Supplementary material: Building and Calibrating a Country-​​​​Level Detailed Global Electricity Model Based on Public Data

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S1 PLEXOS Detailed Equations

**Indices**

j Generation Unit

t Time Period

stor Index related specifically to pumped storage unit

RESup Upper Storage Reservoir

RESlow Lower storage Reservoir

**Variables**

Vjt Integer on/​​​​​​off decision variable for unit j at period t

Xjt Integer on/​​​​​​off decision variable for pumped storage pumping unit j at period t

Ujt Variable that = 1 at period t if unit j has started in previous period else 0

Pjt Power output of unit j (MW)

Hjt Pump load for unit j period t (MW)

Wint Flow into reservoir at time t (MWh)

Woutt Flow out of reservoir at time t (MWh)

Wt Volume of storage at a time t (MWh)

**Parameters**

vl Penalty for loss of load (€/​​​​​​MWh)

vs Penalty for Reserve not met

use Unserved Energy (MWh)

usr Reserve not met (MWh)

D Demand (MW)

obj Objective Function

njt No load cost unit j in period t (€)

cjt Start cost unit j in period t (€)

mjt Production Cost unit j in period t (€)

estor Efficiency of pumping unit (%​​​​)

pmaxj Max power output of a unit j (MW)

pminj Mini stable generation of unit j (MW)

pmpmaxstor Max pumping capacity of pumping unit

Jj Available units in each generator

Jstor Number of pumping units

MRUj Maximum ramp up rate (MW/​​​​​​min)

MRDj Maximum ramp down rate (MW/​​​​​​min)

MUTj Minimum up time (hrs)

Ap Number of hours a unit must initially be online due to its MUT constraint (hrs)

WINT Initial Volume of reservoir (GWh)

W Maximum volume of storage (GWH)

**Objective Function:**



The objective function in PLEXOS is to minimise the start-​​​​​​up cost of each unit (start cost (€)\* number of starts of a unit) + the no load cost of each online unit + production costs of each online unit + the penalty for unserved load+ the penalty of unserved reserve. The objective function is minimised within each simulation period. The simulation solution must also satisfy the constraints below:

**Energy Balance Equation:**



Energy balance equation states that the power output from each unit at each interval minus the pump load from pumped storage units for each interval + unserved energy must equal the demand for power at each interval. (Note that line losses can also be included here but is not shown). As the penalty for unserved energy is high and part of the objective function, the model will generally try to meet demand.

**Operation Constraints on Units:**

Basic operational constraints that limit the operation and flexibility of units such as maximum generation, minimum stable generation, minimum up/​​​​​​down times and ramp rates.





These two equations define the start definition of each unit and are used to track the on/​​​​​​off status of units.



Max Export Capacity: A units power output cannot be greater than it maximum export capacity.



Minimum Stable Generation: A units output must be greater than its minimum stable generation when the unit is online.



Pumping load must be less than maximum pumping capacity for each pumping unit





These constraints limit a pumped storage unit from pumping and generating at same time.





Minimum Up Times[[1]](#footnote-1): (Note the following text is directly from the PLEXOS Help files). The variable *Ap* tracks if any starts have occurred on the unit inside the periods preceding *p* with a window equal to MUT. *i.e.* if no starts happen in the last MUT periods then *Ap* will be zero, but if one (or more) starts have occurred then *Ap* will equal unity. The MUT constraints then set a lower bound on the unit commitment that is normally below zero, but when a unit is started, the bound rises above zero until the minimum up time has expired. This fractional lower bound when considered in an integer program forces the unit to stay on for its minimum up time.





Minimum Down Times: The variable *Ap* tracks if any units have been shut down inside the periods preceding *p* with a window equal to MDT. *i.e.* if no units are shut down in the last MDT periods then *Ap* will be zero, but if one (or more) shutdown then *Ap* will equal unity. The MDT constraints then set an upper bound on the unit commitment that is normally above unity, but when a unit is stopped, the bound falls below unity until the minimum down time has expired.





Maximum Ramp up and down constraints: These constraints limit the change in power output from one time period to another.

**Water Balance Equations**:

These equations track the passage of water from the lower reservoir to the upper reservoir. In this set-​​​​​​up there is no inflow and water volume is conserved.







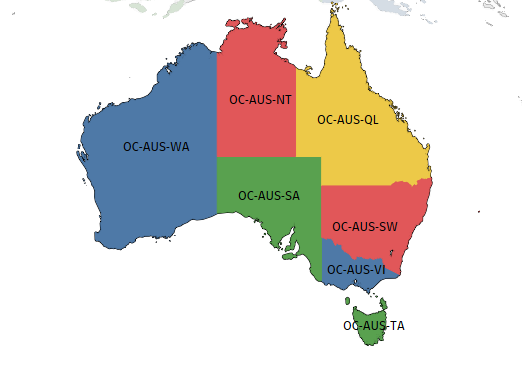


S2 Sub-​​​​​​country nodes

This section describes the used data and methodologies for the spatial representation, hourly demand profiles and transmission capacities of sub-​​​​​​country nodes within the global model.

*Australia*

Australia is subdivided into seven nodes, consisting of the six states (New South Wales, Queensland, South Australia, Tasmania, Western Australia and Victoria) plus the Northern Territory as visualized in figure S2.1. The Australian Capital Territory is assumed to be part of the New South Wales node (OC-​​​​​​AUS-​​​​​​SW). The National Electricity Market (NEM) is a wholesale market operated by the Australian Energy Market Operator (AEMO) that covers the grid connected areas of all nodes apart from OC-​​​​​​AUS-​​​​​​WA and OC-​​​​​​AUS-​​​​​​NT [1]. Historical hourly load for the different regions of NEM, which can be directly correlated to the nodes used for this study, can be retrieved through AEMO’s data dashboard [2]. Albeit not part of the NEM, OC-​​​​​​AUS-​​​​​​WA has its separate wholesale market also operated by AEMO. Historical hourly load data can be retrieved through [3]. No hourly data for OC-​​​​​​AUS-​​​​​​NT could be found, hence we used the profile shape of OC-​​​​​​AUS-​​​​​​WA and scaled it based on 2015 final electricity demand data from [4]. Aggregated transmission capacities between nodes within the NEM has been determined based on [5]. To-​​​​​​date, no cross-​​​​​​nodal transmission lines exist outside the NEM territory [6].

Figure S2.1: Nodal representation of Australia in PLEXOS World. Every copperplated area of an individual colour represents a node with a total of 7 independent nodes.

*Brazil*

Historically, Brazil’s national interconnected electricity system (SIN) consisted of four large grid-​​​​​​connected regions ranging from the South of the country to the North and North-​​​​​​East [7]. In more recent years, several long-​​​​​​distance transmission projects have been implemented which directly interconnect the hydro rich West and North-​​​​​​West of the country with demand centres in central Brazil [8]. We follow Gils and colleagues [9] for the nodal representation of the Brazilian electricity system. Next to the nodes as shown in figure S2.2, this also includes three transmission junction nodes connecting large hydro facilities with demand centers as indicated with an asterisk on the map. We’ve furthermore used [9] to retrieve the transmission capacities between nodes. The system operator of SIN, ‘Operador Nacional do Sistema Eléctrico’ (ONS), provides hourly demand data for historical years including 2015 [10]. The profiles for the ‘Nordeste’ and ‘Sul’ regions correlate to the nodes SA-​​​​​​BRA-​​​​​​NE and SA-​​​​​​BRA-​​​​​​SO as used for this study, whereas ‘Norte’ covers SA-​​​​​​BRA-​​​​​​CN, SA-​​​​​​BRA-​​​​​​NW, SA-​​​​​​BRA-​​​​​​WE and ‘Sudeste/​​​​​​Centro-​​​​​​Oeste’ covers SA-​​​​​​BRA-​​​​​​CW and SA-​​​​​​BRA-​​​​​​SE. For these latter two groups of nodes, we’ve used the relative population size per node based on [11] as a best estimate to disaggregate the regional demand profiles on a nodal basis.



Figure S2.2: Nodal representation of Brazil in PLEXOS World. Every copperplated area of an individual colour represents a node with a total of 10 independent nodes, consisting of 7 nodes with demand and generation portfolios and 3 transmission junction nodes that represent transmission interconnections connecting large hydro facilities with demand centres (indicated with asterisks on the map).

*Canada and the United States*

The grid-​​​​​​connected electricity system in Canada and the US spans multiple time zones, stretching from Pacific Standard Time (-​​​​​​8 UTC) on the west coast to Atlantic Standard Time (-​​​​​​4 UTC) in eastern Canada. There are four main interconnected grids; The Eastern, Western, Quebec and ERCOT interconnections [12]. Electricity system integration through transmission interconnection between these independent grids is limited. As of 2015, the reliability of the four interconnections is governed by 16 different North-​​​​​​American Electric Reliability Corporation (NERC) coordinating regions [13]. To add more complexity, there are nine wholesale markets operated by Independent System Operators (ISO) or Regional Transmission Organizations (RTO) [12]. Approximately 70%​​​​ of demand in the US is supplied through wholesale markets, the remainder through vertically integrated utilities [14]. The US Energy Information Administration (EIA) developed a nodal representation for their National Energy Modelling System (NEMS) with these aspects in mind by disaggregating the country in 22 regions [15]. We follow this approach for the nodal representation of the US, apart from combining the three New York NEMS regions into a singular node. In addition, the insular areas of Alaska, Guam, Hawaii and Puerto Rico are added as seperate nodes. The grid-​​​​​​connected provinces of Canada are represented with eight nodes (New Brunswick, Nova Scotia and Prince Edward Island combined into one node). Furthermore, the isolated systems of The Northwest Territories, Nunavut and Yukon [16] are aggregated into a singular node. Both sets of nodes are visualized in figure S2.3.

All Canadian and US nodes are populated with localized load and transmission data. Hourly load profiles for the Canadian provinces are retrieved from the relevant system operators through online data portals [17–21] and personal communication (L. St-​​​​​​Laurent, Hydro Quebec, 12-​​​​​​02-​​​​​​2018 – B. Owen, Manitoba Hydro, 01-​​​​​​12-​​​​​​2017 – R. Mall, SaskPower, 21-​​​​​​12-​​​​​​2017). Interregional transmission capacities and cross-​​​​​​border capacities towards the US regions are based on reported values [22–28] or derived from maximum reached hourly power exchange values in 2015 as retrieved from [19,29]. We assume that these values equal the NTC between adjacent nodes.

To be able to incorporate accurate data for the US nodes we need to determine which ISO’s, RTO’s and smaller Balancing Authorities (BA) cover the different NEMS regions. This has been done by comparing the status map on the EIA’s US electric system operating data portal [30] with the mapped NEMS regions following [15]. Generally, the different operators clearly fit within a singular node. Yet, in certain situations it is less obvious, requiring additional sources such as market reports of the different BA’s to define the correct spatial representation [31,32,41–50,33–40]. Furthermore, the Southwest Power Pool (SPP), Midcontinent Independent System Operator (MISO) and the PJM interconnection span a larger area covering multiple NEMS regions. Historically, these larger areas were operated by smaller utilities as shown in [51]. We use these former utilities to disaggregate the load and transmission data of the larger SPP, MISO and PJM regions as explained in more detail below‌.

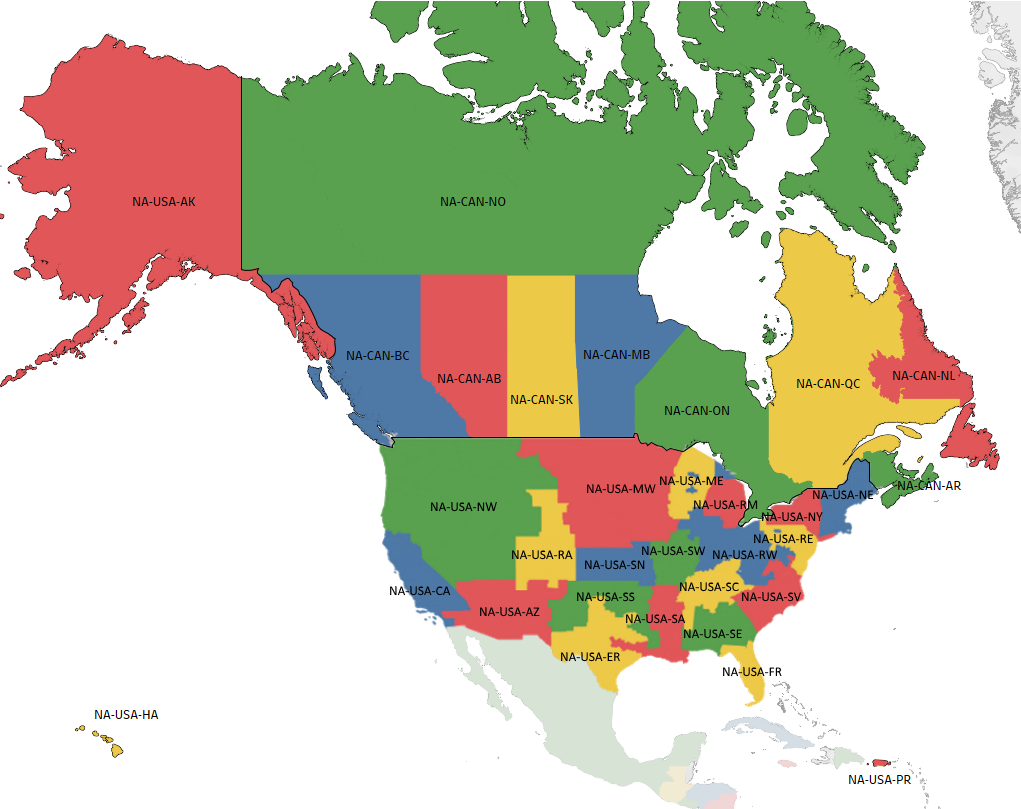


Figure S2.3: Nodal representation of Canada and the US in PLEXOS World. Every copperplated area of an individual colour represents a node with a total of 24 nodes in the US (mainland, in addition to Guam, Hawaii and Puerto Rico) and 9 in Canada. Blue sections in and around NA-​​​​​​USA-​​​​​​ME are part of balancing authorities within NA-​​​​​​USA-​​​​​​RW.

The 2015 hourly load profiles for the US nodes are constructed predominantly based on historically reported data for the different operators as administrated by the Federal Energy Regulatory Commission (FERC) [52]. PJM’s data directory [53] is used to retrieve 2015 hourly load data for the sub-​​​​​​regions within PJM. Profiles from the different operators per node, as identified earlier, are aggregated into a single profile. If available, this has been done by utilizing 2015 data, yet in certain cases data from deviating years had to be scaled and shifted to 2015 values by making use of reported yearly demand or sales data from the relevant operators [54–57]. The profile builder tool within PLEXOS has been used to correctly shift profiles from year to year. Rather than using the reported profiles for SPP, MISO and PJM, we used scaled and shifted historical data from the former utilities who compose these larger operators. This approach allows for more accurate spatial representation of load per US node within the model. Finally, the initial aggregated profiles per node are scaled to overall 2015 demand by combining reported final electricity sales to customers per NEMS region in the Annual Energy Outlook (AEO) of the EIA [58,59] with state level T&​​D losses [60].

Although a dataset exists with all individual power transmission lines in the US [61], this dataset does not incorporate info on potential NTC per line. We therefore use historical hourly exchange data (July 2015-​​​​​​2017) between the different operators [62] as indicator for NTC between US nodes. Data from before July 2015 isn’t available. It is assumed that the maximum reached hourly exchange in the period 2015-​​​​​​2017 counts as indicative NTC between two operators. Similar to the approach for hourly demand, we use additional sources to determine transfer capacities to-​​​​​​ and within the SPP, MISO and PJM parts of the US nodes for improved spatial representation. Transmission lines and capacities towards sub-​​​​​​areas of SPP can be derived from [63] with help from [12,64] to determine where transmission lines cross bordering nodes. No recent data can be found on transmission capacities within the larger SPP region. Hence, we assume that the maximum external flow from a single pathway coming in to a node covered by SPP can also flow towards adjacent nodes covered by SPP. Looking at the quantity-​​​​​​ and voltage of lines running between regions covered by SPP compared to lines to external regions [65] this is a simplified yet best estimate assumption to work with. NTC’s to external operators for nodes (partially) covered by MISO are based on hourly exchange data [62], again with additional sources being used to determine where lines cross bordering nodes [66–68]. Flow between the Midwest and South MISO subregions, in essence between the MISO parts of the US-​​​​​​SRDA and US-​​​​​​SRGW nodes, is constrained to 3GW since exchange occurs through infrastructure of other operators [54]. We assume that this flow can be sustained throughout all areas operated by MISO. Finally, maximum interregional and internal 2015 hourly exchange values for the PJM interconnection are retrieved from their data directory [53] and used to determine NTC’s. All identified capacities between operators are aggregated into a single bidirectional NTC per transmission pathway between adjacent nodes. These values can be found in S6.

*China*

From a data perspective, it is generally difficult to retrieve accurate information on China’s electricity system. This is the case for powerplant information as mentioned in the main text of this study, yet also for sub-​​​​​​country demand and transmission data. For this study, China’s electricity system is mostly based on received data from the authors of a range of studies by He and colleagues in which they introduce a systems approach to decarbonize China’s electricity system [69] and assess China’s renewable resource potential [70,71]. We follow the nodes as used for these studies which is on a per state basis as shown in figure S2.4, in addition we include Hong Kong (AS-​​​​​​CHN-​​​​​​HK) and Macau (AS-​​​​​​CHN-​​​​​​MA) as separate nodes within China’s larger electricity system. Transmission capacities in between the Chinese nodes as of 2015 are based on the same study of He et al.



Figure S2.4: Nodal representation of China and Japan in PLEXOS World. Every copperplated area of an individual colour represents a node with a total of 34 nodes in China and 6 in Japan.

To-​​​​​​date there’s no detailed historical data on hourly demand available for China, not on a regional level nor on an aggregate country level. We therefore developed simplified node specific synthetic hourly demand profiles for the different sub-​​​​​​country Chinese nodes, based on a standard daily shape of hourly demand for China as developed by State Grid [72]. [73] provides state specific monthly electricity demand data for the period 2007-​​​​​​2008. Using the historical relative share of demand per month per state, combined with the standard hourly shape and with 2015 demand data per state or region [74–76] allows us to develop a hourly demand profile for 2015 that is month and node specific. Albeit its obvious limitations, e.g. every day of a certain month has the exact same hourly values, it is currently the best possible approach based on available open data.

*India*

India’s nodal representation is based on the five main regional grids, integrated since 2014 as a national interconnected grid [77]. The nodal representation is shown in S2.5. Internal transmission capacities between the nodes are based on reported values by the Ministry of Power of India [78]. Toktarova et al. [79] has developed synthetic hourly demand profiles for India as a whole. We’ve used their 2020 profile and scaled and shifted it to 2015 values. Monthly peak demand data per state or regional power grid is provided by the Ministry of Power [80]. Per regional grid, directly correlated to our nodes in this study, we’ve altered the synthetic profile for India by scaling the hourly values per month based on the historical 2015 monthly peak demand, creating a node specific hourly profile.

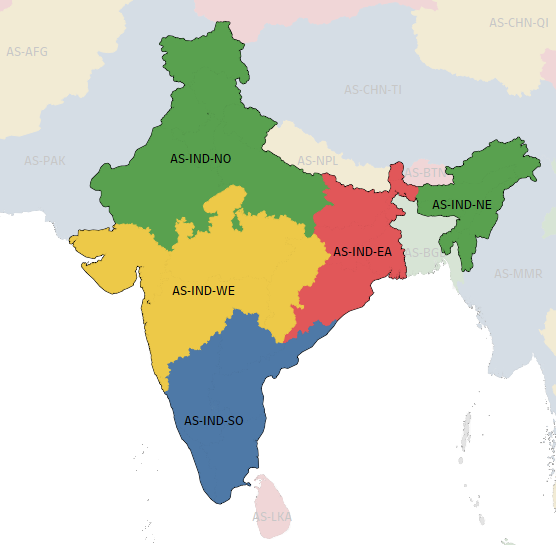


Figure S2.5: Nodal representation of India in PLEXOS World. Every copperplated area of an individual colour represents a node with a total of 5 nodes.

*Japan*

The electricity system of mainland Japan is divided into two asynchronous grids. Western Japan, including the islands of Kyūshū and Shikoku, runs at 60 Hz and Eastern Japan, including the island of Hokkaido, runs at 50 Hz. To-​​​​​​date, the grids are limitedly interconnected with back to back DC links allowing a maximum flow of 0.9 GW [81]. Supply on the islands of Okinawa is mostly based on decentral diesel-​​​​​​based generation and an increasing integration of renewables [82]. For this study, Honshu is divided into two nodes, with the 50/​​​​​​60 Hz grids as separator. Furthermore, the separate islands (Hokkaido, Kyūshū, Okinawa and Shikoku) are represented by individual nodes. See figure S2.4 underneath the China section for the relative nodal representation. Transmission capacity between the Japanese nodes is based on [81], to-​​​​​​date no cross-​​​​​​border interconnections to the Asian mainland exist. The Japanese ministry of Economy, Trade and Industry has provided hourly demand per system operator for the period April 2010 – March 2011. For simplicity, we’ve assumed that the shape of the hourly data for January – March 2011, while maintaining a correct representation of weekdays and weekends, can be used as data for January – March 2010 to create an hourly profile for a full calendar year. The hourly values of the different relevant system operators are combined into a singular profile and scaled and shifted to a node-​​​​​​specific 2015 demand profile.

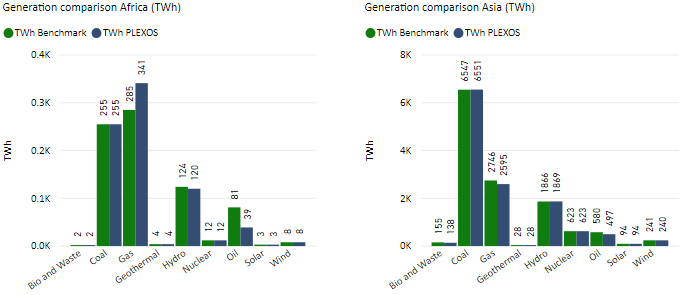
*Russia*

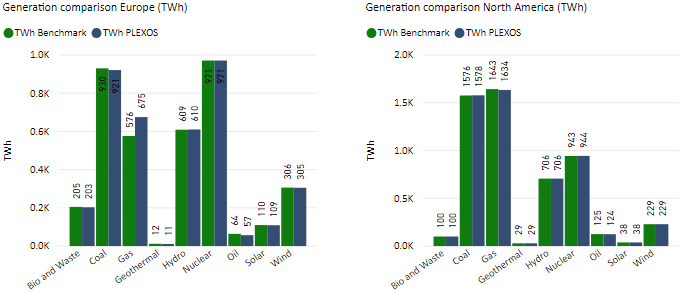
Russia has the largest landmass around the world and covers 11 time zones from UTC +2 (Kaliningrad) to UTC +12 (Far East). From an electricity system perspective, the country is divided in seven operational territories called ‘united energy systems’ (UES) [83]. These UES are used for the nodal representation of Russia in the global electricity system model as shown in figure S2.6. Despite the size of the country, only 2%​​​​ of electricity consumption in Russia is decentralized. The five most western UES are relatively well integrated with significant transmission capacity between regions. Connections towards-​​​​​​ and in between AS-​​​​​​RUS-​​​​​​UR and AS-​​​​​​RUS-​​​​​​FE are weak. Interregional transmission capacities between Russian nodes are based on 2010 data from [84]. The System Operator of the UES (SO UES) provides historical hourly demand data per UES per day [85]. By making use of an automated script, we’ve extracted all data for 2015 and developed node specific hourly profiles for all UES.

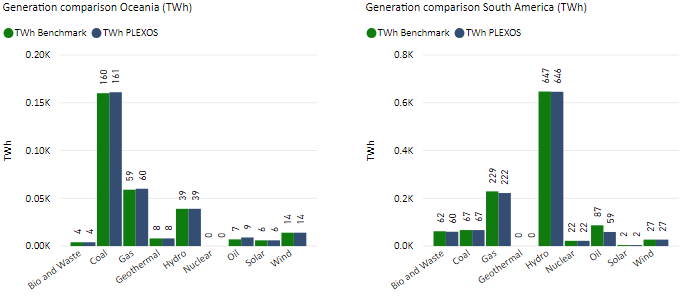
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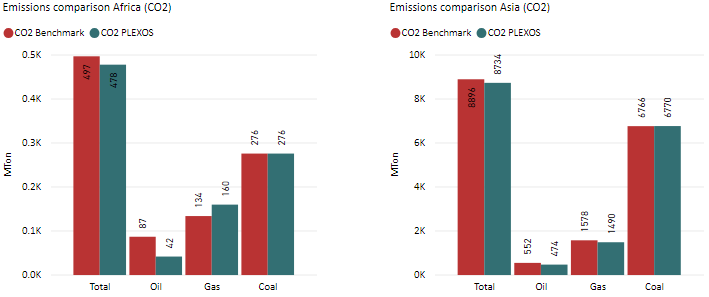
Figure S2.6: Nodal representation of Russia in PLEXOS World. Every copperplated area of an individual colour represents a node with a total of 7 independent nodes.

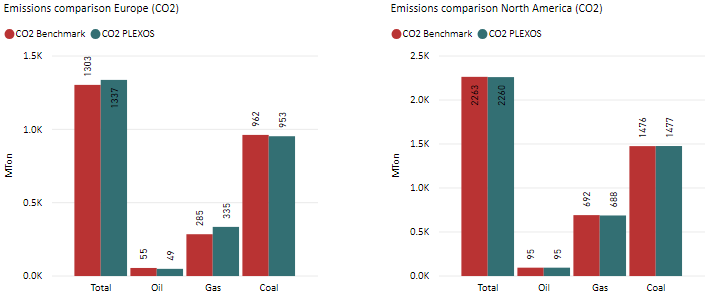
S3 Total generation and emission differences

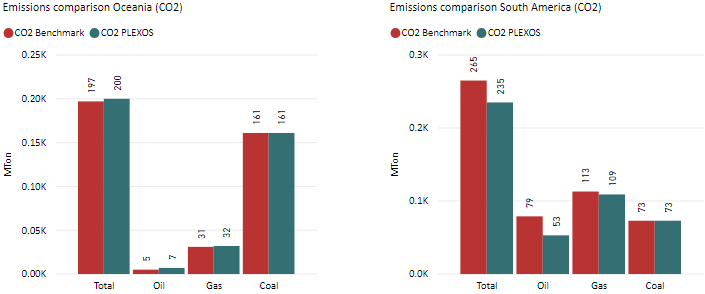












S4 List of nodes

Table S4.1: List of nodes with their geographical representation. Description of the geographical representation of sub-​​​​​​country nodes can be found in S2.

|  |  |  |  |
| --- | --- | --- | --- |
| **Node** | **Continent** | **Country** | **Geographical region** |
| **AF-​​​​​​AGO** | Africa | Angola | Angola |
| **AF-​​​​​​BDI** | Africa | Burundi | Burundi |
| **AF-​​​​​​BEN** | Africa | Benin | Benin |
| **AF-​​​​​​BFA** | Africa | Burkina Faso | Burkina Faso |
| **AF-​​​​​​BWA** | Africa | Botswana | Botswana |
| **AF-​​​​​​CAF** | Africa | Central African Republic | Central African Republic |
| **AF-​​​​​​CIV** | Africa | Cote DIvoire | Cote DIvoire |
| **AF-​​​​​​CMR** | Africa | Cameroon | Cameroon |
| **AF-​​​​​​COD** | Africa | Congo (Kinshasa) | Congo (Kinshasa) |
| **AF-​​​​​​COG** | Africa | Congo (Brazzaville) | Congo (Brazzaville) |
| **AF-​​​​​​CPV** | Africa | Cape Verde | Cape Verde |
| **AF-​​​​​​DJI** | Africa | Djibouti | Djibouti |
| **AF-​​​​​​DZA** | Africa | Algeria | Algeria |
| **AF-​​​​​​EGY** | Africa | Egypt | Egypt |
| **AF-​​​​​​ERI** | Africa | Eritrea | Eritrea |
| **AF-​​​​​​ESH** | Africa | Western Sahara | Western Sahara |
| **AF-​​​​​​ETH** | Africa | Ethiopia | Ethiopia |
| **AF-​​​​​​GAB** | Africa | Gabon | Gabon |
| **AF-​​​​​​GHA** | Africa | Ghana | Ghana |
| **AF-​​​​​​GIN** | Africa | Guinea | Guinea |
| **AF-​​​​​​GMB** | Africa | Gambia | Gambia |
| **AF-​​​​​​GNB** | Africa | Guinea-​​​​​​Bissau | Guinea-​​​​​​Bissau |
| **AF-​​​​​​GNQ** | Africa | Equatorial Guinea | Equatorial Guinea |
| **AF-​​​​​​KEN** | Africa | Kenya | Kenya |
| **AF-​​​​​​LBR** | Africa | Liberia | Liberia |
| **AF-​​​​​​LBY** | Africa | Libya | Libya |
| **AF-​​​​​​LSO** | Africa | Lesotho | Lesotho |
| **AF-​​​​​​MAR** | Africa | Morocco | Morocco |
| **AF-​​​​​​MDG** | Africa | Madagascar | Madagascar |
| **AF-​​​​​​MLI** | Africa | Mali | Mali |
| **AF-​​​​​​MOZ** | Africa | Mozambique | Mozambique |
| **AF-​​​​​​MRT** | Africa | Mauritania | Mauritania |
| **AF-​​​​​​MUS** | Africa | Mauritius | Mauritius |
| **AF-​​​​​​MWI** | Africa | Malawi | Malawi |
| **AF-​​​​​​NAM** | Africa | Namibia | Namibia |
| **AF-​​​​​​NER** | Africa | Niger | Niger |
| **AF-​​​​​​NGA** | Africa | Nigeria | Nigeria |
| **AF-​​​​​​RWA** | Africa | Rwanda | Rwanda |
| **AF-​​​​​​SDN** | Africa | Sudan | Sudan |
| **AF-​​​​​​SEN** | Africa | Senegal | Senegal |
| **AF-​​​​​​SLE** | Africa | Sierra Leone | Sierra Leone |
| **AF-​​​​​​SWZ** | Africa | Swaziland | Swaziland |
| **AF-​​​​​​TGO** | Africa | Togo | Togo |
| **AF-​​​​​​TUN** | Africa | Tunisia | Tunisia |
| **AF-​​​​​​TZA** | Africa | Tanzania | Tanzania |
| **AF-​​​​​​UGA** | Africa | Uganda | Uganda |
| **AF-​​​​​​ZAF** | Africa | South Africa | South Africa |
| **AF-​​​​​​ZMB** | Africa | Zambia | Zambia |
| **AF-​​​​​​ZWE** | Africa | Zimbabwe | Zimbabwe |
| **AS-​​​​​​AFG** | Asia | Afghanistan | Afghanistan |
| **AS-​​​​​​ARE** | Asia | United Arab Emirates | United Arab Emirates |
| **AS-​​​​​​BGD** | Asia | Bangladesh | Bangladesh |
| **AS-​​​​​​BHR** | Asia | Bahrain | Bahrain |
| **AS-​​​​​​BRN** | Asia | Brunei | Brunei |
| **AS-​​​​​​BTN** | Asia | Bhutan | Bhutan |
| **AS-​​​​​​CHN-​​​​​​AN** | Asia | China | Anhui |
| **AS-​​​​​​CHN-​​​​​​BE** | Asia | China | Beijing |
| **AS-​​​​​​CHN-​​​​​​CH** | Asia | China | Chongqing |
| **AS-​​​​​​CHN-​​​​​​EM** | Asia | China | Inner Mongolia (East) |
| **AS-​​​​​​CHN-​​​​​​FU** | Asia | China | Fujian |
| **AS-​​​​​​CHN-​​​​​​GA** | Asia | China | Gansu |
| **AS-​​​​​​CHN-​​​​​​GD** | Asia | China | Guangdong |
| **AS-​​​​​​CHN-​​​​​​GU** | Asia | China | Guizhou |
| **AS-​​​​​​CHN-​​​​​​GX** | Asia | China | Guangxi |
| **AS-​​​​​​CHN-​​​​​​HA** | Asia | China | Hainan |
| **AS-​​​​​​CHN-​​​​​​HB** | Asia | China | Hebei |
| **AS-​​​​​​CHN-​​​​​​HE** | Asia | China | Henan |
| **AS-​​​​​​CHN-​​​​​​HJ** | Asia | China | Heilongjiang |
| **AS-​​​​​​CHN-​​​​​​HK** | Asia | China | Hong Kong |
| **AS-​​​​​​CHN-​​​​​​HN** | Asia | China | Hunan |
| **AS-​​​​​​CHN-​​​​​​HU** | Asia | China | Hubei |
| **AS-​​​​​​CHN-​​​​​​JI** | Asia | China | Jilin |
| **AS-​​​​​​CHN-​​​​​​JS** | Asia | China | Jiangsu |
| **AS-​​​​​​CHN-​​​​​​JX** | Asia | China | Jiangxi |
| **AS-​​​​​​CHN-​​​​​​LI** | Asia | China | Liaoning |
| **AS-​​​​​​CHN-​​​​​​MA** | Asia | China | Macau |
| **AS-​​​​​​CHN-​​​​​​NI** | Asia | China | Ningxia |
| **AS-​​​​​​CHN-​​​​​​QI** | Asia | China | Qinghai |
| **AS-​​​​​​CHN-​​​​​​SC** | Asia | China | Sichuan |
| **AS-​​​​​​CHN-​​​​​​SD** | Asia | China | Shandong |
| **AS-​​​​​​CHN-​​​​​​SH** | Asia | China | Shanghai |
| **AS-​​​​​​CHN-​​​​​​SI** | Asia | China | Shaanxi |
| **AS-​​​​​​CHN-​​​​​​SX** | Asia | China | Shanxi |
| **AS-​​​​​​CHN-​​​​​​TI** | Asia | China | Tibet |
| **AS-​​​​​​CHN-​​​​​​TJ** | Asia | China | Tianjin |
| **AS-​​​​​​CHN-​​​​​​WM** | Asia | China | Inner Mongolia (West) |
| **AS-​​​​​​CHN-​​​​​​XI** | Asia | China | Xinjiang |
| **AS-​​​​​​CHN-​​​​​​YU** | Asia | China | Yunnan |
| **AS-​​​​​​CHN-​​​​​​ZH** | Asia | China | Zhejiang |
| **AS-​​​​​​IDN** | Asia | Indonesia | Indonesia |
| **AS-​​​​​​IND-​​​​​​EA** | Asia | India | Eastern Region |
| **AS-​​​​​​IND-​​​​​​NE** | Asia | India | North-​​​​​​Eastern Region |
| **AS-​​​​​​IND-​​​​​​NO** | Asia | India | Northern Region |
| **AS-​​​​​​IND-​​​​​​SO** | Asia | India | Southern Region |
| **AS-​​​​​​IND-​​​​​​WE** | Asia | India | Western Region |
| **AS-​​​​​​IRN** | Asia | Iran | Iran |
| **AS-​​​​​​IRQ** | Asia | Iraq | Iraq |
| **AS-​​​​​​ISR** | Asia | Israel &​​ Palestina | Israel &​​ Palestina |
| **AS-​​​​​​JOR** | Asia | Jordan | Jordan |
| **AS-​​​​​​JPN-​​​​​​CE** | Asia | Japan | Main 60Hz system (Central) |
| **AS-​​​​​​JPN-​​​​​​HO** | Asia | Japan | Hokkaido |
| **AS-​​​​​​JPN-​​​​​​KY** | Asia | Japan | Kyushu |
| **AS-​​​​​​JPN-​​​​​​OK** | Asia | Japan | Okinawa |
| **AS-​​​​​​JPN-​​​​​​SH** | Asia | Japan | Shikoku |
| **AS-​​​​​​JPN-​​​​​​TO** | Asia | Japan | Main 50Hz system (Tohoku &​​ Tokyo) |
| **AS-​​​​​​KAZ** | Asia | Kazakhstan | Kazakhstan |
| **AS-​​​​​​KGZ** | Asia | Kyrgyzstan | Kyrgyzstan |
| **AS-​​​​​​KHM** | Asia | Cambodia | Cambodia |
| **AS-​​​​​​KOR** | Asia | South Korea | South Korea |
| **AS-​​​​​​KWT** | Asia | Kuwait | Kuwait |
| **AS-​​​​​​LAO** | Asia | Laos | Laos |
| **AS-​​​​​​LBN** | Asia | Lebanon | Lebanon |
| **AS-​​​​​​LKA** | Asia | Sri Lanka | Sri Lanka |
| **AS-​​​​​​MMR** | Asia | Myanmar | Myanmar |
| **AS-​​​​​​MNG** | Asia | Mongolia | Mongolia |
| **AS-​​​​​​MYS** | Asia | Malaysia | Malaysia |
| **AS-​​​​​​NPL** | Asia | Nepal | Nepal |
| **AS-​​​​​​OMN** | Asia | Oman | Oman |
| **AS-​​​​​​PAK** | Asia | Pakistan | Pakistan |
| **AS-​​​​​​PHL** | Asia | Philippines | Philippines |
| **AS-​​​​​​PRK** | Asia | North Korea | North Korea |
| **AS-​​​​​​QAT** | Asia | Qatar | Qatar |
| **AS-​​​​​​RUS-​​​​​​CE** | Asia | Russia | UES Center |
| **AS-​​​​​​RUS-​​​​​​FE** | Asia | Russia | UES Far East |
| **AS-​​​​​​RUS-​​​​​​MV** | Asia | Russia | UES Middle Volga |
| **AS-​​​​​​RUS-​​​​​​NW** | Asia | Russia | UES Northwest |
| **AS-​​​​​​RUS-​​​​​​SI** | Asia | Russia | UES Siberia |
| **AS-​​​​​​RUS-​​​​​​SO** | Asia | Russia | UES South |
| **AS-​​​​​​RUS-​​​​​​UR** | Asia | Russia | UES Ural |
| **AS-​​​​​​SAU** | Asia | Saudi Arabia | Saudi Arabia |
| **AS-​​​​​​SGP** | Asia | Singapore | Singapore |
| **AS-​​​​​​SYR** | Asia | Syria | Syria |
| **AS-​​​​​​THA** | Asia | Thailand | Thailand |
| **AS-​​​​​​TJK** | Asia | Tajikistan | Tajikistan |
| **AS-​​​​​​TKM** | Asia | Turkmenistan | Turkmenistan |
| **AS-​​​​​​TUR** | Asia | Turkey | Turkey |
| **AS-​​​​​​TWN** | Asia | Taiwan | Taiwan |
| **AS-​​​​​​UZB** | Asia | Uzbekistan | Uzbekistan |
| **AS-​​​​​​VNM** | Asia | Vietnam | Vietnam |
| **AS-​​​​​​YEM** | Asia | Yemen | Yemen |
| **EU-​​​​​​ALB** | Europe | Albania | Albania |
| **EU-​​​​​​ARM** | Europe | Armenia | Armenia |
| **EU-​​​​​​AUT** | Europe | Austria | Austria |
| **EU-​​​​​​AZE** | Europe | Azerbaijan | Azerbaijan |
| **EU-​​​​​​BEL** | Europe | Belgium | Belgium |
| **EU-​​​​​​BGR** | Europe | Bulgaria | Bulgaria |
| **EU-​​​​​​BIH** | Europe | Bosnia and Herzegovina | Bosnia and Herzegovina |
| **EU-​​​​​​BLR** | Europe | Belarus | Belarus |
| **EU-​​​​​​CHE** | Europe | Switzerland | Switzerland |
| **EU-​​​​​​CYP** | Europe | Cyprus | Cyprus |
| **EU-​​​​​​CZE** | Europe | Czech Republic | Czech Republic |
| **EU-​​​​​​DEU** | Europe | Germany | Germany |
| **EU-​​​​​​DNK** | Europe | Denmark | Denmark |
| **EU-​​​​​​ESP** | Europe | Spain | Spain |
| **EU-​​​​​​EST** | Europe | Estonia | Estonia |
| **EU-​​​​​​FIN** | Europe | Finland | Finland |
| **EU-​​​​​​FRA** | Europe | France | France |
| **EU-​​​​​​GBR** | Europe | United Kingdom | United Kingdom |
| **EU-​​​​​​GEO** | Europe | Georgia | Georgia |
| **EU-​​​​​​GRC** | Europe | Greece | Greece |
| **EU-​​​​​​HRV** | Europe | Croatia | Croatia |
| **EU-​​​​​​HUN** | Europe | Hungary | Hungary |
| **EU-​​​​​​IRL** | Europe | Ireland | Ireland |
| **EU-​​​​​​ISL** | Europe | Iceland | Iceland |
| **EU-​​​​​​ITA** | Europe | Italy | Italy |
| **EU-​​​​​​KOS** | Europe | Kosovo | Kosovo |
| **EU-​​​​​​LTU** | Europe | Lithuania | Lithuania |
| **EU-​​​​​​LUX** | Europe | Luxembourg | Luxembourg |
| **EU-​​​​​​LVA** | Europe | Latvia | Latvia |
| **EU-​​​​​​MDA** | Europe | Moldova | Moldova |
| **EU-​​​​​​MKD** | Europe | Macedonia | Macedonia |
| **EU-​​​​​​MNE** | Europe | Montenegro | Montenegro |
| **EU-​​​​​​NLD** | Europe | Netherlands | Netherlands |
| **EU-​​​​​​NOR** | Europe | Norway | Norway |
| **EU-​​​​​​POL** | Europe | Poland | Poland |
| **EU-​​​​​​PRT** | Europe | Portugal | Portugal |
| **EU-​​​​​​ROU** | Europe | Romania | Romania |
| **EU-​​​​​​SRB** | Europe | Serbia | Serbia |
| **EU-​​​​​​SVK** | Europe | Slovakia | Slovakia |
| **EU-​​​​​​SVN** | Europe | Slovenia | Slovenia |
| **EU-​​​​​​SWE** | Europe | Sweden | Sweden |
| **EU-​​​​​​UKR** | Europe | Ukraine | Ukraine |
| **NA-​​​​​​CAN-​​​​​​AB** | North America | Canada | Alberta |
| **NA-​​​​​​CAN-​​​​​​AR** | North America | Canada | Atlantic region |
| **NA-​​​​​​CAN-​​​​​​BC** | North America | Canada | British Columbia |
| **NA-​​​​​​CAN-​​​​​​MB** | North America | Canada | Manitoba |
| **NA-​​​​​​CAN-​​​​​​NL** | North America | Canada | Newfoundland &​​ Labrador |
| **NA-​​​​​​CAN-​​​​​​NO** | North America | Canada | Northern Provinces |
| **NA-​​​​​​CAN-​​​​​​ON** | North America | Canada | Ontario |
| **NA-​​​​​​CAN-​​​​​​QC** | North America | Canada | Quebec |
| **NA-​​​​​​CAN-​​​​​​SK** | North America | Canada | Saskatchewan |
| **NA-​​​​​​CRI** | North America | Costa Rica | Costa Rica |
| **NA-​​​​​​CUB** | North America | Cuba | Cuba |
| **NA-​​​​​​DOM** | North America | Dominican Republic | Dominican Republic |
| **NA-​​​​​​GTM** | North America | Guatemala | Guatemala |
| **NA-​​​​​​HND** | North America | Honduras | Honduras |
| **NA-​​​​​​JAM** | North America | Jamaica | Jamaica |
| **NA-​​​​​​MEX** | North America | Mexico | Mexico |
| **NA-​​​​​​NIC** | North America | Nicaragua | Nicaragua |
| **NA-​​​​​​PAN** | North America | Panama | Panama |
| **NA-​​​​​​SLV** | North America | El Salvador | El Salvador |
| **NA-​​​​​​TTO** | North America | Trinidad and Tobago | Trinidad and Tobago |
| **NA-​​​​​​USA-​​​​​​AK** | North America | United States | Alaska |
| **NA-​​​​​​USA-​​​​​​AZ** | North America | United States | EIA NEMS Region AZNM |
| **NA-​​​​​​USA-​​​​​​CA** | North America | United States | EIA NEMS Region CAMX |
| **NA-​​​​​​USA-​​​​​​ER** | North America | United States | EIA NEMS Region ERCT |
| **NA-​​​​​​USA-​​​​​​FR** | North America | United States | EIA NEMS Region FRCC |
| **NA-​​​​​​USA-​​​​​​GU** | North America | United States | Guam |
| **NA-​​​​​​USA-​​​​​​HA** | North America | United States | Hawaii |
| **NA-​​​​​​USA-​​​​​​ME** | North America | United States | EIA NEMS Region MROE |
| **NA-​​​​​​USA-​​​​​​MW** | North America | United States | EIA NEMS Region MROW |
| **NA-​​​​​​USA-​​​​​​NE** | North America | United States | EIA NEMS Region NEWE |
| **NA-​​​​​​USA-​​​​​​NW** | North America | United States | EIA NEMS Region NWPP |
| **NA-​​​​​​USA-​​​​​​NY** | North America | United States | EIA NEMS Regions NYCW, NYLI &​​ NYUP |
| **NA-​​​​​​USA-​​​​​​PR** | North America | United States | Puerto Rico |
| **NA-​​​​​​USA-​​​​​​RA** | North America | United States | EIA NEMS Region RMPA |
| **NA-​​​​​​USA-​​​​​​RE** | North America | United States | EIA NEMS Region RFCE |
| **NA-​​​​​​USA-​​​​​​RM** | North America | United States | EIA NEMS Region RFCM |
| **NA-​​​​​​USA-​​​​​​RW** | North America | United States | EIA NEMS Region RFCW |
| **NA-​​​​​​USA-​​​​​​SA** | North America | United States | EIA NEMS Region SRDA |
| **NA-​​​​​​USA-​​​​​​SC** | North America | United States | EIA NEMS Region SRCE |
| **NA-​​​​​​USA-​​​​​​SE** | North America | United States | EIA NEMS Region SRSE |
| **NA-​​​​​​USA-​​​​​​SN** | North America | United States | EIA NEMS Region SPNO |
| **NA-​​​​​​USA-​​​​​​SS** | North America | United States | EIA NEMS Region SPSO |
| **NA-​​​​​​USA-​​​​​​SV** | North America | United States | EIA NEMS Region SRVC |
| **NA-​​​​​​USA-​​​​​​SW** | North America | United States | EIA NEMS Region SRGW |
| **OC-​​​​​​ATA** | Oceania | Antarctica | Antarctica |
| **OC-​​​​​​AUS-​​​​​​NT** | Oceania | Australia | Northern Territory |
| **OC-​​​​​​AUS-​​​​​​QL** | Oceania | Australia | Queensland |
| **OC-​​​​​​AUS-​​​​​​SA** | Oceania | Australia | South Australia |
| **OC-​​​​​​AUS-​​​​​​SW** | Oceania | Australia | New South Wales |
| **OC-​​​​​​AUS-​​​​​​TA** | Oceania | Australia | Tasmania |
| **OC-​​​​​​AUS-​​​​​​VI** | Oceania | Australia | Victoria |
| **OC-​​​​​​AUS-​​​​​​WA** | Oceania | Australia | Western Australia |
| **OC-​​​​​​FJI** | Oceania | Fiji | Fiji |
| **OC-​​​​​​NZL** | Oceania | New Zealand | New Zealand |
| **OC-​​​​​​PNG** | Oceania | Papua New Guinea | Papua New Guinea |
| **SA-​​​​​​ARG** | South America | Argentina | Argentina |
| **SA-​​​​​​BOL** | South America | Bolivia | Bolivia |
| **SA-​​​​​​BRA-​​​​​​CN** | South America | Brazil | Center-​​​​​​Northern Region |
| **SA-​​​​​​BRA-​​​​​​CW** | South America | Brazil | Center-​​​​​​Western Region |
| **SA-​​​​​​BRA-​​​​​​J1** | South America | Brazil | Transmission Junction J1 |
| **SA-​​​​​​BRA-​​​​​​J2** | South America | Brazil | Transmission Junction J2 |
| **SA-​​​​​​BRA-​​​​​​J3** | South America | Brazil | Transmission Junction J3 |
| **SA-​​​​​​BRA-​​​​​​NE** | South America | Brazil | North-​​​​​​Eastern Region |
| **SA-​​​​​​BRA-​​​​​​NW** | South America | Brazil | North-​​​​​​Western Region |
| **SA-​​​​​​BRA-​​​​​​SE** | South America | Brazil | South-​​​​​​Eastern Region |
| **SA-​​​​​​BRA-​​​​​​SO** | South America | Brazil | Southern Region |
| **SA-​​​​​​BRA-​​​​​​WE** | South America | Brazil | Western Region |
| **SA-​​​​​​CHL** | South America | Chile | Chile |
| **SA-​​​​​​COL** | South America | Colombia | Colombia |
| **SA-​​​​​​ECU** | South America | Ecuador | Ecuador |
| **SA-​​​​​​GUF** | South America | French Guiana | French Guiana |
| **SA-​​​​​​GUY** | South America | Guyana | Guyana |
| **SA-​​​​​​PER** | South America | Peru | Peru |
| **SA-​​​​​​PRY** | South America | Paraguay | Paraguay |
| **SA-​​​​​​URY** | South America | Uruguay | Uruguay |
| **SA-​​​​​​VEN** | South America | Venezuela | Venezuela |

S5 List of publicly available hourly load data

This section includes a full overview of publicly available load data with (sub-​​​​​​) hourly time intervals. Furthermore, hourly data retrieved through personal communication (L. St-​​​​​​Laurent, Hydro Quebec, 12-​​​​​​02-​​​​​​2018 – R. Mall, SaskPower, 21-​​​​​​12-​​​​​​2017, Ukrenergo, 29/​​​​​​10/​​​​​​2018) is included as part of the model input. For synthetic hourly load profiles for countries where no data exists in the public domain it is worth highlighting a study by Toktarova and colleagues [79]. The authors constructed a calibrated method to generate demand profiles for future years based on locational economic, technical and climatic characteristics for almost all countries around the world. All load profiles as used for this study can be found in a separate file in [86].

Table S5.1: Global list of publicly available load data with (sub-​​​​​​)hourly time intervals.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Area** | **Years** | **Coverage of data** | **Resolution** | **Source** |
| AF-​​​​​​ETH | 2013 | Full country | Hourly | [79] |
| AF-​​​​​​KEN | 2010 | Full country | Hourly | [79] |
| AF-​​​​​​MAR | 2010 | Full country | Hourly | [79] |
| AF-​​​​​​TUN | 2010 | Full country | Hourly | [79] |
| AF-​​​​​​ZAF | 2010 | Full country | Hourly | [87] |
| AS-​​​​​​IRN | 2015 | Full country | Hourly | [79] |
| AS-​​​​​​ISR | 2012 | Full country | Hourly | [79] |
| AS-​​​​​​JPN | 2010-​​​​​​2011 | Full country or per operating area/​​​​​​bidding zone | Hourly | [88] |
| AS-​​​​​​KOR | 2015 | Full country | Hourly | [89] |
| AS-​​​​​​LKA | 2013 | Full country | Hourly | [79] |
| AS-​​​​​​MYS | 2017-​​​​​​2020 | Peninsular Malaysia | Hourly | [90] |
| AS-​​​​​​OMN | 2013-​​​​​​2016 | Main Interconnected System | Hourly | [91] |
| AS-​​​​​​PAK | 2008 | Full country | Hourly | [79] |
| AS-​​​​​​RUS | 2008-​​​​​​2020 | Full country or per operating area/​​​​​​bidding zone | Hourly | [85] |
| AS-​​​​​​SAU | 2013 | Full country | Hourly | [79] |
| AS-​​​​​​SGP | 2004-​​​​​​2020 | Full country | Half-​​​​​​Hourly | [92] |
| AS-​​​​​​TUR | 2016-​​​​​​2020 | Full country | Hourly | [93] |
| EU-​​​​​​AUT | 2006-​​​​​​2020 | Full country or per operating area/​​​​​​bidding zone | Hourly | [94,95] |
| EU-​​​​​​BEL | 2006-​​​​​​2020 | Full country or per operating area/​​​​​​bidding zone | Hourly | [94,95] |
| EU-​​​​​​BGR | 2006-​​​​​​2020 | Full country or per operating area/​​​​​​bidding zone | Hourly | [94,95] |
| EU-​​​​​​BIH | 2006-​​​​​​2020 | Full country or per operating area/​​​​​​bidding zone | Hourly | [94,95] |
| EU-​​​​​​CHE | 2006-​​​​​​2020 | Full country or per operating area/​​​​​​bidding zone | Hourly | [94,95] |
| EU-​​​​​​CYP | 2006-​​​​​​2020 | Full country or per operating area/​​​​​​bidding zone | Hourly | [94,95] |
| EU-​​​​​​CZE | 2006-​​​​​​2020 | Full country or per operating area/​​​​​​bidding zone | Hourly | [94,95] |
| EU-​​​​​​DEU | 2006-​​​​​​2020 | Full country or per operating area/​​​​​​bidding zone | Hourly | [94,95] |
| EU-​​​​​​DNK | 2006-​​​​​​2020 | Full country or per operating area/​​​​​​bidding zone | Hourly | [94,95] |
| EU-​​​​​​ESP | 2006-​​​​​​2020 | Full country or per operating area/​​​​​​bidding zone | Hourly | [94,95] |
| EU-​​​​​​EST | 2006-​​​​​​2020 | Full country or per operating area/​​​​​​bidding zone | Hourly | [94,95] |
| EU-​​​​​​FIN | 2006-​​​​​​2020 | Full country or per operating area/​​​​​​bidding zone | Hourly | [94,95] |
| EU-​​​​​​FRA | 2006-​​​​​​2020 | Full country or per operating area/​​​​​​bidding zone | Hourly | [94,95] |
| EU-​​​​​​GBR | 2006-​​​​​​2020 | Full country or per operating area/​​​​​​bidding zone | Hourly | [94,95] |
| EU-​​​​​​GEO | 2017-​​​​​​2020 | Full country | Hourly | [96] |
| EU-​​​​​​GRC | 2006-​​​​​​2020 | Full country or per operating area/​​​​​​bidding zone | Hourly | [94,95] |
| EU-​​​​​​HRV | 2006-​​​​​​2020 | Full country or per operating area/​​​​​​bidding zone | Hourly | [94,95] |
| EU-​​​​​​HUN | 2006-​​​​​​2020 | Full country or per operating area/​​​​​​bidding zone | Hourly | [94,95] |
| EU-​​​​​​IRL | 2006-​​​​​​2020 | Full country or per operating area/​​​​​​bidding zone | Hourly | [94,95] |
| EU-​​​​​​ISL | 2006-​​​​​​2020 | Full country or per operating area/​​​​​​bidding zone | Hourly | [94,95] |
| EU-​​​​​​ITA | 2006-​​​​​​2020 | Full country or per operating area/​​​​​​bidding zone | Hourly | [94,95] |
| EU-​​​​​​LTU | 2006-​​​​​​2020 | Full country or per operating area/​​​​​​bidding zone | Hourly | [94,95] |
| EU-​​​​​​LUX | 2006-​​​​​​2020 | Full country or per operating area/​​​​​​bidding zone | Hourly | [94,95] |
| EU-​​​​​​LVA | 2006-​​​​​​2020 | Full country or per operating area/​​​​​​bidding zone | Hourly | [94,95] |
| EU-​​​​​​MKD | 2006-​​​​​​2020 | Full country or per operating area/​​​​​​bidding zone | Hourly | [94,95] |
| EU-​​​​​​MNE | 2006-​​​​​​2020 | Full country or per operating area/​​​​​​bidding zone | Hourly | [94,95] |
| EU-​​​​​​NLD | 2006-​​​​​​2020 | Full country or per operating area/​​​​​​bidding zone | Hourly | [94,95] |
| EU-​​​​​​NOR | 2006-​​​​​​2020 | Full country or per operating area/​​​​​​bidding zone | Hourly | [94,95] |
| EU-​​​​​​POL | 2006-​​​​​​2020 | Full country or per operating area/​​​​​​bidding zone | Hourly | [94,95] |
| EU-​​​​​​PRT | 2006-​​​​​​2020 | Full country or per operating area/​​​​​​bidding zone | Hourly | [94,95] |
| EU-​​​​​​ROU | 2006-​​​​​​2020 | Full country or per operating area/​​​​​​bidding zone | Hourly | [94,95] |
| EU-​​​​​​SRB | 2006-​​​​​​2020 | Full country or per operating area/​​​​​​bidding zone | Hourly | [94,95] |
| EU-​​​​​​SVK | 2006-​​​​​​2020 | Full country or per operating area/​​​​​​bidding zone | Hourly | [94,95] |
| EU-​​​​​​SVN | 2006-​​​​​​2020 | Full country or per operating area/​​​​​​bidding zone | Hourly | [94,95] |
| EU-​​​​​​SWE | 2006-​​​​​​2020 | Full country or per operating area/​​​​​​bidding zone | Hourly | [94,95] |
| NA-​​​​​​CAN-​​​​​​AB | 2016 | Alberta | Hourly | [20] |
| NA-​​​​​​CAN-​​​​​​AR | 2013-​​​​​​2020 | New Brunswick | Hourly | [18] |
| NA-​​​​​​CAN-​​​​​​AR | 2012-​​​​​​2020 | Nova Scotia | Hourly | [17] |
| NA-​​​​​​CAN-​​​​​​BC | 2001-​​​​​​2020 | British Columbia | Hourly | [21] |
| NA-​​​​​​CAN-​​​​​​ON | 1994-​​​​​​2020 | Ontario | Hourly | [19] |
| NA-​​​​​​CRI | Last 24 hrs | Full country | Per 15 mins | [97] |
| NA-​​​​​​GTM | 2010-​​​​​​2020 | Full country | Hourly | [98] |
| NA-​​​​​​MEX | 2016-​​​​​​2018 | Full country or per operating area/​​​​​​bidding zone | Hourly | [99] |
| NA-​​​​​​NIC | 2010-​​​​​​2020 | Full country | Hourly | [100] |
| NA-​​​​​​PAN | 2016-​​​​​​2020 | Full country | Hourly | [101] |
| NA-​​​​​​SLV | 2018-​​​​​​2020 | Full country | Hourly | [102] |
| NA-​​​​​​USA | 2016-​​​​​​2020 | Full country or per operating area/​​​​​​bidding zone | Hourly | [30] |
| NA-​​​​​​USA | 1993-​​​​​​2018 | Full country or per operating area/​​​​​​bidding zone | Hourly | [52] |
| OC-​​​​​​AUS | 2019-​​​​​​2020 | Full NEM Territory or per province | Hourly | [2] |
| OC-​​​​​​AUS-​​​​​​WA | 2006-​​​​​​2019 | Western Australia | Hourly | [3] |
| OC-​​​​​​NZL | 2010-​​​​​​2020 | Full country or per operating area/​​​​​​bidding zone | Half-​​​​​​Hourly | [103] |
| SA-​​​​​​ARG | 2006-​​​​​​2013 | Full country | Hourly | [104] |
| SA-​​​​​​BRA | 1999-​​​​​​2020 | Full country or per operating area/​​​​​​bidding zone | Hourly | [10] |
| SA-​​​​​​CHL | 2005-​​​​​​2018 | Central System | Hourly | [105] |
| SA-​​​​​​COL | 2010 | Full country | Hourly | [79] |
| SA-​​​​​​PER | 2015-​​​​​​2020 | Full country | Half-​​​​​​Hourly | [106] |
| SA-​​​​​​URY | 2015-​​​​​​2020 | Full country | Hourly | [107] |

S6 List of cross-​​​​​​border transmission capacities

Table S6.1: Global list of net transfer capacities between neighboring nodes as well as transmission pathways of existing and planned subsea interconnectors. Extensive attempts have been made to base the data on reliable sources with 2015 as base year, yet this data is not always available in the public domain. The ‘Data Year’ column indicates for which year the data is valid and footnotes are added at the bottom of the table in case additional comments on the data are required. More detailed description regarding transmission capacities between sub-​​​​​​country nodes can be found in S2.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **From** | **To** | **Max Flow (MW)** | | **Min Flow (MW)** | **Data Year** | **Source** | **Note** |
| AF-​​​​​​AGO | AF-​​​​​​COD | 0 | | 0 | 2015 | [108] |  |
| AF-​​​​​​AGO | AF-​​​​​​COG | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​AGO | AF-​​​​​​NAM | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​AGO | AF-​​​​​​ZMB | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​BDI | AF-​​​​​​COD | | 475 | -​​​​​​475 | 2015 | [108] |  |
| AF-​​​​​​BDI | AF-​​​​​​RWA | | 430 | -​​​​​​430 | 2015 | [108] |  |
| AF-​​​​​​BDI | AF-​​​​​​TZA | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​BEN | AF-​​​​​​BFA | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​BEN | AF-​​​​​​GHA | | 936 | -​​​​​​936 | 2015 | [108] |  |
| AF-​​​​​​BEN | AF-​​​​​​NER | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​BEN | AF-​​​​​​NGA | | 686 | -​​​​​​686 | 2015 | [108] |  |
| AF-​​​​​​BEN | AF-​​​​​​TGO | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​BFA | AF-​​​​​​CIV | | 327 | -​​​​​​327 | 2015 | [108] |  |
| AF-​​​​​​BFA | AF-​​​​​​GHA | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​BFA | AF-​​​​​​MLI | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​BFA | AF-​​​​​​NER | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​BFA | AF-​​​​​​TGO | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​BWA | AF-​​​​​​NAM | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​BWA | AF-​​​​​​ZAF | | 1300 | -​​​​​​1300 | 2015 | [108] |  |
| AF-​​​​​​BWA | AF-​​​​​​ZMB | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​BWA | AF-​​​​​​ZWE | | 650 | -​​​​​​650 | 2015 | [108] |  |
| AF-​​​​​​CAF | AF-​​​​​​CMR | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​CAF | AF-​​​​​​COD | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​CAF | AF-​​​​​​COG | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​CAF | AF-​​​​​​SDN | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​CIV | AF-​​​​​​GHA | | 982 | -​​​​​​982 | 2015 | [108] |  |
| AF-​​​​​​CIV | AF-​​​​​​GIN | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​CIV | AF-​​​​​​LBR | | 338 | -​​​​​​338 | 2015 | [108] |  |
| AF-​​​​​​CIV | AF-​​​​​​MLI | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​CMR | AF-​​​​​​COG | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​CMR | AF-​​​​​​GAB | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​CMR | AF-​​​​​​GNQ | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​CMR | AF-​​​​​​NGA | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​COD | AF-​​​​​​COG | | 60 | -​​​​​​60 | 2015 | [108] |  |
| AF-​​​​​​COD | AF-​​​​​​RWA | | 527 | -​​​​​​527 | 2015 | [108] |  |
| AF-​​​​​​COD | AF-​​​​​​TZA | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​COD | AF-​​​​​​UGA | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​COD | AF-​​​​​​ZMB | | 310 | -​​​​​​310 | 2015 | [108] |  |
| AF-​​​​​​COG | AF-​​​​​​GAB | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​COG | AF-​​​​​​RWA | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​COG | AF-​​​​​​TZA | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​DJI | AF-​​​​​​ERI | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​DJI | AF-​​​​​​ETH | | 180 | -​​​​​​180 | 2015 | [108] |  |
| AF-​​​​​​DZA | AF-​​​​​​ESH | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​DZA | AF-​​​​​​LBY | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​DZA | AF-​​​​​​MAR | | 400 | -​​​​​​400 | 2013 | [109] |  |
| AF-​​​​​​DZA | AF-​​​​​​MLI | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​DZA | AF-​​​​​​MRT | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​DZA | AF-​​​​​​NER | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​DZA | AF-​​​​​​TUN | | 150 | -​​​​​​150 | 2013 | [109] |  |
| AF-​​​​​​EGY | AF-​​​​​​LBY | | 180 | -​​​​​​180 | 2013 | [109] |  |
| AF-​​​​​​EGY | AF-​​​​​​SDN | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​EGY | AS-​​​​​​ISR | | 17 | 0 | 2015 | [108] |  |
| AF-​​​​​​EGY | AS-​​​​​​JOR | | 450 | -​​​​​​200 | 2013 | [109] | Subsea line |
| AF-​​​​​​ERI | AF-​​​​​​ETH | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​ERI | AF-​​​​​​SDN | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​ESH | AF-​​​​​​MAR | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​ESH | AF-​​​​​​MRT | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​ETH | AF-​​​​​​KEN | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​ETH | AF-​​​​​​SDN | | 200 | -​​​​​​200 | 2015 | [108] |  |
| AF-​​​​​​GAB | AF-​​​​​​GNQ | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​GHA | AF-​​​​​​TGO | | 963 | -​​​​​​963 | 2015 | [108] |  |
| AF-​​​​​​GIN | AF-​​​​​​GNB | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​GIN | AF-​​​​​​LBR | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​GIN | AF-​​​​​​MLI | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​GIN | AF-​​​​​​SEN | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​GIN | AF-​​​​​​SLE | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​GMB | AF-​​​​​​SEN | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​GNB | AF-​​​​​​SEN | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​KEN | AF-​​​​​​TZA | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​KEN | AF-​​​​​​UGA | | 418 | -​​​​​​418 | 2015 | [108] |  |
| AF-​​​​​​LBR | AF-​​​​​​SLE | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​LBY | AF-​​​​​​NER | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​LBY | AF-​​​​​​SDN | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​LBY | AF-​​​​​​TUN | | 200 | -​​​​​​200 | 2015 | [108] |  |
| AF-​​​​​​LSO | AF-​​​​​​ZAF | | 230 | -​​​​​​230 | 2015 | [108] |  |
| AF-​​​​​​MLI | AF-​​​​​​MRT | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​MLI | AF-​​​​​​NER | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​MLI | AF-​​​​​​SEN | | 100 | -​​​​​​100 | 2015 | [108] |  |
| AF-​​​​​​MOZ | AF-​​​​​​MWI | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​MOZ | AF-​​​​​​SWZ | | 1450 | -​​​​​​1450 | 2015 | [108] |  |
| AF-​​​​​​MOZ | AF-​​​​​​TZA | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​MOZ | AF-​​​​​​ZAF | | 3850 | -​​​​​​3850 | 2015 | [108] |  |
| AF-​​​​​​MOZ | AF-​​​​​​ZMB | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​MOZ | AF-​​​​​​ZWE | | 700 | -​​​​​​700 | 2015 | [108] |  |
| AF-​​​​​​MRT | AF-​​​​​​SEN | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​MWI | AF-​​​​​​TZA | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​MWI | AF-​​​​​​ZMB | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​NAM | AF-​​​​​​ZAF | | 750 | -​​​​​​750 | 2015 | [108] |  |
| AF-​​​​​​NAM | AF-​​​​​​ZMB | | 200 | -​​​​​​200 | 2015 | [108] |  |
| AF-​​​​​​NER | AF-​​​​​​NGA | | 169 | -​​​​​​169 | 2015 | [108] |  |
| AF-​​​​​​NGA | AF-​​​​​​TGO | | 686 | -​​​​​​686 | 2015 | [108] |  |
| AF-​​​​​​RWA | AF-​​​​​​TZA | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​RWA | AF-​​​​​​UGA | | 250 | -​​​​​​250 | 2015 | [108] |  |
| AF-​​​​​​SWZ | AF-​​​​​​ZAF | | 1450 | -​​​​​​1450 | 2015 | [108] |  |
| AF-​​​​​​TZA | AF-​​​​​​UGA | | 59 | -​​​​​​59 | 2015 | [108] |  |
| AF-​​​​​​TZA | AF-​​​​​​ZMB | | 0 | 0 | 2015 | [108] |  |
| AF-​​​​​​ZAF | AF-​​​​​​ZWE | | 600 | -​​​​​​600 | 2015 | [108] |  |
| AF-​​​​​​ZMB | AF-​​​​​​ZWE | | 700 | -​​​​​​700 | 2015 | [108] |  |
| AS-​​​​​​AFG | AS-​​​​​​CHN-​​​​​​XI | | 0 | 0 | 2015 | [110] |  |
| AS-​​​​​​AFG | AS-​​​​​​IRN | | 56 | -​​​​​​56 | 2006 | [111] |  |
| AS-​​​​​​AFG | AS-​​​​​​PAK | | 0 | 0 | 2018 | [112] |  |
| AS-​​​​​​AFG | AS-​​​​​​TJK | | 300 | -​​​​​​300 | 2006 | [111] |  |
| AS-​​​​​​AFG | AS-​​​​​​TKM | | 300 | -​​​​​​300 | 2006 | [111] |  |
| AS-​​​​​​AFG | AS-​​​​​​UZB | | 300 | -​​​​​​300 | 2017 | [113] |  |
| AS-​​​​​​ARE | AS-​​​​​​OMN | | 400 | -​​​​​​400 | 2013 | [109] |  |
| AS-​​​​​​ARE | AS-​​​​​​SAU | | 900 | -​​​​​​900 | 2013 | [109] |  |
| AS-​​​​​​BGD | AS-​​​​​​IND-​​​​​​EA | | 500 | -​​​​​​500 | 2018 | [114] |  |
| AS-​​​​​​BGD | AS-​​​​​​IND-​​​​​​NE | | 160 | -​​​​​​160 | 2018 | [114] |  |
| AS-​​​​​​BGD | AS-​​​​​​MMR | | 0 | 0 | 2018 | [114] |  |
| AS-​​​​​​BHR | AS-​​​​​​SAU | | 600 | -​​​​​​600 | 2013 | [109] |  |
| AS-​​​​​​BRN | AS-​​​​​​MYS | | 0 | 0 | 2015 | [115,116] |  |
| AS-​​​​​​BTN | AS-​​​​​​CHN-​​​​​​TI | | 0 | 0 | 2015 | [110] |  |
| AS-​​​​​​BTN | AS-​​​​​​IND-​​​​​​EA | | 1980 | 0 | 2014 | [117] |  |
| AS-​​​​​​CHN-​​​​​​AN | AS-​​​​​​CHN-​​​​​​HB | | 4000 | -​​​​​​4000 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​AN | AS-​​​​​​CHN-​​​​​​HE | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​AN | AS-​​​​​​CHN-​​​​​​HU | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​AN | AS-​​​​​​CHN-​​​​​​JS | | 5000 | -​​​​​​5000 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​AN | AS-​​​​​​CHN-​​​​​​JX | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​AN | AS-​​​​​​CHN-​​​​​​SD | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​AN | AS-​​​​​​CHN-​​​​​​ZH | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​BE | AS-​​​​​​CHN-​​​​​​EM | | 5000 | -​​​​​​5000 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​BE | AS-​​​​​​CHN-​​​​​​HB | | 4000 | -​​​​​​4000 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​BE | AS-​​​​​​CHN-​​​​​​TJ | | 5000 | -​​​​​​5000 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​CH | AS-​​​​​​CHN-​​​​​​GU | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​CH | AS-​​​​​​CHN-​​​​​​HB | | 4000 | -​​​​​​4000 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​CH | AS-​​​​​​CHN-​​​​​​HN | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​CH | AS-​​​​​​CHN-​​​​​​HU | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​CH | AS-​​​​​​CHN-​​​​​​SC | | 4000 | -​​​​​​4000 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​CH | AS-​​​​​​CHN-​​​​​​SI | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​CH | AS-​​​​​​CHN-​​​​​​SX | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​EM | AS-​​​​​​CHN-​​​​​​HB | | 4000 | -​​​​​​4000 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​EM | AS-​​​​​​CHN-​​​​​​HJ | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​EM | AS-​​​​​​CHN-​​​​​​JI | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​EM | AS-​​​​​​CHN-​​​​​​LI | | 4000 | -​​​​​​4000 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​EM | AS-​​​​​​CHN-​​​​​​SD | | 14400 | -​​​​​​14400 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​EM | AS-​​​​​​CHN-​​​​​​TJ | | 4000 | -​​​​​​4000 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​EM | AS-​​​​​​CHN-​​​​​​WM | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​EM | AS-​​​​​​MNG | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​FU | AS-​​​​​​CHN-​​​​​​GD | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​FU | AS-​​​​​​CHN-​​​​​​JX | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​FU | AS-​​​​​​CHN-​​​​​​ZH | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​GA | AS-​​​​​​CHN-​​​​​​JS | | 7200 | -​​​​​​7200 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​GA | AS-​​​​​​CHN-​​​​​​NI | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​GA | AS-​​​​​​CHN-​​​​​​QI | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​GA | AS-​​​​​​CHN-​​​​​​SC | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​GA | AS-​​​​​​CHN-​​​​​​SI | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​GA | AS-​​​​​​CHN-​​​​​​WM | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​GA | AS-​​​​​​CHN-​​​​​​XI | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​GA | AS-​​​​​​MNG | | 0 | 0 | 2015 | [110] |  |
| AS-​​​​​​CHN-​​​​​​GD | AS-​​​​​​CHN-​​​​​​GX | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​GD | AS-​​​​​​CHN-​​​​​​HA | | 600 | -​​​​​​600 | 2015 | [118] |  |
| AS-​​​​​​CHN-​​​​​​GD | AS-​​​​​​CHN-​​​​​​HK | | 1978 | -​​​​​​1978 | 2014-​​​​​​2018 | [119] | Estimate1 |
| AS-​​​​​​CHN-​​​​​​GD | AS-​​​​​​CHN-​​​​​​HN | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​GD | AS-​​​​​​CHN-​​​​​​JX | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​GD | AS-​​​​​​CHN-​​​​​​MA | | 1750 | -​​​​​​1750 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​GD | AS-​​​​​​CHN-​​​​​​SC | | 6400 | -​​​​​​6400 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​GD | AS-​​​​​​CHN-​​​​​​YU | | 5000 | -​​​​​​5000 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​GU | AS-​​​​​​CHN-​​​​​​GX | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​GU | AS-​​​​​​CHN-​​​​​​HN | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​GU | AS-​​​​​​CHN-​​​​​​JS | | 7200 | -​​​​​​7200 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​GU | AS-​​​​​​CHN-​​​​​​SC | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​GU | AS-​​​​​​CHN-​​​​​​YU | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​GX | AS-​​​​​​CHN-​​​​​​HN | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​GX | AS-​​​​​​CHN-​​​​​​XI | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​GX | AS-​​​​​​CHN-​​​​​​YU | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​GX | AS-​​​​​​VNM | | 0 | 0 | 2015 | [110] |  |
| AS-​​​​​​CHN-​​​​​​HB | AS-​​​​​​CHN-​​​​​​HE | | 4000 | -​​​​​​4000 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​HB | AS-​​​​​​CHN-​​​​​​LI | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​HB | AS-​​​​​​CHN-​​​​​​SD | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​HB | AS-​​​​​​CHN-​​​​​​SX | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​HB | AS-​​​​​​CHN-​​​​​​TJ | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​HB | AS-​​​​​​CHN-​​​​​​WM | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​HE | AS-​​​​​​CHN-​​​​​​HU | | 4000 | -​​​​​​4000 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​HE | AS-​​​​​​CHN-​​​​​​JS | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​HE | AS-​​​​​​CHN-​​​​​​SD | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​HE | AS-​​​​​​CHN-​​​​​​SI | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​HE | AS-​​​​​​CHN-​​​​​​SX | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​HE | AS-​​​​​​CHN-​​​​​​XI | | 14400 | -​​​​​​14400 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​HJ | AS-​​​​​​CHN-​​​​​​JI | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​HJ | AS-​​​​​​RUS-​​​​​​FE | | 1000 | -​​​​​​1000 | 2015 | [120] |  |
| AS-​​​​​​CHN-​​​​​​HJ | AS-​​​​​​RUS-​​​​​​SI | | 0 | 0 | 2015 | [110] |  |
| AS-​​​​​​CHN-​​​​​​HN | AS-​​​​​​CHN-​​​​​​HU | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​HN | AS-​​​​​​CHN-​​​​​​JX | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​HN | AS-​​​​​​CHN-​​​​​​SC | | 8000 | -​​​​​​8000 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​HN | AS-​​​​​​CHN-​​​​​​SX | | 5000 | -​​​​​​5000 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​HU | AS-​​​​​​CHN-​​​​​​JX | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​HU | AS-​​​​​​CHN-​​​​​​SI | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​JI | AS-​​​​​​CHN-​​​​​​LI | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​JI | AS-​​​​​​PRK | | 0 | 0 | 2015 | [110] |  |
| AS-​​​​​​CHN-​​​​​​JS | AS-​​​​​​CHN-​​​​​​SD | | 5000 | -​​​​​​5000 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​JS | AS-​​​​​​CHN-​​​​​​SH | | 5000 | -​​​​​​5000 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​JS | AS-​​​​​​CHN-​​​​​​SI | | 4000 | -​​​​​​4000 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​JS | AS-​​​​​​CHN-​​​​​​SX | | 5000 | -​​​​​​5000 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​JS | AS-​​​​​​CHN-​​​​​​ZH | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​JX | AS-​​​​​​CHN-​​​​​​WM | | 7200 | -​​​​​​7200 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​JX | AS-​​​​​​CHN-​​​​​​ZH | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​LI | AS-​​​​​​PRK | | 100 | -​​​​​​100 | 2017 | [121] | Estimate2 |
| AS-​​​​​​CHN-​​​​​​NI | AS-​​​​​​CHN-​​​​​​SD | | 4000 | -​​​​​​4000 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​NI | AS-​​​​​​CHN-​​​​​​SI | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​NI | AS-​​​​​​CHN-​​​​​​WM | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​NI | AS-​​​​​​CHN-​​​​​​ZH | | 7200 | -​​​​​​7200 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​QI | AS-​​​​​​CHN-​​​​​​SC | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​QI | AS-​​​​​​CHN-​​​​​​TI | | 1500 | -​​​​​​1500 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​QI | AS-​​​​​​CHN-​​​​​​XI | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​SC | AS-​​​​​​CHN-​​​​​​TI | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​SC | AS-​​​​​​CHN-​​​​​​YU | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​SD | AS-​​​​​​CHN-​​​​​​SX | | 4000 | -​​​​​​4000 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​SD | AS-​​​​​​CHN-​​​​​​TJ | | 5000 | -​​​​​​5000 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​SH | AS-​​​​​​CHN-​​​​​​ZH | | 5000 | -​​​​​​5000 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​SI | AS-​​​​​​CHN-​​​​​​SC | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​SI | AS-​​​​​​CHN-​​​​​​SX | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​SI | AS-​​​​​​CHN-​​​​​​WM | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​SX | AS-​​​​​​CHN-​​​​​​WM | | 9000 | -​​​​​​9000 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​TI | AS-​​​​​​CHN-​​​​​​XI | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​TI | AS-​​​​​​CHN-​​​​​​YU | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​TI | AS-​​​​​​IND-​​​​​​NE | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​TI | AS-​​​​​​IND-​​​​​​NO | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​TI | AS-​​​​​​MMR | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​TI | AS-​​​​​​NPL | | 0 | 0 | 2015 | [110] |  |
| AS-​​​​​​CHN-​​​​​​TI | AS-​​​​​​PAK | | 0 | 0 | 2015 | [110] |  |
| AS-​​​​​​CHN-​​​​​​WM | AS-​​​​​​MNG | | 0 | 0 | 2015 | [110] |  |
| AS-​​​​​​CHN-​​​​​​WM | AS-​​​​​​RUS-​​​​​​SI | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​XI | AS-​​​​​​IND-​​​​​​NO | | 0 | 0 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​XI | AS-​​​​​​KAZ | | 0 | 0 | 2015 | [110] |  |
| AS-​​​​​​CHN-​​​​​​XI | AS-​​​​​​KGZ | | 0 | 0 | 2015 | [110] |  |
| AS-​​​​​​CHN-​​​​​​XI | AS-​​​​​​MNG | | 0 | 0 | 2015 | [110] |  |
| AS-​​​​​​CHN-​​​​​​XI | AS-​​​​​​PAK | | 0 | 0 | 2015 | [110] |  |
| AS-​​​​​​CHN-​​​​​​XI | AS-​​​​​​RUS-​​​​​​SI | | 0 | 0 | 2015 | [110] |  |
| AS-​​​​​​CHN-​​​​​​XI | AS-​​​​​​TJK | | 0 | 0 | 2015 | [110] |  |
| AS-​​​​​​CHN-​​​​​​YU | AS-​​​​​​CHN-​​​​​​ZH | | 7200 | -​​​​​​7200 | 2016 | [69–71] |  |
| AS-​​​​​​CHN-​​​​​​YU | AS-​​​​​​MMR | | 600 | -​​​​​​600 | 2015 | [110] |  |
| AS-​​​​​​CHN-​​​​​​YU | AS-​​​​​​VNM | | 500 | -​​​​​​500 | 2015 | [110] |  |
| AS-​​​​​​IDN | AS-​​​​​​MYS | | 0 | 0 | 2015 | [115,116] | Planned subsea line |
| AS-​​​​​​IDN | AS-​​​​​​PHL | | 0 | 0 | 2014 | [115,116] | Planned subsea line |
| AS-​​​​​​IDN | AS-​​​​​​SGP | | 0 | 0 | 2015 | [115,116] | Planned subsea line |
| AS-​​​​​​IDN | OC-​​​​​​PNG | | 0 | 0 | 2015 | [122] |  |
| AS-​​​​​​IND-​​​​​​EA | AS-​​​​​​IND-​​​​​​NE | | 2860 | -​​​​​​2860 | 2015 | [78] |  |
| AS-​​​​​​IND-​​​​​​EA | AS-​​​​​​IND-​​​​​​NO | | 14230 | -​​​​​​14230 | 2015 | [78] |  |
| AS-​​​​​​IND-​​​​​​EA | AS-​​​​​​IND-​​​​​​SO | | 3630 | -​​​​​​3630 | 2015 | [78] |  |
| AS-​​​​​​IND-​​​​​​EA | AS-​​​​​​IND-​​​​​​WE | | 10690 | -​​​​​​10690 | 2015 | [78] |  |
| AS-​​​​​​IND-​​​​​​EA | AS-​​​​​​NPL | | 150 | -​​​​​​150 | 2015 | [123] |  |
| AS-​​​​​​IND-​​​​​​NE | AS-​​​​​​MMR | | 3 | -​​​​​​3 | 2018 | [114] |  |
| AS-​​​​​​IND-​​​​​​NO | AS-​​​​​​IND-​​​​​​WE | | 8720 | -​​​​​​8720 | 2015 | [78] |  |
| AS-​​​​​​IND-​​​​​​NO | AS-​​​​​​NPL | | 350 | -​​​​​​350 | 2015 | [123] |  |
| AS-​​​​​​IND-​​​​​​NO | AS-​​​​​​PAK | | 500 | -​​​​​​500 | 2014 | [124] |  |
| AS-​​​​​​IND-​​​​​​SO | AS-​​​​​​IND-​​​​​​WE | | 5720 | -​​​​​​5720 | 2015 | [78] |  |
| AS-​​​​​​IND-​​​​​​SO | AS-​​​​​​LKA | | 0 | 0 | 2018 | [114] | Planned subsea line |
| AS-​​​​​​IND-​​​​​​WE | AS-​​​​​​PAK | | 0 | 0 | 2014 | [124] |  |
| AS-​​​​​​IRN | AS-​​​​​​IRQ | | 700 | -​​​​​​700 | 2015 | [125] |  |
| AS-​​​​​​IRN | AS-​​​​​​PAK | | 74 | -​​​​​​74 | 2015 | [126] |  |
| AS-​​​​​​IRN | AS-​​​​​​TKM | | 350 | -​​​​​​350 | 2016 | [127] |  |
| AS-​​​​​​IRN | AS-​​​​​​TUR | | 0 | 0 | 2017 | [128] |  |
| AS-​​​​​​IRQ | AS-​​​​​​JOR | | 0 | 0 | 2015 | [125] |  |
| AS-​​​​​​IRQ | AS-​​​​​​KWT | | 0 | 0 | 2015 | [125] |  |
| AS-​​​​​​IRQ | AS-​​​​​​SAU | | 0 | 0 | 2015 | [125] |  |
| AS-​​​​​​IRQ | AS-​​​​​​SYR | | 0 | 0 | 2015 | [125] |  |
| AS-​​​​​​IRQ | AS-​​​​​​TUR | | 0 | 0 | 2017 | [128] |  |
| AS-​​​​​​ISR | AS-​​​​​​JOR | | 0 | -​​​​​​20 | 2013 | [109] |  |
| AS-​​​​​​ISR | AS-​​​​​​LBN | | 0 | 0 | 2018 | [129] |  |
| AS-​​​​​​ISR | AS-​​​​​​SYR | | 0 | 0 | 2018 | [129] |  |
| AS-​​​​​​JOR | AS-​​​​​​SAU | | 0 | 0 | 2019 | [130] |  |
| AS-​​​​​​JOR | AS-​​​​​​SYR | | 350 | -​​​​​​200 | 2013 | [109] |  |
| AS-​​​​​​JPN-​​​​​​CE | AS-​​​​​​JPN-​​​​​​KY | | 2800 | -​​​​​​2800 | 2015 | [81] |  |
| AS-​​​​​​JPN-​​​​​​CE | AS-​​​​​​JPN-​​​​​​SH | | 2600 | -​​​​​​2600 | 2015 | [81] |  |
| AS-​​​​​​JPN-​​​​​​CE | AS-​​​​​​JPN-​​​​​​TO | | 900 | -​​​​​​900 | 2015 | [81] |  |
| AS-​​​​​​JPN-​​​​​​HO | AS-​​​​​​JPN-​​​​​​TO | | 600 | -​​​​​​600 | 2015 | [81] |  |
| AS-​​​​​​KAZ | AS-​​​​​​KGZ | | 2540 | -​​​​​​2540 | 2016 | [131] |  |
| AS-​​​​​​KAZ | AS-​​​​​​RUS-​​​​​​CE | | 0 | 0 | 2016 | [131] |  |
| AS-​​​​​​KAZ | AS-​​​​​​RUS-​​​​​​MV | | 370 | -​​​​​​370 | 2016 | [131] |  |
| AS-​​​​​​KAZ | AS-​​​​​​RUS-​​​​​​SI | | 4200 | -​​​​​​4200 | 2016 | [131] |  |
| AS-​​​​​​KAZ | AS-​​​​​​RUS-​​​​​​UR | | 5860 | -​​​​​​5860 | 2016 | [131] |  |
| AS-​​​​​​KAZ | AS-​​​​​​TKM | | 0 | 0 | 2016 | [131] |  |
| AS-​​​​​​KAZ | AS-​​​​​​UZB | | 1900 | -​​​​​​1900 | 2016 | [131] |  |
| AS-​​​​​​KGZ | AS-​​​​​​TJK | | 412 | -​​​​​​412 | 2016 | [132] |  |
| AS-​​​​​​KGZ | AS-​​​​​​UZB | | 1500 | -​​​​​​1500 | 2016 | [132] |  |
| AS-​​​​​​KHM | AS-​​​​​​LAO | | 0 | 0 | 2015 | [115,116] |  |
| AS-​​​​​​KHM | AS-​​​​​​THA | | 100 | -​​​​​​100 | 2015 | [115,116] |  |
| AS-​​​​​​KHM | AS-​​​​​​VNM | | 200 | -​​​​​​200 | 2015 | [115,116] |  |
| AS-​​​​​​KOR | AS-​​​​​​PRK | | 0 | 0 | 2015 | [133] |  |
| AS-​​​​​​KWT | AS-​​​​​​SAU | | 1200 | -​​​​​​1200 | 2013 | [109] |  |
| AS-​​​​​​LAO | AS-​​​​​​MMR | | 5 | -​​​​​​5 | 2018 | [134] |  |
| AS-​​​​​​LAO | AS-​​​​​​THA | | 2111 | -​​​​​​2111 | 2015 | [115,116] |  |
| AS-​​​​​​LAO | AS-​​​​​​VNM | | 248 | -​​​​​​248 | 2015 | [115,116] |  |
| AS-​​​​​​LBN | AS-​​​​​​SYR | | 160 | -​​​​​​50 | 2013 | [109] |  |
| AS-​​​​​​MMR | AS-​​​​​​THA | | 0 | 0 | 2015 | [115,116] |  |
| AS-​​​​​​MNG | AS-​​​​​​RUS-​​​​​​SI | | 100 | -​​​​​​100 | 2017 | [113] |  |
| AS-​​​​​​MYS | AS-​​​​​​PHL | | 0 | 0 | 2015 | [115,116] | Planned subsea line |
| AS-​​​​​​MYS | AS-​​​​​​THA | | 380 | -​​​​​​380 | 2015 | [115,116] |  |
| AS-​​​​​​OMN | AS-​​​​​​SAU | | 0 | 0 | 2013 | [109] |  |
| AS-​​​​​​OMN | AS-​​​​​​YEM | | 0 | 0 | 2018 | [135] |  |
| AS-​​​​​​PRK | AS-​​​​​​RUS-​​​​​​FE | | 0 | 0 | 2015 | [133] |  |
| AS-​​​​​​QAT | AS-​​​​​​SAU | | 750 | -​​​​​​750 | 2013 | [109] |  |
| AS-​​​​​​RUS-​​​​​​CE | AS-​​​​​​RUS-​​​​​​MV | | 3500 | -​​​​​​3500 | 2010 | [84] |  |
| AS-​​​​​​RUS-​​​​​​CE | AS-​​​​​​RUS-​​​​​​NW | | 1500 | -​​​​​​1500 | 2010 | [84] |  |
| AS-​​​​​​RUS-​​​​​​CE | AS-​​​​​​RUS-​​​​​​SO | | 2400 | -​​​​​​2400 | 2010 | [84] |  |
| AS-​​​​​​RUS-​​​​​​CE | EU-​​​​​​UKR | | 1800 | -​​​​​​1800 | 2019 | [136] |  |
| AS-​​​​​​RUS-​​​​​​FE | AS-​​​​​​RUS-​​​​​​SI | | 0 | 0 | 2010 | [84] |  |
| AS-​​​​​​RUS-​​​​​​MV | AS-​​​​​​RUS-​​​​​​UR | | 3000 | -​​​​​​3000 | 2010 | [84] |  |
| AS-​​​​​​RUS-​​​​​​NW | AS-​​​​​​RUS-​​​​​​UR | | 0 | 0 | 2010 | [84] |  |
| AS-​​​​​​RUS-​​​​​​SI | AS-​​​​​​RUS-​​​​​​UR | | 3300 | -​​​​​​3300 | 2010 | [84] |  |
| AS-​​​​​​RUS-​​​​​​SO | EU-​​​​​​UKR | | 1200 | -​​​​​​1200 | 2019 | [136] |  |
| AS-​​​​​​SAU | AS-​​​​​​YEM | | 0 | 0 | 2018 | [135] |  |
| AS-​​​​​​SYR | AS-​​​​​​TUR | | 250 | -​​​​​​250 | 2013 | [109] |  |
| AS-​​​​​​TJK | AS-​​​​​​UZB | | 5445 | -​​​​​​5445 | 2016 | [132] |  |
| AS-​​​​​​TKM | AS-​​​​​​UZB | | 0 | 0 | 2018 | [137] |  |
| EU-​​​​​​ALB | EU-​​​​​​GRC | | 250 | -​​​​​​250 | 2015 | [138] | Estimate3 |
| EU-​​​​​​ALB | EU-​​​​​​KOS | | 210 | -​​​​​​210 | 2012 | [139] |  |
| EU-​​​​​​ALB | EU-​​​​​​MKD | | 0 | 0 | 2012 | [139] |  |
| EU-​​​​​​ARM | AS-​​​​​​IRN | | 300 | -​​​​​​300 | 2016 | [140] |  |
| EU-​​​​​​ARM | AS-​​​​​​TUR | | 0 | 0 | 2015 | [141] |  |
| EU-​​​​​​ARM | EU-​​​​​​AZE | | 0 | 0 | 2016 | [140] |  |
| EU-​​​​​​ARM | EU-​​​​​​GEO | | 150 | -​​​​​​150 | 2015 | [142] |  |
| EU-​​​​​​AUT | EU-​​​​​​CHE | | 1700 | -​​​​​​1700 | 2015 | [143] | UCC EU model |
| EU-​​​​​​AUT | EU-​​​​​​CZE | | 1000 | -​​​​​​1200 | 2015 | [143] | UCC EU model |
| EU-​​​​​​AUT | EU-​​​​​​DEU | | 2100 | -​​​​​​2100 | 2015 | [143] | UCC EU model |
| EU-​​​​​​AUT | EU-​​​​​​HUN | | 1200 | -​​​​​​800 | 2015 | [143] | UCC EU model |
| EU-​​​​​​AUT | EU-​​​​​​ITA | | 405 | -​​​​​​235 | 2015 | [143] | UCC EU model |
| EU-​​​​​​AUT | EU-​​​​​​SVK | | 0 | 0 | 2015 | [143] | UCC EU model |
| EU-​​​​​​AUT | EU-​​​​​​SVN | | 1200 | -​​​​​​1200 | 2015 | [143] | UCC EU model |
| EU-​​​​​​AZE | AS-​​​​​​IRN | | 800 | -​​​​​​800 | 2015 | [144] |  |
| EU-​​​​​​AZE | AS-​​​​​​RUS-​​​​​​SO | | 500 | -​​​​​​850 | 2015 | [144] |  |
| EU-​​​​​​AZE | AS-​​​​​​TUR | | 100 | -​​​​​​100 | 2015 | [144] |  |
| EU-​​​​​​AZE | EU-​​​​​​GEO | | 1020 | -​​​​​​1020 | 2015 | [142] |  |
| EU-​​​​​​BEL | EU-​​​​​​DEU | | 0 | 0 | 2015 | [143] | UCC EU model |
| EU-​​​​​​BEL | EU-​​​​​​FRA | | 1800 | -​​​​​​3300 | 2015 | [143] | UCC EU model |
| EU-​​​​​​BEL | EU-​​​​​​GBR | | 0 | 0 | 2015 | [145] | Planned subsea line |
| EU-​​​​​​BEL | EU-​​​​​​LUX | | 180 | 0 | 2015 | [143] | UCC EU model |
| EU-​​​​​​BEL | EU-​​​​​​NLD | | 400 | -​​​​​​400 | 2015 | [143] | UCC EU model |
| EU-​​​​​​BGR | AS-​​​​​​TUR | | 650 | -​​​​​​500 | 2017 | [146] |  |
| EU-​​​​​​BGR | EU-​​​​​​GRC | | 1728 | -​​​​​​1032 | 2015 | [143] | UCC EU model |
| EU-​​​​​​BGR | EU-​​​​​​MKD | | 400 | -​​​​​​200 | 2011 | [147] |  |
| EU-​​​​​​BGR | EU-​​​​​​ROU | | 400 | -​​​​​​300 | 2015 | [143] | UCC EU model |
| EU-​​​​​​BGR | EU-​​​​​​SRB | | 600 | -​​​​​​300 | 2015 | [148] | Estimate3 |
| EU-​​​​​​BIH | EU-​​​​​​HRV | | 800 | -​​​​​​800 | 2015 | [148] | Estimate3 |
| EU-​​​​​​BIH | EU-​​​​​​MNE | | 725 | -​​​​​​725 | 2015 | [149] | Estimate4 |
| EU-​​​​​​BIH | EU-​​​​​​SRB | | 600 | -​​​​​​600 | 2015 | [148] | Estimate3 |
| EU-​​​​​​BLR | AS-​​​​​​RUS-​​​​​​CE | | 859 | -​​​​​​1117 | 2006 | [150] |  |
| EU-​​​​​​BLR | AS-​​​​​​RUS-​​​​​​NW | | 141 | -​​​​​​183 | 2006 | [150] |  |
| EU-​​​​​​BLR | EU-​​​​​​LTU | | 1300 | -​​​​​​1350 | 2014 | [151] |  |
| EU-​​​​​​BLR | EU-​​​​​​LVA | | 0 | 0 | 2015 | [152] |  |
| EU-​​​​​​BLR | EU-​​​​​​POL | | 0 | 0 | 2013 | [153] |  |
| EU-​​​​​​BLR | EU-​​​​​​UKR | | 900 | -​​​​​​900 | 2018 | [136] |  |
| EU-​​​​​​CHE | EU-​​​​​​DEU | | 4700 | -​​​​​​3286 | 2015 | [143] | UCC EU model |
| EU-​​​​​​CHE | EU-​​​​​​FRA | | 1300 | -​​​​​​3200 | 2015 | [143] | UCC EU model |
| EU-​​​​​​CHE | EU-​​​​​​ITA | | 4090 | -​​​​​​3260 | 2015 | [143] | UCC EU model |
| EU-​​​​​​CYP | AF-​​​​​​EGY | | 0 | 0 | 2018 | [154] | Planned subsea line |
| EU-​​​​​​CYP | AS-​​​​​​ISR | | 0 | 0 | 2015 | [145] | Planned subsea line |
| EU-​​​​​​CYP | EU-​​​​​​GRC | | 0 | 0 | 2015 | [145] | Planned subsea line |
| EU-​​​​​​CZE | EU-​​​​​​DEU | | 300 | 0 | 2015 | [143] | UCC EU model |
| EU-​​​​​​CZE | EU-​​​​​​POL | | 500 | -​​​​​​600 | 2015 | [143] | UCC EU model |
| EU-​​​​​​CZE | EU-​​​​​​SVK | | 2100 | -​​​​​​1100 | 2015 | [143] | UCC EU model |
| EU-​​​​​​DEU | EU-​​​​​​DNK | | 2350 | -​​​​​​2380 | 2015 | [143] | UCC EU model |
| EU-​​​​​​DEU | EU-​​​​​​FRA | | 3000 | -​​​​​​3000 | 2015 | [143] | UCC EU model |
| EU-​​​​​​DEU | EU-​​​​​​LUX | | 2300 | -​​​​​​2300 | 2015 | [143] | UCC EU model |
| EU-​​​​​​DEU | EU-​​​​​​NLD | | 3100 | -​​​​​​3300 | 2015 | [143] | UCC EU model |
| EU-​​​​​​DEU | EU-​​​​​​NOR | | 0 | 0 | 2015 | [145] | Planned subsea line |
| EU-​​​​​​DEU | EU-​​​​​​POL | | 0 | -​​​​​​1500 | 2015 | [143] | UCC EU model |
| EU-​​​​​​DEU | EU-​​​​​​SWE | | 600 | -​​​​​​600 | 2015 | [143] | Subsea, UCC EU model |
| EU-​​​​​​DNK | EU-​​​​​​GBR | | 0 | 0 | 2015 | [155] | Planned subsea line |
| EU-​​​​​​DNK | EU-​​​​​​NLD | | 0 | 0 | 2015 | [155] | Planned subsea line |
| EU-​​​​​​DNK | EU-​​​​​​NOR | | 1640 | -​​​​​​1640 | 2015 | [143] | Subsea, UCC EU model |
| EU-​​​​​​DNK | EU-​​​​​​SWE | | 2440 | -​​​​​​1980 | 2015 | [143] | Subsea, UCC EU model |
| EU-​​​​​​ESP | AF-​​​​​​MAR | | 700 | -​​​​​​700 | 2015 | [143] | Subsea, UCC EU model |
| EU-​​​​​​ESP | EU-​​​​​​FRA | | 1900 | -​​​​​​2700 | 2015 | [143] | UCC EU model |
| EU-​​​​​​ESP | EU-​​​​​​PRT | | 2600 | -​​​​​​2150 | 2015 | [143] | UCC EU model |
| EU-​​​​​​EST | AS-​​​​​​RUS-​​​​​​NW | | 850 | -​​​​​​1000 | 2014 | [151] |  |
| EU-​​​​​​EST | EU-​​​​​​FIN | | 1016 | -​​​​​​1000 | 2015 | [143] | UCC EU model |
| EU-​​​​​​EST | EU-​​​​​​LVA | | 1100 | -​​​​​​1100 | 2015 | [143] | UCC EU model |
| EU-​​​​​​FIN | AS-​​​​​​RUS-​​​​​​NW | | 320 | -​​​​​​1300 | 2016 | [156] |  |
| EU-​​​​​​FIN | EU-​​​​​​NOR | | 126 | -​​​​​​126 | 2015 | [157] |  |
| EU-​​​​​​FIN | EU-​​​​​​SWE | | 1500 | -​​​​​​1900 | 2015 | [143] | UCC EU model |
| EU-​​​​​​FRA | EU-​​​​​​GBR | | 2000 | -​​​​​​2000 | 2015 | [143] | Subsea, UCC EU model |
| EU-​​​​​​FRA | EU-​​​​​​IRL | | 0 | 0 | 2015 | [155] | Planned subsea line |
| EU-​​​​​​FRA | EU-​​​​​​ITA | | 4350 | -​​​​​​2160 | 2015 | [143] | UCC EU model |
| EU-​​​​​​FRA | EU-​​​​​​LUX | | 380 | 0 | 2015 | [143] | UCC EU model |
| EU-​​​​​​GBR | EU-​​​​​​IRL | | 800 | -​​​​​​800 | 2015 | [143] | Subsea, UCC EU model |
| EU-​​​​​​GBR | EU-​​​​​​ISL | | 0 | 0 | 2015 | [145] | Planned subsea line |
| EU-​​​​​​GBR | EU-​​​​​​NLD | | 1000 | -​​​​​​1000 | 2015 | [143] | Subsea, UCC EU model |
| EU-​​​​​​GBR | EU-​​​​​​NOR | | 0 | 0 | 2015 | [145] | Planned subsea line |
| EU-​​​​​​GEO | AS-​​​​​​RUS-​​​​​​SO | | 750 | -​​​​​​850 | 2015 | [142] |  |
| EU-​​​​​​GEO | AS-​​​​​​TUR | | 850 | -​​​​​​850 | 2015 | [142] |  |
| EU-​​​​​​GRC | AS-​​​​​​TUR | | 650 | -​​​​​​500 | 2017 | [146] |  |
| EU-​​​​​​GRC | EU-​​​​​​ITA | | 500 | -​​​​​​500 | 2015 | [143] | Subsea, UCC EU model |
| EU-​​​​​​GRC | EU-​​​​​​MKD | | 350 | -​​​​​​450 | 2015 | [148] | Estimate3 |
| EU-​​​​​​HRV | EU-​​​​​​HUN | | 2000 | -​​​​​​2000 | 2015 | [143] | UCC EU model |
| EU-​​​​​​HRV | EU-​​​​​​MNE | | 0 | 0 | 2015 | [152] |  |
| EU-​​​​​​HRV | EU-​​​​​​SRB | | 600 | -​​​​​​600 | 2015 | [148] | Estimate3 |
| EU-​​​​​​HRV | EU-​​​​​​SVN | | 2000 | -​​​​​​2000 | 2015 | [148] | Estimate3 |
| EU-​​​​​​HUN | EU-​​​​​​ROU | | 1300 | -​​​​​​1400 | 2015 | [143] | UCC EU model |
| EU-​​​​​​HUN | EU-​​​​​​SRB | | 700 | -​​​​​​800 | 2015 | [148] | Estimate3 |
| EU-​​​​​​HUN | EU-​​​​​​SVK | | 1800 | -​​​​​​450 | 2015 | [143] | UCC EU model |
| EU-​​​​​​HUN | EU-​​​​​​SVN | | 1700 | -​​​​​​2000 | 2015 | [143] | UCC EU model |
| EU-​​​​​​HUN | EU-​​​​​​UKR | | 650 | -​​​​​​650 | 2018 | [136] |  |
| EU-​​​​​​ITA | AF-​​​​​​TUN | | 0 | 0 | 2016 | [158] | Planned subsea line |
| EU-​​​​​​ITA | EU-​​​​​​SVN | | 580 | -​​​​​​530 | 2015 | [143] |  |
| EU-​​​​​​KOS | EU-​​​​​​MKD | | 400 | -​​​​​​400 | 2011 | [159] |  |
| EU-​​​​​​KOS | EU-​​​​​​MNE | | 400 | -​​​​​​400 | 2011 | [159] |  |
| EU-​​​​​​KOS | EU-​​​​​​SRB | | 600 | -​​​​​​600 | 2011 | [159] |  |
| EU-​​​​​​LTU | AS-​​​​​​RUS-​​​​​​NW | | 680 | -​​​​​​600 | 2014 | [151] |  |
| EU-​​​​​​LTU | EU-​​​​​​LVA | | 1500 | -​​​​​​1200 | 2015 | [143] | UCC EU model |
| EU-​​​​​​LTU | EU-​​​​​​POL | | 500 | 0 | 2015 | [143] | UCC EU model |
| EU-​​​​​​LTU | EU-​​​​​​SWE | | 700 | -​​​​​​700 | 2015 | [143] | Subsea, UCC EU model |
| EU-​​​​​​LVA | AS-​​​​​​RUS-​​​​​​NW | | 1200 | -​​​​​​1500 | 2006 | [150] |  |
| EU-​​​​​​MDA | EU-​​​​​​ROU | | 0 | 0 | 2015 | [148] | Estimate3 |
| EU-​​​​​​MDA | EU-​​​​​​UKR | | 700 | -​​​​​​700 | 2018 | [136] |  |
| EU-​​​​​​MKD | EU-​​​​​​SRB | | 300 | -​​​​​​700 | 2015 | [148] | Estimate3 |
| EU-​​​​​​MNE | EU-​​​​​​SRB | | 700 | -​​​​​​700 | 2015 | [148] | Estimate3 |
| EU-​​​​​​NLD | EU-​​​​​​NOR | | 700 | -​​​​​​700 | 2015 | [143] | Subsea, UCC EU model |
| EU-​​​​​​NOR | AS-​​​​​​RUS-​​​​​​NW | | 50 | -​​​​​​50 | 2013 | [160] |  |
| EU-​​​​​​NOR | EU-​​​​​​SWE | | 3695 | -​​​​​​3995 | 2015 | [143] | UCC EU model |
| EU-​​​​​​POL | EU-​​​​​​SVK | | 990 | -​​​​​​990 | 2015 | [143] | UCC EU model |
| EU-​​​​​​POL | EU-​​​​​​SWE | | 600 | -​​​​​​600 | 2015 | [143] | Subsea, UCC EU model |
| EU-​​​​​​POL | EU-​​​​​​UKR | | 235 | -​​​​​​235 | 2018 | [136] |  |
| EU-​​​​​​ROU | EU-​​​​​​SRB | | 700 | -​​​​​​800 | 2015 | [148] |  |
| EU-​​​​​​ROU | EU-​​​​​​UKR | | 650 | -​​​​​​650 | 2018 | [136] |  |
| EU-​​​​​​SVK | EU-​​​​​​UKR | | 650 | -​​​​​​650 | 2018 | [136] |  |
| NA-​​​​​​CAN-​​​​​​AB | NA-​​​​​​CAN-​​​​​​BC | | 1000 | -​​​​​​1200 | 2015 | [26] |  |
| NA-​​​​​​CAN-​​​​​​AB | NA-​​​​​​CAN-​​​​​​NO | | 0 | 0 | 2015 | [26] |  |
| NA-​​​​​​CAN-​​​​​​AB | NA-​​​​​​CAN-​​​​​​SK | | 150 | -​​​​​​150 | 2015 | [26] |  |
| NA-​​​​​​CAN-​​​​​​AB | NA-​​​​​​USA-​​​​​​NW | | 325 | -​​​​​​300 | 2015 | [26] |  |
| NA-​​​​​​CAN-​​​​​​AR | NA-​​​​​​CAN-​​​​​​QC | | 785 | -​​​​​​1029 | 2015 | [28] |  |
| NA-​​​​​​CAN-​​​​​​AR | NA-​​​​​​USA-​​​​​​NE | | 1120 | -​​​​​​750 | 2015 | [6] |  |
| NA-​​​​​​CAN-​​​​​​BC | NA-​​​​​​CAN-​​​​​​NO | | 0 | 0 | 2015 | [29] | Estimate4 |
| NA-​​​​​​CAN-​​​​​​BC | NA-​​​​​​USA-​​​​​​AK | | 0 | 0 | 2015 | [29] | Estimate4 |
| NA-​​​​​​CAN-​​​​​​BC | NA-​​​​​​USA-​​​​​​NW | | 2364 | -​​​​​​2364 | 2015 | [29] | Estimate4 |
| NA-​​​​​​CAN-​​​​​​MB | NA-​​​​​​CAN-​​​​​​NO | | 0 | 0 | 2015 | [27] |  |
| NA-​​​​​​CAN-​​​​​​MB | NA-​​​​​​CAN-​​​​​​ON | | 234 | -​​​​​​234 | 2015 | [27] |  |
| NA-​​​​​​CAN-​​​​​​MB | NA-​​​​​​CAN-​​​​​​SK | | 220 | -​​​​​​175 | 2015 | [27] |  |
| NA-​​​​​​CAN-​​​​​​MB | NA-​​​​​​USA-​​​​​​MW | | 2100 | -​​​​​​2100 | 2015 | [27] |  |
| NA-​​​​​​CAN-​​​​​​NL | NA-​​​​​​CAN-​​​​​​QC | | 5150 | 0 | 2012 | [25] |  |
| NA-​​​​​​CAN-​​​​​​NO | NA-​​​​​​CAN-​​​​​​SK | | 0 | 0 | 2015 | [24] |  |
| NA-​​​​​​CAN-​​​​​​ON | NA-​​​​​​CAN-​​​​​​QC | | 1970 | -​​​​​​2705 | 2015 | [6] |  |
| NA-​​​​​​CAN-​​​​​​ON | NA-​​​​​​USA-​​​​​​MW | | 132 | -​​​​​​132 | 2015 | [19] | Estimate4 |
| NA-​​​​​​CAN-​​​​​​ON | NA-​​​​​​USA-​​​​​​NY | | 1949 | -​​​​​​1949 | 2015 | [19] | Estimate4 |
| NA-​​​​​​CAN-​​​​​​ON | NA-​​​​​​USA-​​​​​​RM | | 1747 | -​​​​​​1747 | 2015 | [19] | Estimate4 |
| NA-​​​​​​CAN-​​​​​​QC | NA-​​​​​​USA-​​​​​​NE | | 2275 | -​​​​​​2170 | 2015 | [6] |  |
| NA-​​​​​​CAN-​​​​​​QC | NA-​​​​​​USA-​​​​​​NY | | 1999 | -​​​​​​1100 | 2015 | [6] |  |
| NA-​​​​​​CAN-​​​​​​SK | NA-​​​​​​USA-​​​​​​MW | | 100 | -​​​​​​50 | 2015 | [24] |  |
| NA-​​​​​​CRI | NA-​​​​​​NIC | | 300 | -​​​​​​300 | 2015 | [161] |  |
| NA-​​​​​​CRI | NA-​​​​​​PAN | | 300 | -​​​​​​300 | 2015 | [161] |  |
| NA-​​​​​​GTM | NA-​​​​​​HND | | 300 | -​​​​​​300 | 2015 | [161] |  |
| NA-​​​​​​GTM | NA-​​​​​​MEX | | 200 | -​​​​​​200 | 2015 | [161] |  |
| NA-​​​​​​GTM | NA-​​​​​​SLV | | 300 | -​​​​​​300 | 2015 | [161] |  |
| NA-​​​​​​HND | NA-​​​​​​NIC | | 300 | -​​​​​​300 | 2015 | [161] |  |
| NA-​​​​​​HND | NA-​​​​​​SLV | | 300 | -​​​​​​300 | 2015 | [161] |  |
| NA-​​​​​​USA-​​​​​​AZ | NA-​​​​​​MEX | | 0 | 0 | 2015-​​​​​​2017 | [62] | Estimate4 |
| NA-​​​​​​USA-​​​​​​AZ | NA-​​​​​​USA-​​​​​​CA | | 7247 | -​​​​​​7247 | 2015-​​​​​​2017 | [62] | Estimate4 |
| NA-​​​​​​USA-​​​​​​AZ | NA-​​​​​​USA-​​​​​​ER | | 0 | 0 | 2015-​​​​​​2017 | [62] | Estimate4 |
| NA-​​​​​​USA-​​​​​​AZ | NA-​​​​​​USA-​​​​​​NW | | 2067 | -​​​​​​2067 | 2015-​​​​​​2017 | [62] | Estimate4 |
| NA-​​​​​​USA-​​​​​​AZ | NA-​​​​​​USA-​​​​​​RA | | 1960 | -​​​​​​1960 | 2015-​​​​​​2017 | [62] | Estimate4 |
| NA-​​​​​​USA-​​​​​​AZ | NA-​​​​​​USA-​​​​​​SS | | 400 | -​​​​​​400 | 2015-​​​​​​2017 | [63] |  |
| NA-​​​​​​USA-​​​​​​CA | NA-​​​​​​MEX | | 408 | -​​​​​​408 | 2015-​​​​​​2017 | [62] | Estimate4 |
| NA-​​​​​​USA-​​​​​​CA | NA-​​​​​​USA-​​​​​​NW | | 10211 | -​​​​​​10211 | 2015-​​​​​​2017 | [62] | Estimate4 |
| NA-​​​​​​USA-​​​​​​ER | NA-​​​​​​MEX | | 431 | -​​​​​​431 | 2015-​​​​​​2017 | [62] | Estimate4 |
| NA-​​​​​​USA-​​​​​​ER | NA-​​​​​​USA-​​​​​​SA | | 0 | 0 | 2015-​​​​​​2017 | [62] | Estimate4 |
| NA-​​​​​​USA-​​​​​​ER | NA-​​​​​​USA-​​​​​​SS | | 834 | -​​​​​​834 | 2015-​​​​​​2017 | [62] | Estimate4 |
| NA-​​​​​​USA-​​​​​​FR | NA-​​​​​​USA-​​​​​​SE | | 3897 | -​​​​​​3897 | 2015-​​​​​​2017 | [62] | Estimate4 |
| NA-​​​​​​USA-​​​​​​ME | NA-​​​​​​USA-​​​​​​MW | | 3000 | -​​​​​​3000 | 2015-​​​​​​2017 | [62] | Estimate6 |
| NA-​​​​​​USA-​​​​​​NW | NA-​​​​​​CAN-​​​​​​SK | | 0 | 0 | 2015-​​​​​​2017 | [62] | Estimate4 |
| NA-​​​​​​USA-​​​​​​NW | NA-​​​​​​USA-​​​​​​MW | | 187 | -​​​​​​187 | 2015-​​​​​​2017 | [62] | Estimate4 |
| NA-​​​​​​USA-​​​​​​NW | NA-​​​​​​USA-​​​​​​RA | | 1827 | -​​​​​​1827 | 2015-​​​​​​2017 | [62] | Estimate4 |
| NA-​​​​​​USA-​​​​​​NY | NA-​​​​​​USA-​​​​​​NE | | 1764 | -​​​​​​1764 | 2015-​​​​​​2017 | [62] | Estimate4 |
| NA-​​​​​​USA-​​​​​​RA | NA-​​​​​​USA-​​​​​​MW | | 432 | -​​​​​​432 | 2015-​​​​​​2017 | [62] | Estimate4 |
| NA-​​​​​​USA-​​​​​​RA | NA-​​​​​​USA-​​​​​​SN | | 210 | -​​​​​​210 | 2015-​​​​​​2017 | [63] |  |
| NA-​​​​​​USA-​​​​​​RA | NA-​​​​​​USA-​​​​​​SS | | 0 | 0 | 2015-​​​​​​2017 | [62] | Estimate4 |
| NA-​​​​​​USA-​​​​​​RE | NA-​​​​​​USA-​​​​​​NY | | 4086 | -​​​​​​4086 | 2015-​​​​​​2017 | [53] |  |
| NA-​​​​​​USA-​​​​​​RE | NA-​​​​​​USA-​​​​​​SV | | 4529 | -​​​​​​4529 | 2015-​​​​​​2017 | [53] |  |
| NA-​​​​​​USA-​​​​​​RW | NA-​​​​​​USA-​​​​​​ME | | 1456 | -​​​​​​1456 | 2015-​​​​​​2017 | [53] |  |
| NA-​​​​​​USA-​​​​​​RW | NA-​​​​​​USA-​​​​​​MW | | 2196 | -​​​​​​2196 | 2015-​​​​​​2017 | [53] |  |
| NA-​​​​​​USA-​​​​​​RW | NA-​​​​​​USA-​​​​​​RE | | 6793 | -​​​​​​6793 | 2015-​​​​​​2017 | [53] |  |
| NA-​​​​​​USA-​​​​​​RW | NA-​​​​​​USA-​​​​​​RM | | 5320 | -​​​​​​5320 | 2015-​​​​​​2017 | [53] |  |
| NA-​​​​​​USA-​​​​​​RW | NA-​​​​​​USA-​​​​​​SV | | 7342 | -​​​​​​7342 | 2015-​​​​​​2017 | [53] |  |
| NA-​​​​​​USA-​​​​​​SA | NA-​​​​​​USA-​​​​​​SN | | 0 | 0 | 2015-​​​​​​2017 | [62] | Estimate4 |
| NA-​​​​​​USA-​​​​​​SA | NA-​​​​​​USA-​​​​​​SW | | 3000 | -​​​​​​3000 | 2015-​​​​​​2017 | [62] | Estimate6 |
| NA-​​​​​​USA-​​​​​​SC | NA-​​​​​​USA-​​​​​​RW | | 4859 | -​​​​​​4859 | 2015-​​​​​​2017 | [62] | Estimate4 |
| NA-​​​​​​USA-​​​​​​SC | NA-​​​​​​USA-​​​​​​SA | | 2371 | -​​​​​​2371 | 2015-​​​​​​2017 | [62] | Estimate4 |
| NA-​​​​​​USA-​​​​​​SC | NA-​​​​​​USA-​​​​​​SV | | 592 | -​​​​​​592 | 2015-​​​​​​2017 | [62] | Estimate4 |
| NA-​​​​​​USA-​​​​​​SE | NA-​​​​​​USA-​​​​​​SA | | 2032 | -​​​​​​2032 | 2015-​​​​​​2017 | [62] | Estimate4 |
| NA-​​​​​​USA-​​​​​​SE | NA-​​​​​​USA-​​​​​​SC | | 4405 | -​​​​​​4405 | 2015-​​​​​​2017 | [62] | Estimate4 |
| NA-​​​​​​USA-​​​​​​SE | NA-​​​​​​USA-​​​​​​SV | | 4896 | -​​​​​​4896 | 2015-​​​​​​2017 | [62] | Estimate4 |
| NA-​​​​​​USA-​​​​​​SN | NA-​​​​​​USA-​​​​​​MW | | 2668 | -​​​​​​2668 | 2015-​​​​​​2017 | [63] | Estimate5 |
| NA-​​​​​​USA-​​​​​​SN | NA-​​​​​​USA-​​​​​​SW | | 6978 | -​​​​​​6978 | 2015-​​​​​​2017 | [63] |  |
| NA-​​​​​​USA-​​​​​​SS | NA-​​​​​​USA-​​​​​​SA | | 6889 | -​​​​​​6889 | 2015-​​​​​​2017 | [62] | Estimate4 |
| NA-​​​​​​USA-​​​​​​SS | NA-​​​​​​USA-​​​​​​SN | | 6889 | -​​​​​​6889 | 2015-​​​​​​2017 | [62] | Estimate5 |
| NA-​​​​​​USA-​​​​​​SW | NA-​​​​​​USA-​​​​​​MW | | 3000 | -​​​​​​3000 | 2015-​​​​​​2017 | [62] | Estimate6 |
| NA-​​​​​​USA-​​​​​​SW | NA-​​​​​​USA-​​​​​​RW | | 6295 | -​​​​​​6295 | 2015-​​​​​​2017 | [62] | Estimate6 |
| NA-​​​​​​USA-​​​​​​SW | NA-​​​​​​USA-​​​​​​SC | | 2970 | -​​​​​​2970 | 2015-​​​​​​2017 | [62] | Estimate4 |
| OC-​​​​​​AUS-​​​​​​NT | OC-​​​​​​AUS-​​​​​​QL | | 0 | 0 | 2019 | [6] |  |
| OC-​​​​​​AUS-​​​​​​NT | OC-​​​​​​AUS-​​​​​​SA | | 0 | 0 | 2019 | [6] |  |
| OC-​​​​​​AUS-​​​​​​NT | OC-​​​​​​AUS-​​​​​​WA | | 0 | 0 | 2019 | [6] |  |
| OC-​​​​​​AUS-​​​​​​QL | OC-​​​​​​AUS-​​​​​​SA | | 0 | 0 | 2019 | [6] |  |
| OC-​​​​​​AUS-​​​​​​QL | OC-​​​​​​AUS-​​​​​​SW | | 1288 | -​​​​​​707 | 2017 | [5] |  |
| OC-​​​​​​AUS-​​​​​​SA | OC-​​​​​​AUS-​​​​​​SW | | 0 | 0 | 2019 | [6] |  |
| OC-​​​​​​AUS-​​​​​​SA | OC-​​​​​​AUS-​​​​​​VI | | 660 | -​​​​​​680 | 2017 | [5] |  |
| OC-​​​​​​AUS-​​​​​​SA | OC-​​​​​​AUS-​​​​​​WA | | 0 | 0 | 2019 | [6] |  |
| OC-​​​​​​AUS-​​​​​​SW | OC-​​​​​​AUS-​​​​​​VI | | 1350 | -​​​​​​1600 | 2017 | [5] |  |
| OC-​​​​​​AUS-​​​​​​TA | OC-​​​​​​AUS-​​​​​​VI | | 594 | -​​​​​​478 | 2017 | [5] |  |
| SA-​​​​​​ARG | SA-​​​​​​BOL | | 0 | 0 | 2015 | [161] |  |
| SA-​​​​​​ARG | SA-​​​​​​BRA-​​​​​​SO | | 2250 | -​​​​​​2250 | 2015 | [161] |  |
| SA-​​​​​​ARG | SA-​​​​​​CHL | | 633 | -​​​​​​633 | 2015 | [161] |  |
| SA-​​​​​​ARG | SA-​​​​​​PRY | | 3320 | -​​​​​​3320 | 2015 | [161] |  |
| SA-​​​​​​ARG | SA-​​​​​​URY | | 3276 | -​​​​​​3276 | 2015 | [161] |  |
| SA-​​​​​​BOL | SA-​​​​​​BRA-​​​​​​CW | | 0 | 0 | 2015 | [161] |  |
| SA-​​​​​​BOL | SA-​​​​​​BRA-​​​​​​WE | | 0 | 0 | 2015 | [161] |  |
| SA-​​​​​​BOL | SA-​​​​​​CHL | | 0 | 0 | 2015 | [161] |  |
| SA-​​​​​​BOL | SA-​​​​​​PER | | 0 | 0 | 2015 | [161] |  |
| SA-​​​​​​BOL | SA-​​​​​​PRY | | 0 | 0 | 2015 | [161] |  |
| SA-​​​​​​BRA-​​​​​​CN | SA-​​​​​​BRA-​​​​​​CW | | 0 | 0 | 2017 | [9] |  |
| SA-​​​​​​BRA-​​​​​​CN | SA-​​​​​​BRA-​​​​​​J2 | | 8518 | -​​​​​​8518 | 2017 | [9] |  |
| SA-​​​​​​BRA-​​​​​​CN | SA-​​​​​​BRA-​​​​​​J3 | | 13700 | -​​​​​​13700 | 2017 | [9] |  |
| SA-​​​​​​BRA-​​​​​​CN | SA-​​​​​​BRA-​​​​​​NE | | 0 | 0 | 2017 | [9] |  |
| SA-​​​​​​BRA-​​​​​​CN | SA-​​​​​​BRA-​​​​​​NW | | 0 | 0 | 2017 | [9] |  |
| SA-​​​​​​BRA-​​​​​​CN | SA-​​​​​​GUY | | 0 | 0 | 2015 | [161] |  |
| SA-​​​​​​BRA-​​​​​​CW | SA-​​​​​​BRA-​​​​​​J2 | | 5598 | -​​​​​​5380 | 2017 | [9] |  |
| SA-​​​​​​BRA-​​​​​​CW | SA-​​​​​​BRA-​​​​​​NE | | 0 | 0 | 2017 | [9] |  |
| SA-​​​​​​BRA-​​​​​​CW | SA-​​​​​​BRA-​​​​​​NW | | 0 | 0 | 2017 | [9] |  |
| SA-​​​​​​BRA-​​​​​​CW | SA-​​​​​​BRA-​​​​​​SE | | 15000 | -​​​​​​15000 | 2017 | [9] |  |
| SA-​​​​​​BRA-​​​​​​CW | SA-​​​​​​BRA-​​​​​​SO | | 0 | 0 | 2017 | [9] |  |
| SA-​​​​​​BRA-​​​​​​CW | SA-​​​​​​BRA-​​​​​​WE | | 7092 | -​​​​​​7092 | 2017 | [9] |  |
| SA-​​​​​​BRA-​​​​​​CW | SA-​​​​​​PRY | | 0 | 0 | 2015 | [161] |  |
| SA-​​​​​​BRA-​​​​​​J1 | SA-​​​​​​BRA-​​​​​​SE | | 6800 | -​​​​​​6800 | 2017 | [9] |  |
| SA-​​​​​​BRA-​​​​​​J1 | SA-​​​​​​BRA-​​​​​​SO | | 8726 | -​​​​​​8617 | 2017 | [9] |  |
| SA-​​​​​​BRA-​​​​​​J2 | SA-​​​​​​BRA-​​​​​​J3 | | 4115 | -​​​​​​4115 | 2017 | [9] |  |
| SA-​​​​​​BRA-​​​​​​J2 | SA-​​​​​​BRA-​​​​​​NE | | 8200 | -​​​​​​4849 | 2017 | [9] |  |
| SA-​​​​​​BRA-​​​​​​J3 | SA-​​​​​​BRA-​​​​​​NW | | 2700 | -​​​​​​2700 | 2017 | [9] |  |
| SA-​​​​​​BRA-​​​​​​J3 | SA-​​​​​​BRA-​​​​​​SE | | 8000 | -​​​​​​8000 | 2017 | [9] |  |
| SA-​​​​​​BRA-​​​​​​NE | SA-​​​​​​BRA-​​​​​​SE | | 6936 | -​​​​​​6500 | 2017 | [9] |  |
| SA-​​​​​​BRA-​​​​​​NW | SA-​​​​​​BRA-​​​​​​WE | | 0 | 0 | 2017 | [9] |  |
| SA-​​​​​​BRA-​​​​​​NW | SA-​​​​​​COL | | 0 | 0 | 2015 | [161] |  |
| SA-​​​​​​BRA-​​​​​​NW | SA-​​​​​​GUF | | 0 | 0 | 2015 | [161] |  |
| SA-​​​​​​BRA-​​​​​​NW | SA-​​​​​​GUY | | 0 | 0 | 2015 | [161] |  |
| SA-​​​​​​BRA-​​​​​​NW | SA-​​​​​​PER | | 0 | 0 | 2015 | [161] |  |
| SA-​​​​​​BRA-​​​​​​NW | SA-​​​​​​VEN | | 200 | -​​​​​​200 | 2015 | [161] |  |
| SA-​​​​​​BRA-​​​​​​SE | SA-​​​​​​BRA-​​​​​​SO | | 14920 | -​​​​​​14608 | 2017 | [9] |  |
| SA-​​​​​​BRA-​​​​​​SO | SA-​​​​​​PRY | | 7000 | -​​​​​​7000 | 2015 | [161] |  |
| SA-​​​​​​BRA-​​​​​​SO | SA-​​​​​​URY | | 570 | -​​​​​​570 | 2015 | [161] |  |
| SA-​​​​​​BRA-​​​​​​WE | SA-​​​​​​PER | | 0 | 0 | 2015 | [161] |  |
| SA-​​​​​​CHL | SA-​​​​​​PER | | 0 | 0 | 2015 | [161] |  |
| SA-​​​​​​COL | NA-​​​​​​PAN | | 0 | 0 | 2015 | [161] |  |
| SA-​​​​​​COL | SA-​​​​​​ECU | | 613 | -​​​​​​613 | 2015 | [161] |  |
| SA-​​​​​​COL | SA-​​​​​​PER | | 0 | 0 | 2015 | [161] |  |
| SA-​​​​​​COL | SA-​​​​​​VEN | | 394 | -​​​​​​394 | 2015 | [161] |  |
| SA-​​​​​​ECU | SA-​​​​​​PER | | 110 | -​​​​​​110 | 2015 | [161] |  |
| SA-​​​​​​GUY | SA-​​​​​​VEN | | 0 | 0 | 2015 | [161] |  |

1 Estimate based on contracted supply from Guangdong to Hong Kong.

2 Estimate based on mentioned yearly export values.

3 Estimate based on forecasted month/​​​​​​year ahead values.

4 Estimate based on the assumption that the maximum hourly exchange value in the specified period represents the NTC.

5 Estimate based on the assumption that maximum external flow from a single pathway coming in to a node covered by SPP can also flow towards adjacent nodes covered by SPP (See Section S2 underneath Canada and the United States for further explanation).

6 Estimate based on the assumption that maximum external flow from a single pathway coming in to a node covered by MISO can also flow towards adjacent nodes covered by MISO (See Section S2 underneath Canada and the United States for further explanation).

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1. PLEXOS Help Files [↑](#footnote-ref-1)