Appendix A

Scenario trajectories and CO_2 emissions in the World Energy Outlook, 2000-2050

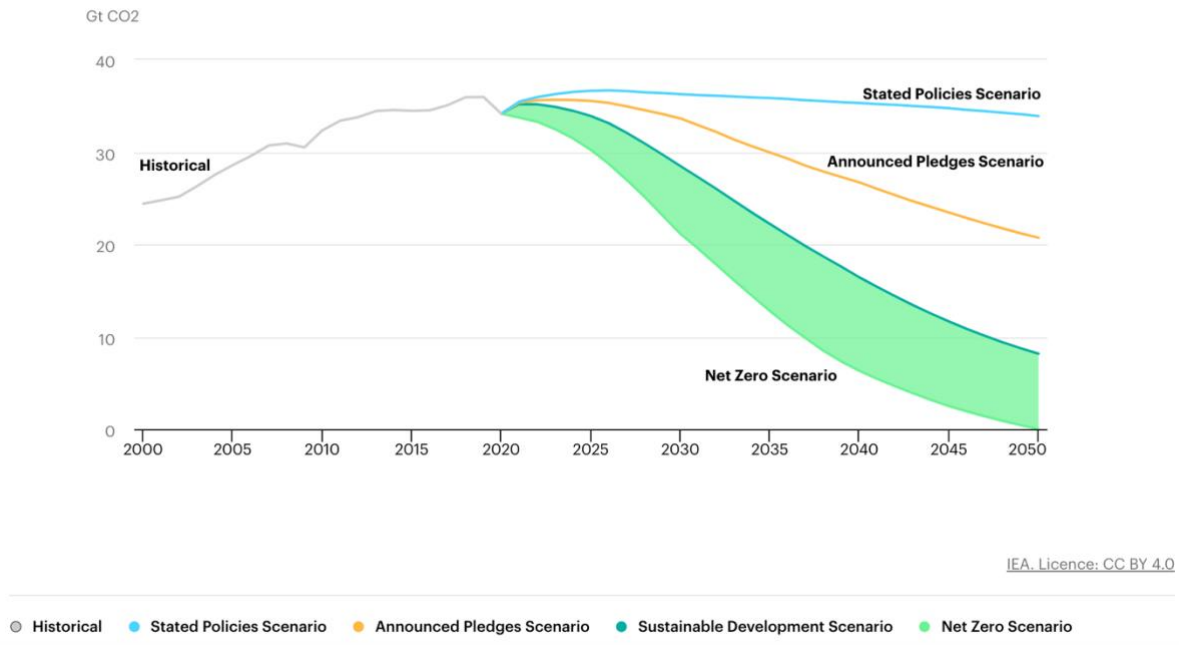

Figure 22: CO_2 emissions in the World Energy Outlook, 2000-2050 (IEA, n.d.-d.)

Appendix B

The EU’s diversification away from Russian gas, 2019-2022

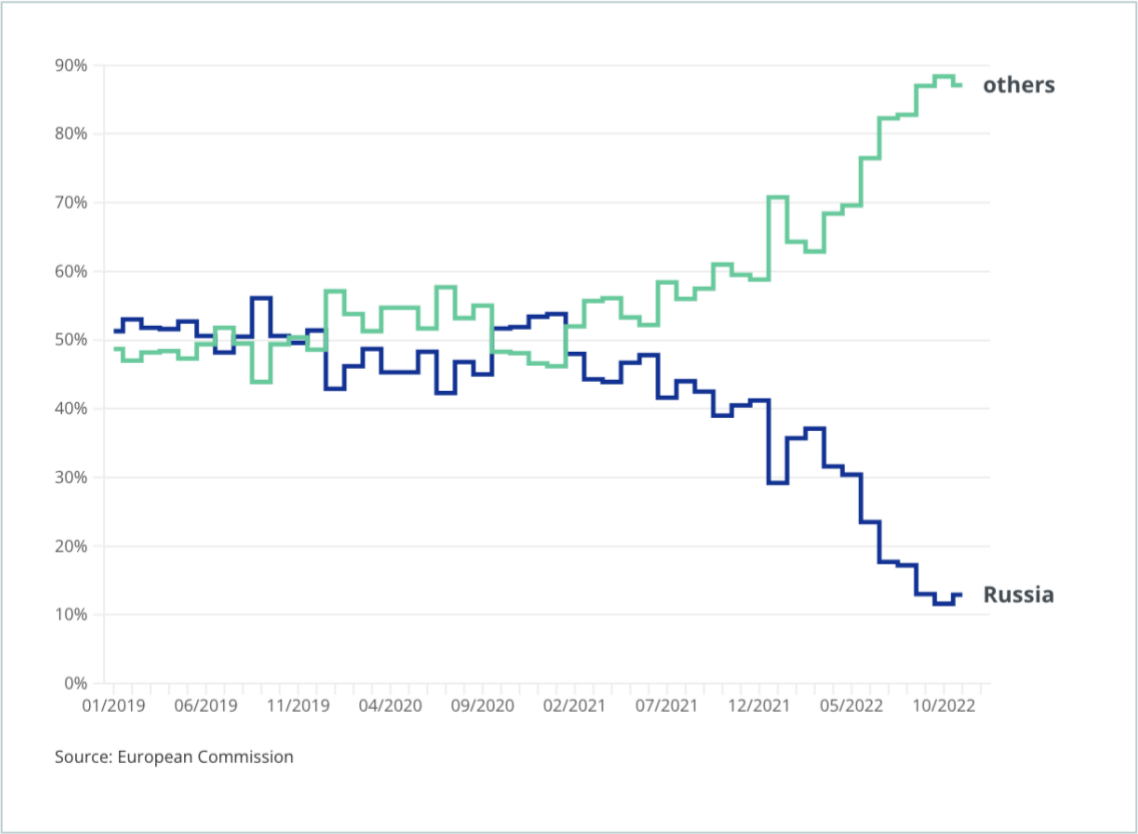

Figure 23: The European Union's diversification away from Russian gas, 2019-2022 (European Commission, 2023d)

The chart shows the monthly share of gas delivered to the EU by Russia compared with other countries between January 2019 and November 2022. From January 2019 to the second half of 2021, Russia maintained a dominant position in the EU gas market, with its share hovering around 50%. However, a notable shift occurred thereafter, leading to a rapid decline in Russia's gas share and the emergence of other suppliers. This trend accelerated throughout 2022 (European Commission, 2023d).

By June 2022, Russia's share of EU gas imports dropped below 20%, and by November of the same year, it reached a mere 12.9%. During the period spanning January to November 2022, Russia, inclusive of pipeline gas and LNG imports, accounted for less than a quarter of the EU's gas imports. Approximately an equal proportion originated from Norway, while Algeria contributed 11.6%. Additionally, LNG imports, excluding Russia, primarily sourced from the United States, Qatar, and Nigeria, represented 25.7% of the EU's gas imports (European Commission, 2023d).

Appendix C

REPowerEU in comparison to EU energy law

Table 3: REPowerEU in comparison to EU energy law (Arthur Cox, 2022).

	Current law under the Clean Energy Package	**FF55 Proposals**	**REPowerEU Proposals**
2030 Renewable Electricity Target (% of gross final energy consumption being met by RE sources)	At least 32%	At least 40%	At least 45%
2030 Energy Efficiency Target (Reduction in energy consumption)	At least 23.5% reduction in both primary and final energy consumption relative to the 2007 Reference Scenario	At least 39% and 36% reduction for primary and final energy consumption respectively relative to the 2007 Reference Scenario*	At least 41.5% and 39% reduction for primary and final energy consumption respectively relative the 2007 Reference Scenario**

**Equivalent to* at least 9% reduction in energy consumption compared to the new 2020 Reference Scenario.

***Equivalent to* at least 13% reduction in energy consumption compared to the 2020 Reference Scenario.

Appendix D

Cost estimates for green hydrogen in 2030, 2040 and 2050

There are various studies that estimate the cost of green hydrogen, and to create our estimates table in chapter 5.2.2, we have used different sources in order to give the most precise depiction.

The estimate for 2030 is based on IEA's (2022y) report "Global Hydrogen Review 2022" and presents a cost raging from 1.18 to 4.08 EUR/kg. This gives an average of 2.63 EUR/kg for green hydrogen.

There are fewer studies providing cost estimates for 2040, but a study by Wood Mackenzie (n.d.) conducted in 2020 expects cost of green hydrogen to drop by up to 64% compared to 2020 prices. We have used two sources to give a price estimate for 2020, which is IEA (2021c) estimating a range from 3.10 to 6.65 EUR/kg and the European Commission (2020a) estimating a range from 2.50 to 5.50 EUR/kg. Taking an average of the 2020 estimated and deducting the 64% reduction in cost, the estimated cost for 2040 is 1.15 EUR/kg.

The estimate for 2050 is by two studies we have found, projected to be below 0.89 EUR/kg (IEA, 2022c; Bloomberg NEF, 2020) in locations where there is potential for RE sources. To be conservative, we have used a cost estimate equal to 0.89 EUR/kg for this time frame.

Appendix E

Investment by 2030 for reaching the REPowerEU objectives

Table 4: Investment by 2030 for reaching the REPowerEU objectives (European Commission, 2022d)

Investment areas	**REPowerEU**	**FF55**	**Difference**
Installed wind capacity (GW)	510	469	41
Installed solar PV capacity (GW)	592	530	62
Net imports of hydrogen (Mt)	6.16	0.05	6.11

Appendix F

Summary of renewable energy benchmarks in REPowerEU plans and main and accelerated cases from the IEA

Table 5: Summary of renewable energy benchmarks in REPowerEU plans and main / accelerated cases from the IEA (IEA, 2022d)

Segment	REPowerEU benchmarks, 2030*	Main case/ accelerated case benchmarks, 2027*
Electricity**	69%	54% / n/a
Solar capacity (GW)	592	396 / 471
Wind capacity (GW)	510	291 /316
Transport***	32%	16% / 20%
Heating and cooling		
Share of renewable energy in heating and cooling	2.3-percentage-point average annual increase to 2030	0.9-percentage-point average annual increase to 2030****
Share of renewable energy in industry	1.9-percentage-point average annual increase to 2030	0.9-percentage-point average annual increase to 2030 ****
Share of renewable energy in buildings sector final energy consumption	60%	32%****

* REPowerEU targets 45% renewable energy share, in combination with numerous other objectives and commitments. EC modelled the package to determine renewable energy shares likely necessary in electricity, transport and heating

** Electricity and transport shares are not REPowerEU targets, but estimates of shares needed to achieve goals in REPowerEU

*** Including RED II multipliers

**** Excluding ambient heat harnessed by heat pumps

Appendix G

Expanded representation of the Norwegian power market system with focus on NO5, Bergen

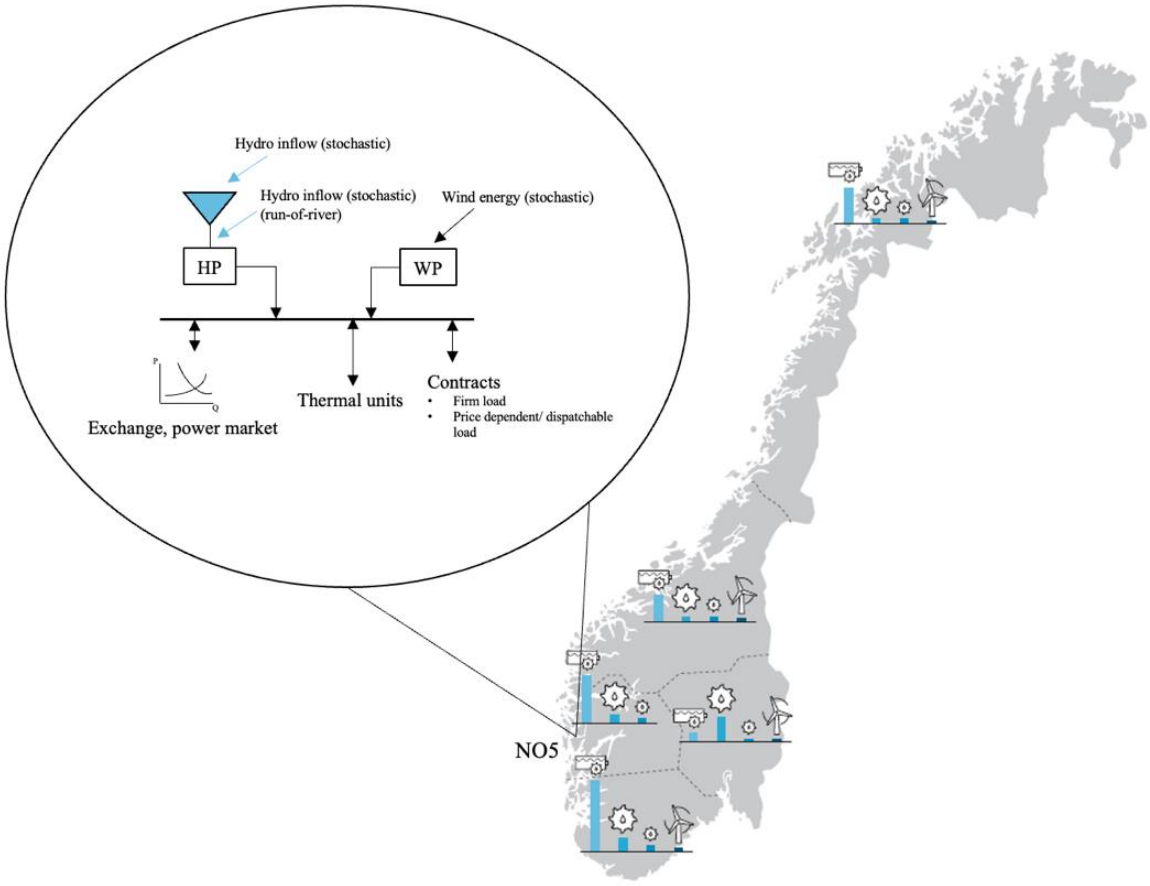

Figure 24: Expanded representation of the Norwegian power market systems with focus on the NO5 area, Bergen (Norwegian Ministry of Petroleum and Energy, n.d.; Vogstad, 2000)