

# TABLE OF CONTENTS

## PART A: OVERVIEW AND INTRODUCTION

Overview and key findings	27
An energy world in lockdown	59

## PART B: SCENARIOS

### SUSTAINABLE RECOVERY

Building on a sustainable recovery	87
Achieving net-zero emissions by 2050	123

### AN UNCERTAIN RETURN

Outlook for energy demand	163
Outlook for electricity	213
Outlook for fuel supply	253

### A LONGER PANDEMIC

A delayed recovery	295
--------------------	-----

## ANNEXES

Foreword	3
Acknowledgements	5
Executive summary	17

## Part A: Overview and Introduction **25**

### **1** Overview and key findings **27**

Introduction	29
--------------	----

Impacts of Covid-19 on the energy outlook	30
---	----

1.1 The pandemic is far from over and many uncertainties remain	30
1.2 Today's policy settings do not produce a decisive break in the outlook for CO <sub>2</sub> emissions, but a more sustainable recovery is possible	32
1.3 Renewables are taking power and solar is the new king	34
1.4 Modern societies are becoming ever more reliant on electricity, but weak grids could prove to be an Achilles heel	36
1.5 The pandemic could trigger lasting changes in consumer behaviour, but these would not transform the oil market on their own	37
1.6 Lower fuel prices are a mixed blessing for energy security and sustainability	38
1.7 This is a crisis that penalises the most vulnerable	40
1.8 Covid-19 sharpens the dilemmas facing the oil and gas industry	42

Prospects for clean energy transitions	43
--	----

1.9 Enhanced clean energy policies and investments can make 2019 the peak year for energy-related emissions	44
1.10 Today's energy infrastructure, if operated as per past practices, would lock in a temperature rise of 1.65 °C	45
1.11 Within ten years, in the SDS, the drop in air pollutants would produce significantly cleaner air than experienced during the 2020 lockdowns	46
1.12 Gases – of different sorts – are pivotal to different stages of energy transitions, but are still in search of clear roles and business models	47
1.13 Transitions depend on government actions, but more than 70% of related investments could come from private actors	51
1.14 Net-zero pledges for 2050 and earlier are already essential to the SDS; achieving global net-zero by 2050 would require a dramatic extra push	53
1.15 Behavioural changes are essential to achieve the scale and speed of emissions reductions required in the NZE2050	55
1.16 If energy transitions are not secure, then they will not be rapid either	56

<b>2</b>	<b>An energy world in lockdown</b>	<b>59</b>
2.1	Overview	61
2.2	Energy and Covid-19 pandemic	61
2.2.1	Impacts by fuel and technology	66
2.3	Which way from here?	72
2.3.1	New questions and uncertainties	72
2.3.2	Designing the scenarios	76
	<b>Part B: Scenarios – Sustainable recovery</b>	<b>85</b>
<b>3</b>	<b>Building on a sustainable recovery</b>	<b>87</b>
3.1	Introduction	89
3.1.1	How has Covid-19 affected the Sustainable Development Scenario?	89
3.2	Energy access	91
3.2.1	Impacts of the pandemic	92
3.2.2	A pathway to universal energy access by 2030	96
3.3	Air pollution	98
3.3.1	Impacts of the pandemic	98
3.3.2	A pathway to cleaner air by 2030	99
3.4	Greenhouse gas emissions	101
3.4.1	Impacts of the pandemic	101
3.4.2	CO <sub>2</sub> emissions from existing energy infrastructure	102
3.4.3	Energy sector transformation to 2030	104
3.4.4	Investment and finance	115
3.4.5	Trends after 2030	121
<b>4</b>	<b>Achieving net-zero emissions by 2050</b>	<b>123</b>
4.1	Introduction	125
4.2	A pathway towards global net-zero emissions in 2050	126
4.2.1	Primary energy demand and total final consumption	127
4.2.2	Electricity supply	132
4.2.3	Industry	136
4.2.4	Transport	138
4.2.5	Buildings	139
4.3	Role of behaviour changes in the NZE2050	142
4.3.1	CO <sub>2</sub> emissions savings from behaviour changes in the NZE2050	143
4.3.2	Further details on behaviour changes	146

4.4	Lessons from countries with zero emissions targets	152
4.4.1	Net-zero emissions in the European Union in the SDS	156
4.4.2	Lessons for policy makers and industry	159
4.5	Conclusions	160

## Part B: Scenarios – An uncertain return 163

### 5 Outlook for energy demand 163

5.1	Overview	165
5.1.1	Uneven rebound to 2030	165
5.1.2	Beyond 2030	173
5.2	Oil	177
5.2.1	Overview of oil demand trends	177
5.2.2	Oil demand by sector	180
5.3	Natural gas	187
5.3.1	Overview of natural gas demand trends	187
5.4	Coal	195
5.4.1	Overview of coal demand trends	195
5.5	Nuclear	199
5.6	Renewables	199
5.6.1	Renewables demand by sector	202
5.7	Energy efficiency	206
5.7.1	Energy efficiency by sector	208

### 6 Outlook for electricity 213

6.1	Introduction	215
6.2	Outlook for electricity demand	216
6.2.1	Overview	216
6.2.2	Electricity demand by sector	217
6.2.3	Electricity demand by region	219
6.3	Outlook for electricity supply	222
6.3.1	Overview	222
6.3.2	Renewables	227
6.3.3	Coal-fired power	229
6.3.4	Natural gas-fired power	232
6.3.5	Nuclear power	232
6.3.6	Focus on financing costs for utility-scale solar PV	234
6.4	Outlook for flexibility	241
6.4.1	Electricity networks	242

6.4.2	Energy storage	246
6.4.3	Demand-side response	248
6.5	Implications for sustainability	249
6.5.1	CO <sub>2</sub> and pollutant emissions	249
6.5.2	Electricity access	250

## 7

### Outlook for fuel supply **253**

7.1	Introduction	255
7.2	Oil supply	258
7.2.1	Upstream	258
7.2.2	Refining	267
7.3	Natural gas supply	270
7.4	Coal supply	279
7.5	Other fuels	285
7.5.1	Modern use of solid biomass	285
7.5.2	Liquid biofuels	286
7.5.3	Biogas and biomethane	287
7.5.4	Nuclear fuels	289
7.5.5	Low-carbon hydrogen	289

## Part B: Scenarios – A longer pandemic **295**

## 8

### A delayed recovery **295**

8.1	Introduction	297
8.1.1	A delayed recovery to 2030	299
8.1.2	Longer term outlook	300
8.2	Impacts of a Delayed Recovery Scenario	302
8.2.1	Oil	302
8.2.2	Electricity	305
8.2.3	Natural gas	311
8.2.4	Coal	313
8.2.5	Renewables	315
8.2.6	Nuclear	316
8.2.7	Efficiency	317
8.3	Implications of a Delayed Recovery Scenario	318
8.3.1	Energy security	318
8.3.2	Emissions	321
8.3.3	Inequality and energy access	323
8.3.4	Investment	324
8.3.5	Innovation	328

## **Annexes**

**331**

Annex A. Tables for scenario projections	333
Annex B. Design of the scenarios	415
Annex C. Definitions	429
Annex D. References	443
Annex E. Inputs to the World Energy Model	457