Nord Stream 2 and its effects on European wholesale power prices

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1 BACKGROUND AND MOTIVATION

This study at hand is a sequel to the analysis "Impacts of Nord Stream 2 on the EU natural gas market" by ewi ER&S (2017). Whereas the latter study focused on gas prices, this study assesses the effects of Nord Stream 2 on wholesale electricity prices in the EU. The precedent analysis' key finding was that Nord Stream 2 causes European wholesale gas prices to decrease, since Nord Stream 2 will enhance the competition of LNG and Russian gas. LNG, which is most often the price setting source of gas, will have to compete with more Russian gas, which can be shipped to Northwest Europe at lower costs thanks to Nord Stream 2. Russian gas being available at lower costs will thus reduce the LNG import needs, thus LNG prices. Lower LNG prices will lead to lower wholesale gas prices in each EU member state, as price signals will be spread across the EU internal market, which will further improve thanks to new cross-border gas transport capacities and EU market rules being implemented. The study found that in 2020, Nord Stream 2 causes a price advantage for EU average wholesale gas prices between 1.6 to 4.9 EUR/MWh, depending on how tight the global LNG market is. Thus, gas consumers have to pay 7 to 24 bn EUR per year less when Nord Stream 2 is used.

Besides gas, electricity is an important cost component in the energy bill of EU end consumers. In the light of Europe's climate targets and decreasing coal-fired power generation, gas-fired power plants will become more and more the price-setting units in the wholesale market.[1] Thus, gas prices will increasingly drive power prices, as a lower/higher gas prices decreases/increases the marginal costs of gas-fired power stations, hence the shape and the height of the merit order. This is independent from any question around Nord Stream 2. However, as Nord Stream 2 will have a lowering impact on wholesale gas prices, it is likely that also power prices will be lower in a scenario where Nord Stream 2 pipeline system (NSP 2) is available compared to the contrary case – an effect, which this study wants to analyze.

[1] The merit order is a way of ranking power generation units based on an ascending order of their short-term marginal costs (y-axis) together with their capacity (x-axis). It is a usual and largely applied model to explain price formation in the power market: Price equals the marginal cost of the last power plant in the merit order that is needed to satisfy demand in a certain hour, thereby setting the price. Today, gas and hard coal fired-power plants are often the price-setting power plants. Hence a higher/lower gas price directly changes the marginal generation costs of a gas-fired power plant including the price-setting ones. Hence, the electricity price for *all volumes* produced is changed accordingly, which is the predominant effect of lower gas prices due to NSP2 on power prices.
There is a small additional effect when the lower gas price can result in a change of the merit order between some gas and some old coal fired power plant because gas fired power becomes marginally cheaper than the otherwise price setting coal fired power plant. This results in marginally more gas demand for power generation as gas replaces coal for some marginal plants. This effect is reflected by the DIMENSION model, but not in the TIGER model used in the original study. The original study made a simplifying assumption that gas demand for power generation would remain the same in the different scenarios, thus slightly underestimating the positive effects of NSP2 on the overall gas bill. When looking at the effects for the final customers, the cost savings of the power plants due to lower gas prices is netted out to avoid double counting as they are – inclusive of the volume effect – accounted for in the savings on the electricity bill of the customers.
The new study thus presents a more comprehensive and accurate overall picture of the benefit of Nord Stream 2 to European gas and electricity consumers.

2 METHODOLOGY AND ASSUMPTIONS

Thus, the study aims at quantifying the effects on power prices and end consumer costs for the years 2020, 2025 and 2030, thus the same years, for which gas prices have been derived in ewi ER&S (2017). The quantification will be model-based on ewi's European power market model DIMENSION. The analysis comprises four model runs, which are identical in every assumption and every parameter except for the assumed gas prices. The gas price parameter is crucial for the determination of power prices, as it is an important factor concerning the marginal costs of gas-fired power plants and their position in the merit order. 4 different parameter sets of wholesale gas prices are used and taken from ewi ER&S (2017): the "Low LNG demand" (Low) and the "High LNG demand" (High) scenario each with and without the use of Nord Stream 2. Comparing current forward prices (as of Sept 2018) from TTF, we observe that these are within the range of high and low scenario without NSP 2, indicating that scenarios "Low" and "High" span a reasonable range of gas prices.

Other important assumptions (which are identical among the scenario though) are: Other fuel prices are taken from IEA's World Energy Outlook 2017 CPS scenario.[2] EU electricity demand grows by an annual average of 0.4% per year. Climate targets and CO_2 price mechanisms are modelled according to the EU emission trading system (EU ETS) and its latest reforms.[3] Renewable energy targets are met. Country-specific coal phase-outs (e.g. France, Netherlands and further) are modelled, if a legally binding political decision has been made. Thus, a politically induced German coal phase-out, which is current debated, is not modelled.[4]

[2] We took the CPS scenario since current fuel prices rather reflect the CPS fuel prices than e.g. NPS fuel prices.
[3] Main elements of the reform include: Increase of the linear reduction factor of emission allowances to 2.2% per year, cancellation of certificates beyond the market stability reserve, optional cancelling of certificates by member state according to the amount of power-plant closures.
[4] A German coal phase-out would make gas-fired units becoming price-setting even more often. Hence gas prices would affect power prices even more. Thus the gas price decreasing effect of Nord Stream 2 would lead to even higher price reductions in the electricity market.

3 PRICE EFFECTS AND THE COST TO CONSUMERS

The power market modelling yields wholesale power prices for each of the four model runs. The effect of Nord Stream 2 on power prices is derived by comparing the power prices with and without usage of Nord Stream 2 for a) the “Low” scenario and b) the “High” scenario. The effect on electricity consumer expenses is derived by multiplying electricity demand and the price differences for each EU member state.

In order to derive the overall effect on energy costs for EU end consumers, hence expenses for gas and electricity, we have to adjust the expenses for gas derived in ewi ER&S (2017): In ewi ER&S (2017), gas-fired power plants were regarded as consumers. Thus, lower expenses for gas consumers caused by Nord Stream 2 included all final energy consumption (industry, commercial/residential buildings and transport) plus gas consumption by the power sector. However, for this analysis we have to avoid double-counting of cost savings from gas use in power generation: Cost savings for gas use by gas-fired plants lead to lower electricity prices. Hence, the cost advantage is only accounted for once, i.e. in the electricity market, however not in the gas market in this analysis. This is why the consumer welfare benefit concerning the gas market is lower in this analysis compared to ewi ER&S (2017).

4 MAIN FINDINGS

Scenario Low: Between 2020 and 2030, electricity wholesale prices are 2.2 to 4.3 EUR/MWh lower with Nord Stream 2, leading to significant savings for EU consumers of about 7 to 14 bn EUR per year in the power market alone (see Figure 1).

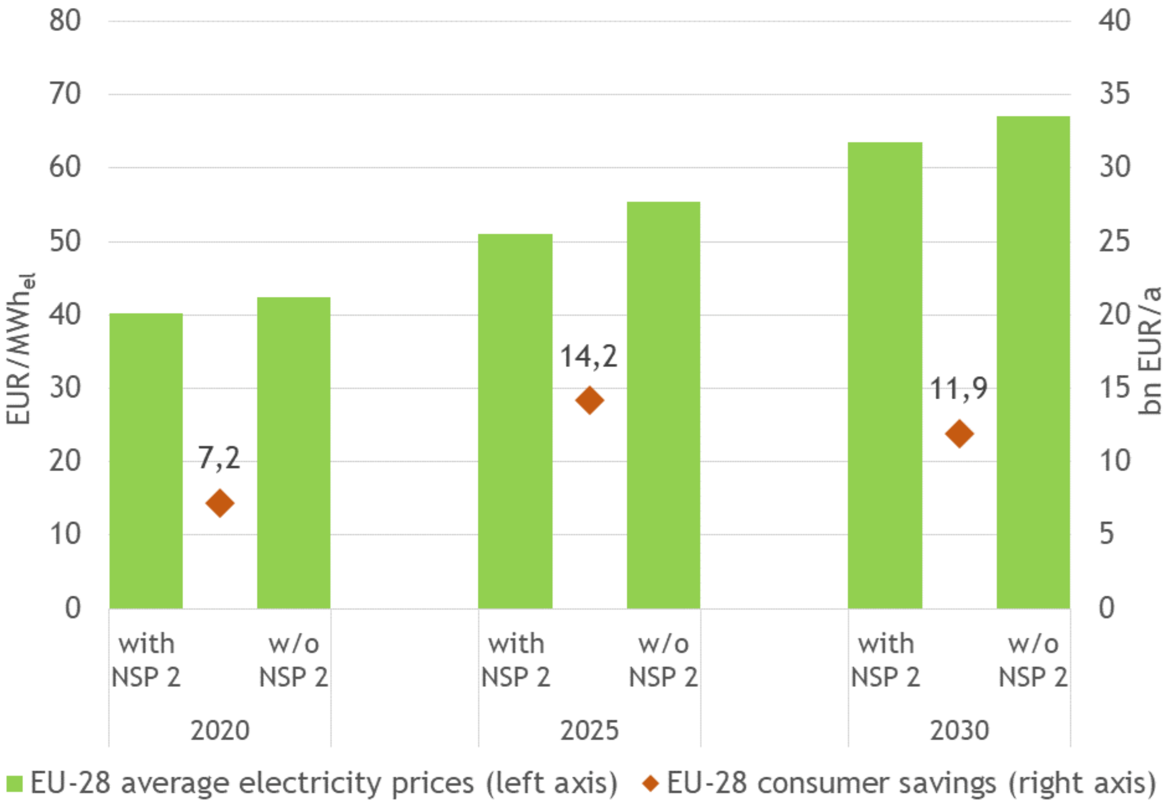

FIGURE 1: EU-28 AVERAGE ELECTRICITY PRICES WITH AND WITHOUT NORD STREAM 2 AND ANNUAL CONSUMER SAVINGS CAUSED BY NORD STREAM 2 (SCENARIO "LOW")

Source: ewi ER&S

Scenario High: The abovementioned effects are amplified in a scenario with tight global LNG markets. Electricity wholesale prices are 6.5 to 10.7 EUR/MWh lower with Nord Stream 2. EU electricity consumers benefit by 21 to 35 bn EUR per year (see Figure 2).

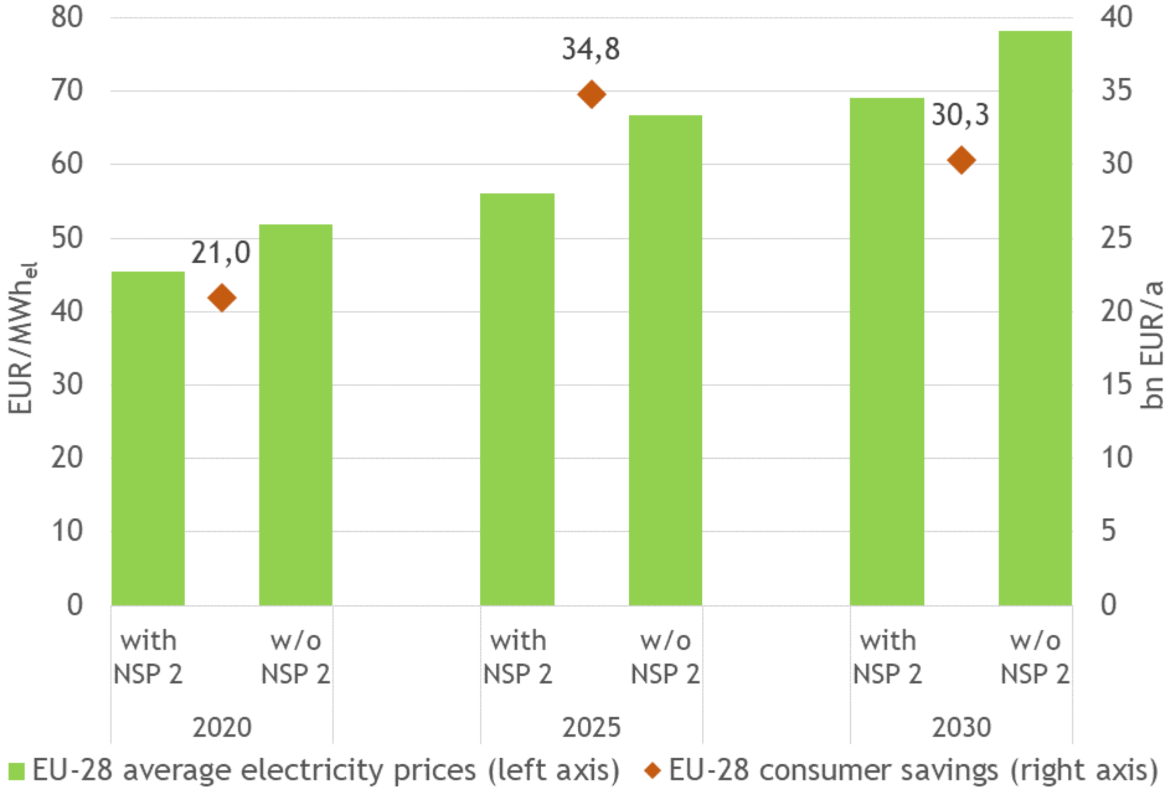

FIGURE 2: EU-28 AVERAGE ELECTRICITY PRICES WITH AND WITHOUT NORD STREAM 2 AND ANNUAL CONSUMER SAVINGS CAUSED BY NORD STREAM 2 (SCENARIO "HIGH")

Source: ewi ER&S

Lower gas and electricity prices due to NSP2 imply double digit billion EUR cost savings for EU-28 energy consumers. In total, hence for electricity and gas, EU consumers benefit by 13 to 23 bn EUR per year (scenario "Low") and 39 to 60 bn EUR per year (scenario "High") from Nord Stream 2 (see Figure 3).

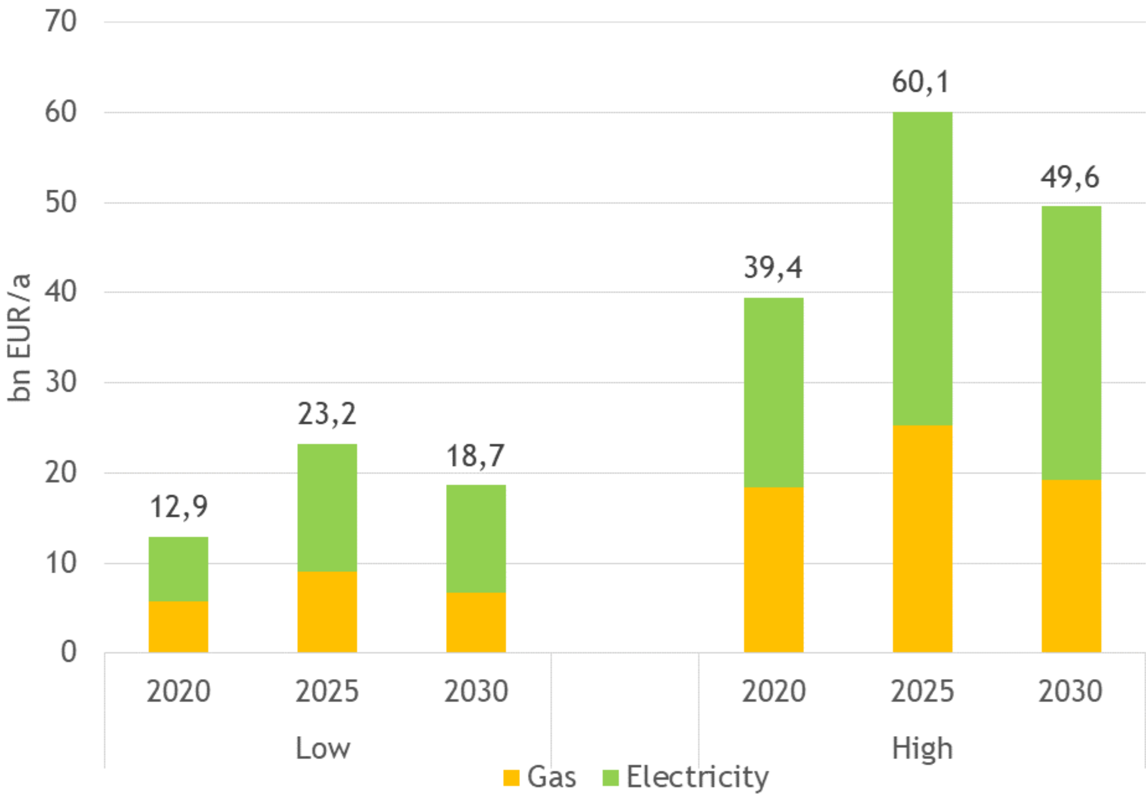

FIGURE 3: EU-28 ANNUAL CONSUMER SAVINGS (GAS AND POWER) CAUSED BY NORD STREAM 2

Source: ewi ER&S

Energy consumers in each member state benefit from lower electricity and gas prices and expenses. For example, three states with high gas demand and existing gas-fired capacity savings from lower electricity prices are:

- British electricity consumers benefit by 1.0 to 1.6 bn EUR ("Low") and 3.3 to 4.4 bn EUR ("High") respectively (see Figure 4).[5]
- German electricity consumers benefit by 1.0 to 2.4 bn EUR ("Low") and 2.6 to 5.3 bn EUR ("High") respectively (see Figure 5).
- Italian electricity consumers benefit by 1.0 to 1.4 bn EUR ("Low") and 3.0 to 4.1 bn EUR ("High") respectively (see Figure 6).

[5] Assuming an exchange rate of 1.12 EUR/GBP, this equals 0.9 to 1.5 bn GBP ("Low") and 2.9 to 3.9 bn GBP ("High") respectively. The electricity price difference in the UK ranges between 2.5 and 4.1 GBP/MWh ("Low") and between 8.2 and 10.8 GBP/MWh ("High").

FIGURE 4: UK ANNUAL CONSUMER SAVINGS FOR ELECTRICITY CAUSED BY NORD STREAM 2

(LEFT: SCENARIO "LOW", RIGHT: SCENARIO "HIGH")

Source: ewi ER&S

FIGURE 5: DE ANNUAL CONSUMER SAVINGS FOR ELECTRICITY CAUSED BY NORD STREAM 2

(LEFT: SCENARIO "LOW", RIGHT: SCENARIO "HIGH")

Source: ewi ER&S

FIGURE 6: IT ANNUAL CONSUMER SAVINGS FOR ELECTRICITY CAUSED BY NORD STREAM 2

(LEFT: SCENARIO "LOW", RIGHT: SCENARIO "HIGH")

Source: ewi ER&S

The chemical industry is the industry sector, which benefits most from energy cost savings in a scenario with Nord Stream 2.[6] Between 2020 and 2030, it benefits by an annual 1.0 to 1.7 bn EUR savings for gas and power due to Nord Stream 2 in a scenario when LNG markets are relaxed ("Low"). Annual savings increase to 2.9 to 4.4 bn EUR in a scenario with tight LNG markets ("High"). Other energy intensive industry sectors such as iron and steel or non-ferrous metals similarly benefit in the range of 3 to 4-digit million EUR amount per year (see Figure 7).

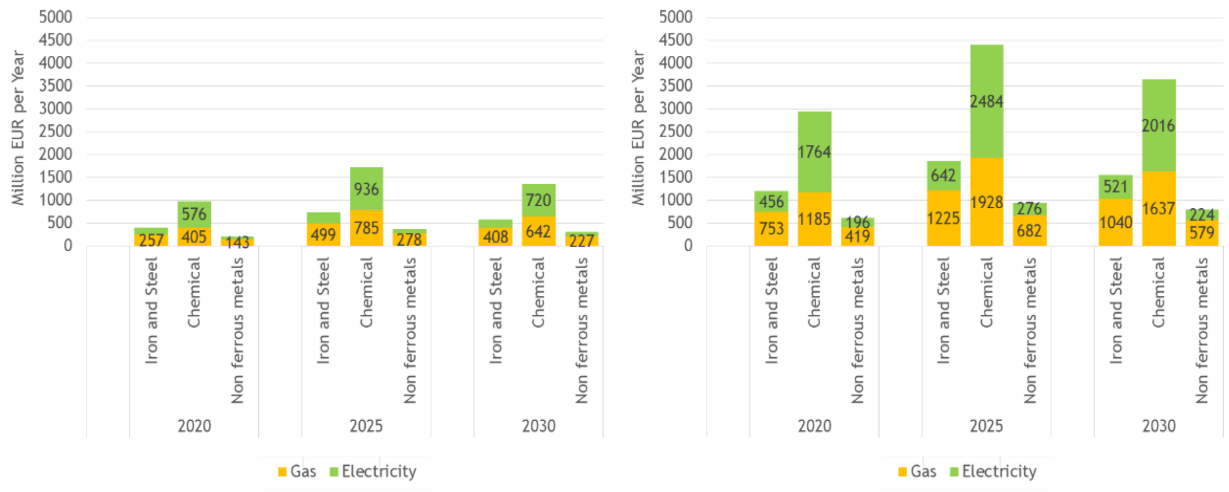

FIGURE 7: ENERGY COST SAVINGS (GAS AND POWER) FOR EXEMPLARY INDUSTRY BRANCHES CAUSED BY NORD STREAM 2

Source: ewi ER&S

[6] The chemical industry consumes 32 bcm, including feedstock gas. This equals ca. 31% of industrial gas consumption. Source: Eurostat (2018)

ANNEX: THE DIMENSION MODEL BY EWI ER&S IN DETAIL

DIMENSION is a cost optimization model for the European power markets. The model simulates the future development of power plants and storages. In this respect, the model performs a cost-minimizing dispatch as well as capacity addition and reduction of various technologies. The capacity extension of renewable energy sources is considered in a cost-minimizing fashion with respect to the surrounding political framework. The EU ETS is considered in the model as this mechanism drives the investment decision for capacity additions significantly in the next years.

The years to be simulated and the temporal resolution can be freely specified. Currently, DIMENSION covers 28 countries (see Figure 8). The individual power plants and storages of these countries are stored in the regularly updated ewi ER&S databank.

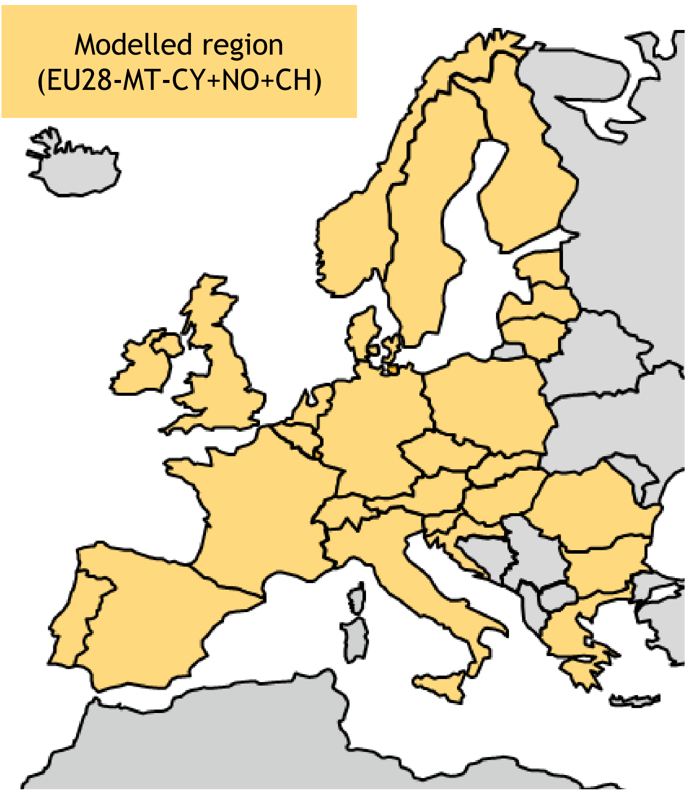

FIGURE 8: MODELLED REGIONS IN DIMENSION+

Source: own illustration

The model DIMENSION forecasts the future development of power plants as well as storage capacities, combined heat and power as well as power-to-gas and power-to-fuel technologies. The investment decisions and generation profiles for a wide range of energy providers are optimized endogenously. These include:

- conventional plants
- combined heat and power (CHP)

- nuclear
- onshore and offshore wind turbines
- roof and base photovoltaic (PV) systems
- biomass (CHP-) power plants (solid and gas)
- hydro power plants
- geothermal power plants
- concentrating solar power (CSP) plants (including thermal energy storage devices)
- storage technologies (pump, hydro and compressed air energy (CAES))
- power-to-gas/fuel technologies such as electrolysis, methanisation and Fischer-Tropsch systems.

Technological improvements in, e.g., efficiency are taken into account using vintage classes. These are then included in the model as an additional technology option that is only available at a certain point in time onwards. Renewable sources of energy are modelled in a great variety in terms of regional and temporal resolution.

There are various modules in addition to the core DIMENSION model explained above: e.g. for Demand Side Management (DSM) and combined heat and power (CHP).

LIST OF ABBREVIATIONS

CAES	Compressed Air Energy Storage
CHP	Combined Heat and Power
CPS	Current Policies Scenario
CSP	Concentrating Solar Power
DSM	Demand Side Management
EU	European Union
EU ETS	European Union Emissions Trading System
LNG	Liquefied Natural Gas
NPS	New Policies Scenario
NSP 2	Nord Stream 2 pipeline system
PV	Photovoltaic

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