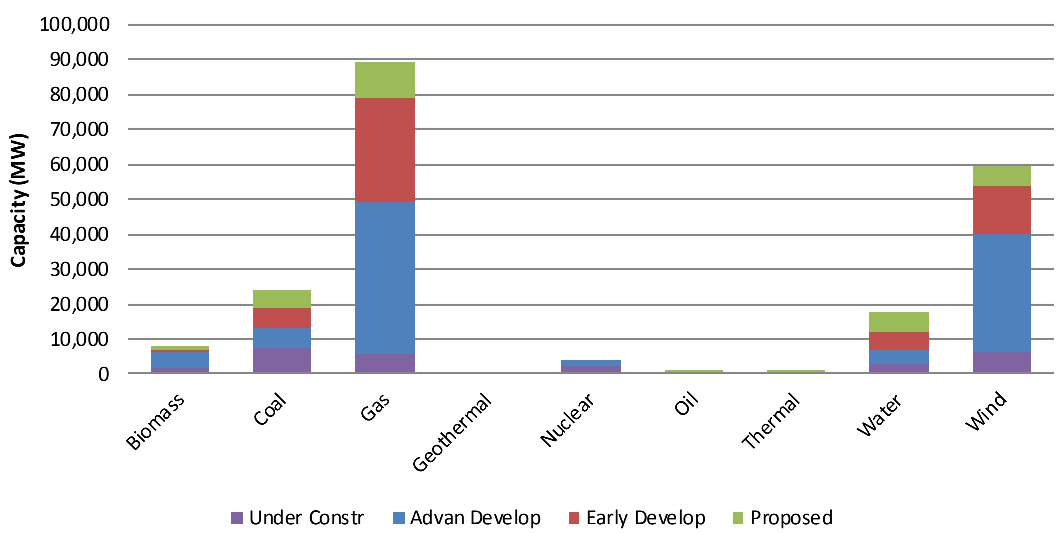
Source: S&P Global Platts Powervision

Figure 7: Wind Farm Power Plant Projects



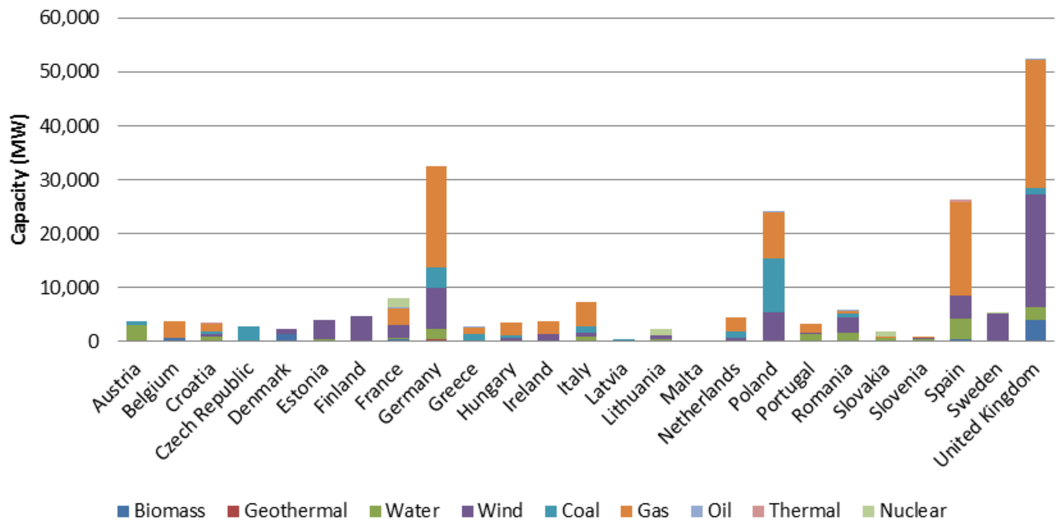
Source: S&P Global Platts Powervision

Figure 8: Power Plant Projects by Fuel Type and Status



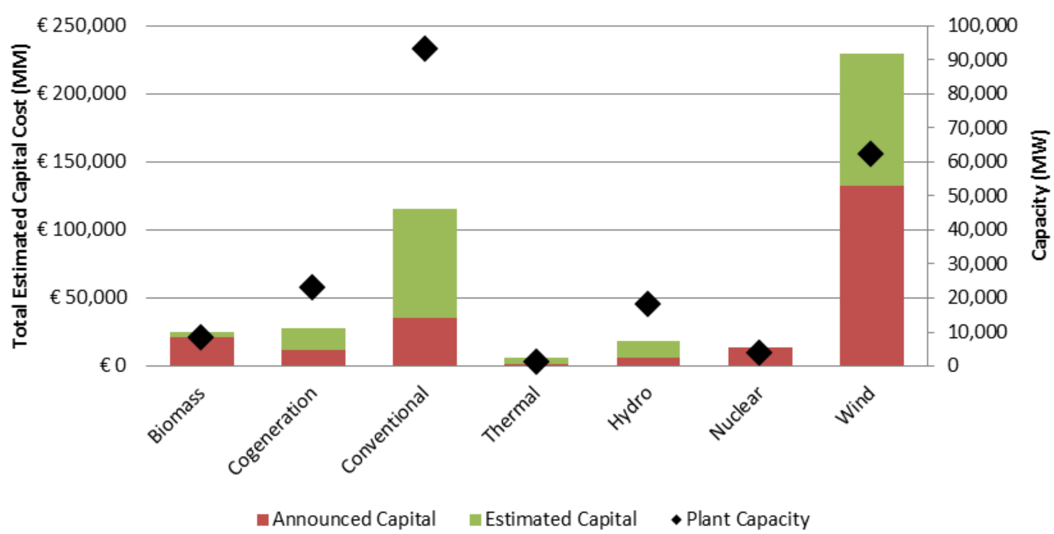
Source: S&P Global Platts Powervision

Figure 9: Power Plant Projects by Fuel Type and Member State



Source: S&P Global Platts Powervision

Figure 10: Capital Investment for Planned Plant Projects v Planned Plant Capacity



Source: S&P Global Platts Powervision

APPENDIX II – New Refinery Projects and Associated Costs

In addition to the relatively small number of new refinery projects and upgrades in the European member states, publically available information and data, including capacity of new units, the increase in capacity post-upgrade of the refinery, and the costs associated with the projects, is scarce. As mentioned, the European refinery market is opaque and little publicly available data exists. Platts has utilized primary research in order to track refinery projects and associated costs, but the information and data reporting is inconsistent. In the following section, Platts will briefly describe the publically announced refinery projects in the European Union, as well as any information that could be found regarding capital costs. Platts estimates that there are 17 refinery projects slated for completion in the 0-5 year time frame that account for a cumulative of €11,467 million in capital investment in the European refining market.

ExxonMobil and Total have both embarked on refinery upgrades to their Antwerp refineries in **Belgium**. ExxonMobil has announced plans to invest approximately €1,300 million to install a new delayed coker unit, but did not announce the incremental capacity of the coker upon completion. Total has announced plans to invest approximately €1,000 in upgrades at its Antwerp refinery that include a solvent de-asphalting unit, a mild hydrocracking unit, and an expansion to capture refinery gases for use in its petrochemical chemical complex. The upgrade will increase hydrocracking capacity by 20 Mb/d. Capacity additions or modifications from the other new infrastructure has not been announced.

Lukoil has announced plans to invest approximately €1,300 to upgrade its Burgas refinery in **Bulgaria**. The key component of the upgrade is the construction of a heavy oil residue hydrocracking unit and includes a new sulfur recovery unit. The upgrade will increase hydrocracking capacity in Bulgaria by 50 Mb/d. No capacity modifications were announced for the new sulfur recovery unit.

INA Industrija Nafte DD has announced a residue upgrade program at its Rijecka refinery in **Croatia**. The upgrade program includes a delayed coker and is expected to cost approximately €350 million. INA Industrija Nafte DD also announced plans to include two additional LPG amine treatment units, which is expected to cost an incremental €590 million. No capacity modifications were mentioned with the announcements.

Neste Corporation has announced plans to reconfigure its Naantali refinery in **Finland** at an estimated investment cost of €60 million and to add a new solvent de-asphalt pretreatment unit at its Porvoo refinery at an estimated investment cost of €200 million. The projects coincide with Neste's plan to integrate the Naantali refinery with its Porvoo refinery at an estimated investment cost of €500 million, for a total investment of €760 million at Finland refineries. No capacity modifications were mentioned with the announcements.

In **France**, Total is investing €200 million to convert its La Mede refinery into a biorefinery and €400 million to upgrade its Donges refinery. The Donges upgrade will include a new desulfurization unit and a steam methane reformer. No capacity modifications were mentioned with the announcements. ENI also plans to convert its Venice refinery in **Italy** into a biorefinery. Though ENI does not mention a cost of investment for the project, the project cost is likely comparable to Total's €200 million cost for the conversion.

ExxonMobil has announced plans to expand its hydrocracker unit at its Rotterdam refinery in the **Netherlands**. The estimated cost of the projects exceeds €1,300 million as it also includes new storage tanks. The project will increase the capacity of the Rotterdam hydrocracker by 20 Mb/d. ExxonMobil also announced plans to add high-quality lubricants production to the Rotterdam refinery, which would cost roughly €200 million. Additionally, Shell has announced plans to build a solvent de-asphalter at its Pernis refinery in Rotterdam. No estimates of capital investment were announced, but the unit likely requires costs similar to the solvent de-asphalter unit being constructed in Finland for €200 million.

Grupa Lotos SA has announced plans to upgrade its Gdansk refinery in **Poland** by constructing a delayed coker, a coker naphtha hydrotreater, and a hydrogen generation unit. The total cost of the project is estimated at €517 million. No capacity modifications were mentioned with the announcements.

As of early 2016, the National Iranian Oil Refining and Distribution Company announced a plan to build a €1,800 million refinery in Algeciras, **Spain** with a capacity of 120 Mb/d. The plan is still in its infancy, but could feasibly be completed in the 0-5 year time frame. Cepsa also plans to invest approximately €1,000 million in an expansion at its Gibraltar-San Roque refinery. One of the drivers of the project is a new hydrocracker, but no capacity estimates have been announced.

Preem has announced plans for a new vacuum distillation unit at its Lysekil refinery in **Sweden**. No cost or capacity was announced with the project, but design has already begun. Platts estimates that the cost of completion is similar to the costs of other standalone units being constructed in Europe at approximately €350 million.

There are no publically announced refinery projects in Austria, the Czech Republic, Denmark, Estonia, Germany, Greece, Hungary, Ireland, Latvia, Lithuania, Luxembourg, Malta, Portugal, Romania, Slovakia, Slovenia, and the United Kingdom.