Supplementary Information

Robust climate tests for fossil fuel supply under the Paris Agreement

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Draft: April 26, 2026

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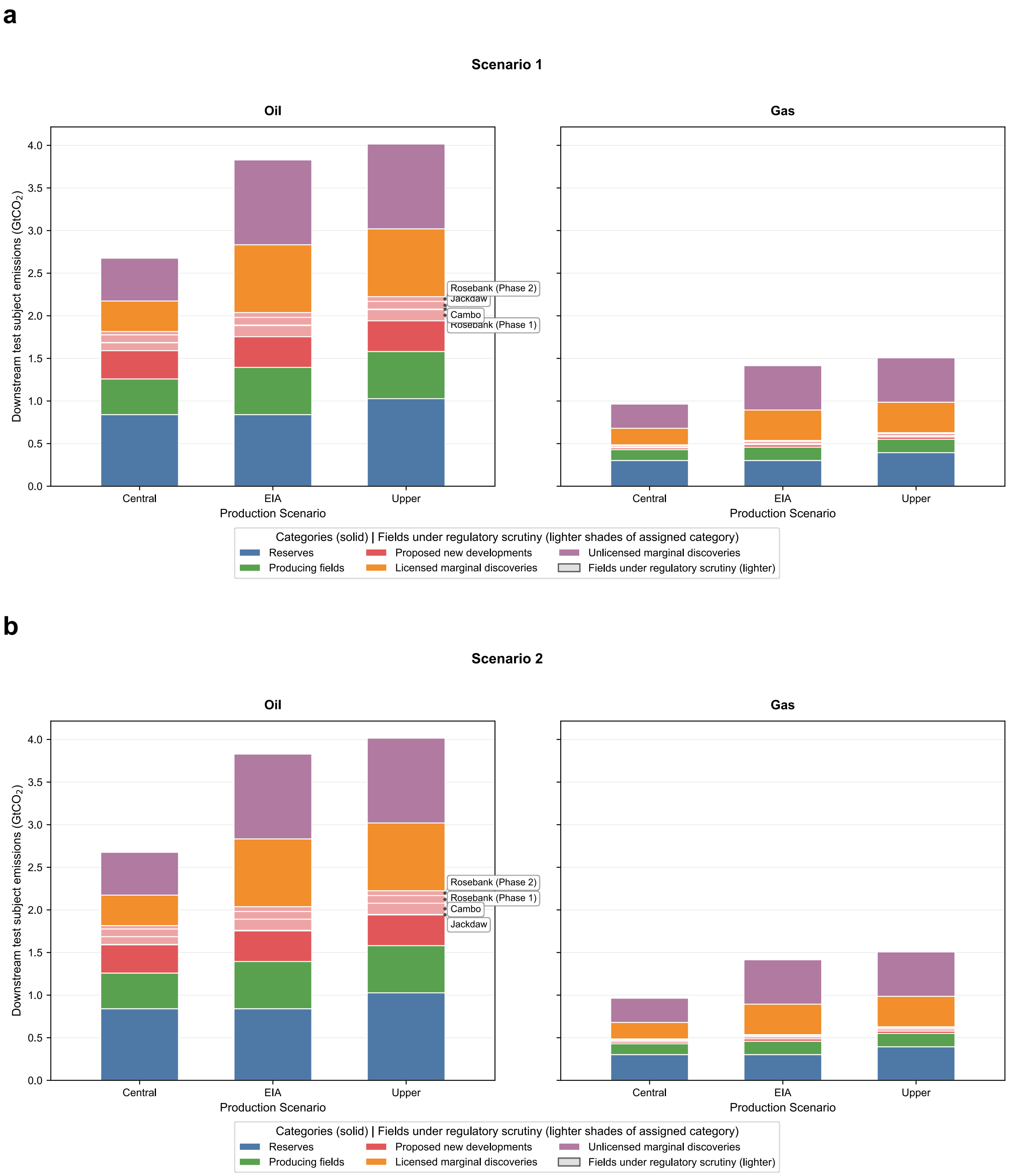
Supplementary Results

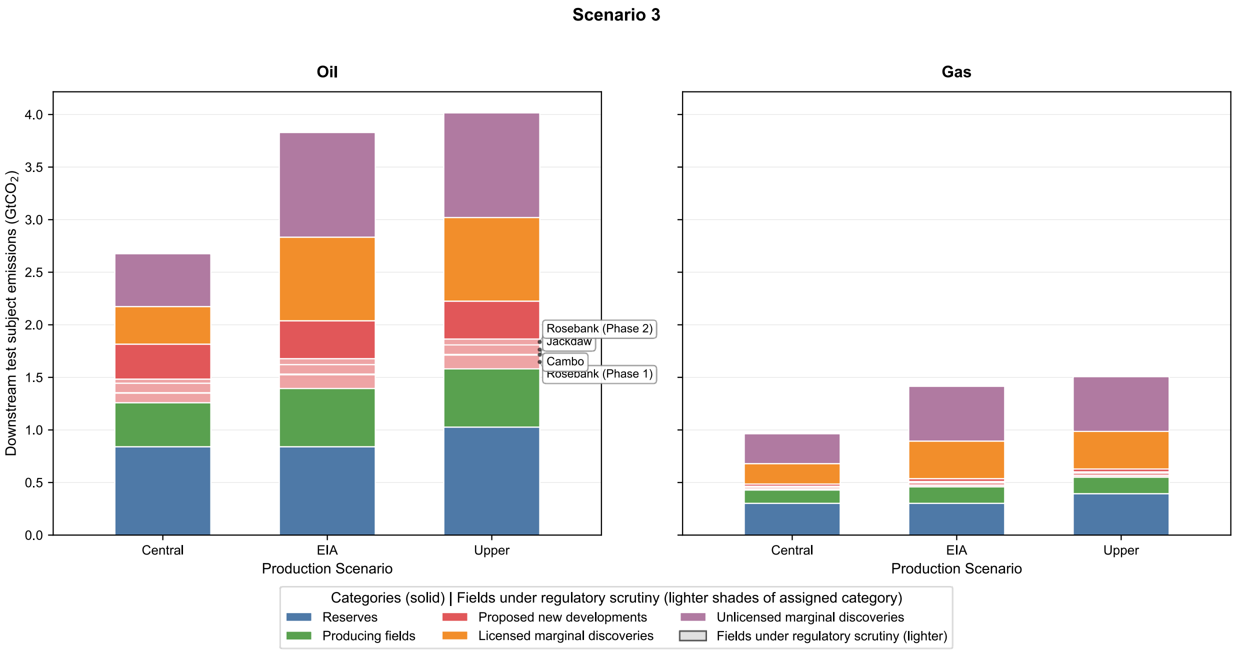
Table S1 | Alternative stacking orders for test subjects

	Ordering scenario							
#	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1	Reserves	Reserves	Reserves	Reserves	Reserves exc. fields under regulatory scrutiny	Reserves exc. fields under regulatory scrutiny	Reserves exc. fields under regulatory scrutiny	Reserves exc. fields under regulatory scrutiny
2	Contingent resources in producing fields	Contingent resources in producing fields	Contingent resources in producing fields	Contingent resources in producing fields	Rosebank (Phase 1)	Jackdaw	Rosebank (Phase 1)	Jackdaw
3	Contingent resources in proposed new developments	Contingent resources in proposed new developments	Rosebank (Phase 1)	Jackdaw	Jackdaw	Rosebank (Phase 1)	Jackdaw	Rosebank (Phase 1)
4	Rosebank (Phase 1)	Jackdaw	Cambo	Cambo	Contingent resources in producing fields	Contingent resources in producing fields	Contingent resources in producing fields	Contingent resources in producing fields
5	Cambo	Cambo	Jackdaw	Rosebank (Phase 1)	Contingent resources in proposed new developments	Contingent resources in proposed new developments	Cambo	Rosebank (Phase 2)
6	Jackdaw	Rosebank (Phase 1)	Rosebank (Phase 2)	Rosebank (Phase 2)	Cambo	Cambo	Rosebank (Phase 2)	Cambo
7	Rosebank (Phase 2)	Rosebank (Phase 2)	Contingent resources in proposed new developments	Contingent resources in proposed new developments	Rosebank (Phase 2)	Rosebank (Phase 2)	Remaining contingent resources in proposed new developments	Remaining contingent resources in proposed new developments
8	Marginal discoveries (lic.)	Marginal discoveries (lic.)	Marginal discoveries (lic.)	Marginal discoveries (lic.)	Marginal discoveries (lic.)	Marginal discoveries (lic.)	Marginal discoveries (lic.)	Marginal discoveries (lic.)
9	Marginal discoveries (unlic.)	Marginal discoveries (unlic.)	Marginal discoveries (unlic.)	Marginal discoveries (unlic.)	Marginal discoveries (unlic.)	Marginal discoveries (unlic.)	Marginal discoveries (unlic.)	Marginal discoveries (unlic.)

Test subjects are stacked cumulatively (octothorpe-labeled column on leftmost side). Main results use Scenario 7. Marginal discoveries (lic.) =Contingent resources in marginal discoveries (licensed); Marginal discoveries (unlic.) = Contingent resources in marginal discoveries (unlicensed). Fields under regulatory scrutiny are classified as “Contingent resources in proposed new developments” in stacking scenarios 1–4 and as “Reserves” in scenarios 5–8.


a
Scenario 1
Oil
Gas
Downstream test subject emissions (GtCO$_2$)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
Central
EIA
Upper
Production Scenario
Rosebank (Phase 2)
Jackdaw
Cambo
Rosebank (Phase 1)
Categories (solid) | Fields under regulatory scrutiny (lighter shades of assigned category)
Reserves
Producing fields
Proposed new developments
Licensed marginal discoveries
Unlicensed marginal discoveries
Fields under regulatory scrutiny (lighter)
b
Scenario 2
Oil
Gas
Downstream test subject emissions (GtCO$_2$)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
Central
EIA
Upper
Production Scenario
Rosebank (Phase 2)
Rosebank (Phase 1)
Cambo
Jackdaw
Categories (solid) | Fields under regulatory scrutiny (lighter shades of assigned category)
Reserves
Producing fields
Proposed new developments
Licensed marginal discoveries
Unlicensed marginal discoveries
Fields under regulatory scrutiny (lighter)

c


Scenario 3
Oil
Gas
Downstream test subject emissions (GtCO₂)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
Rosebank (Phase 2)
Jackdaw
Cambo
Rosebank (Phase 1)
Central
EIA
Upper
Production Scenario
Central
EIA
Upper
Production Scenario
Categories (solid) | Fields under regulatory scrutiny (lighter shades of assigned category)
Reserves
Producing fields
Proposed new developments
Licensed marginal discoveries
Unlicensed marginal discoveries
Fields under regulatory scrutiny (lighter)

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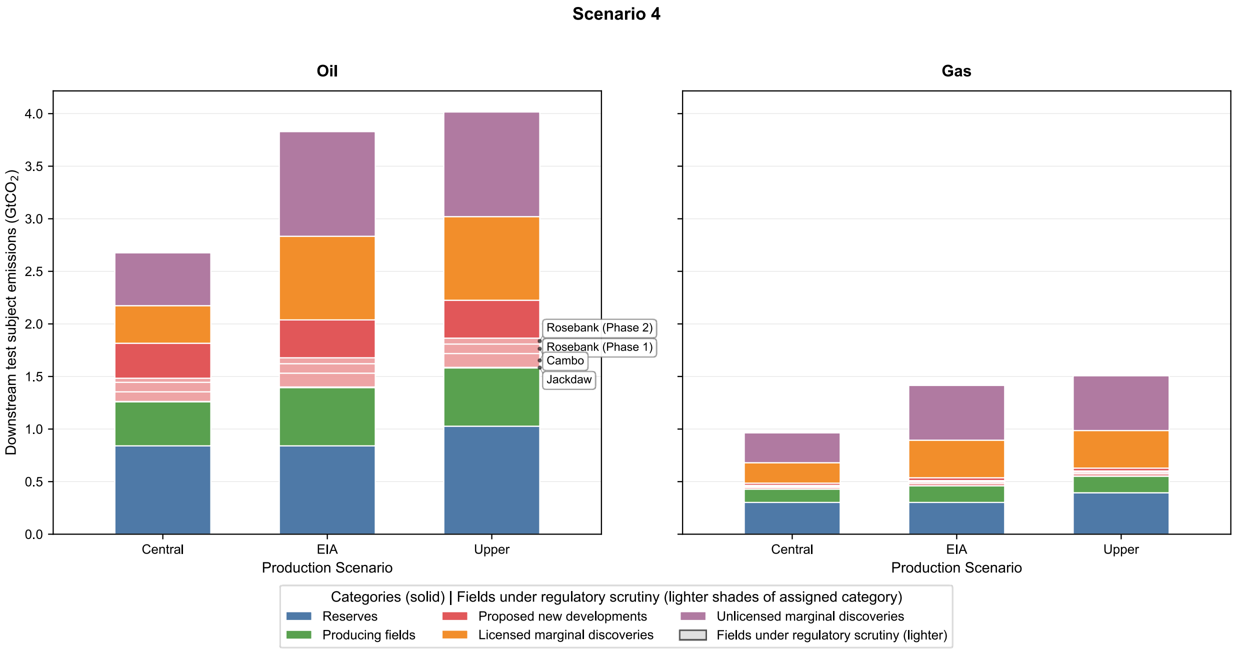
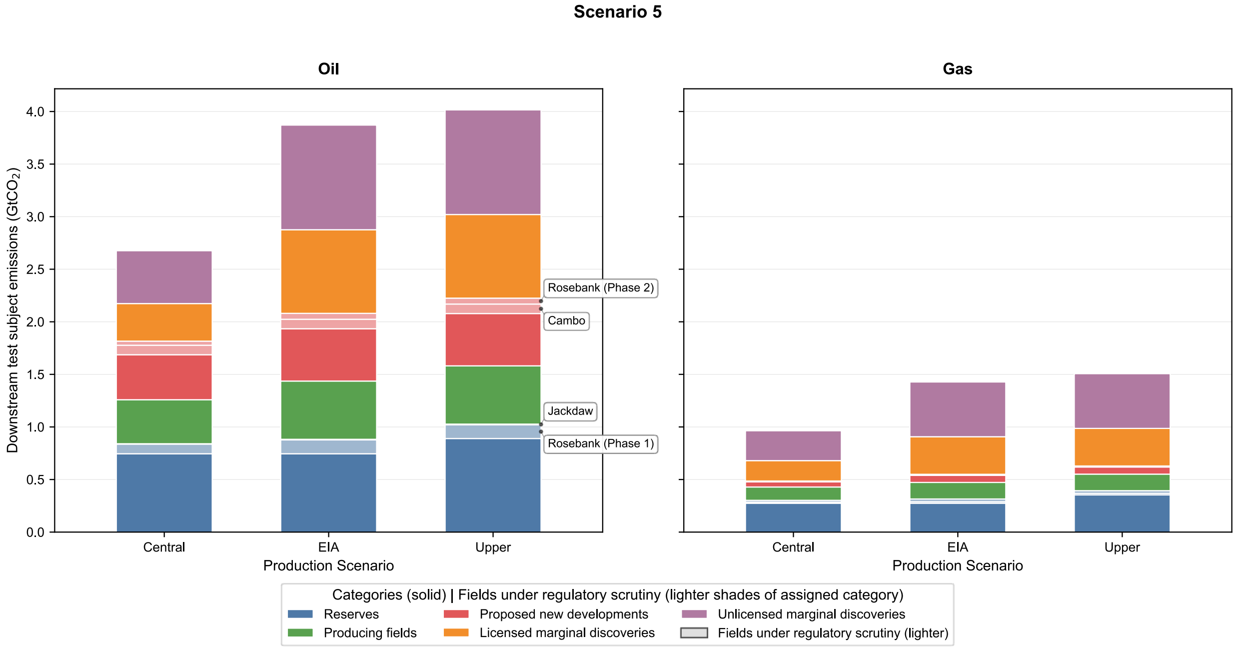
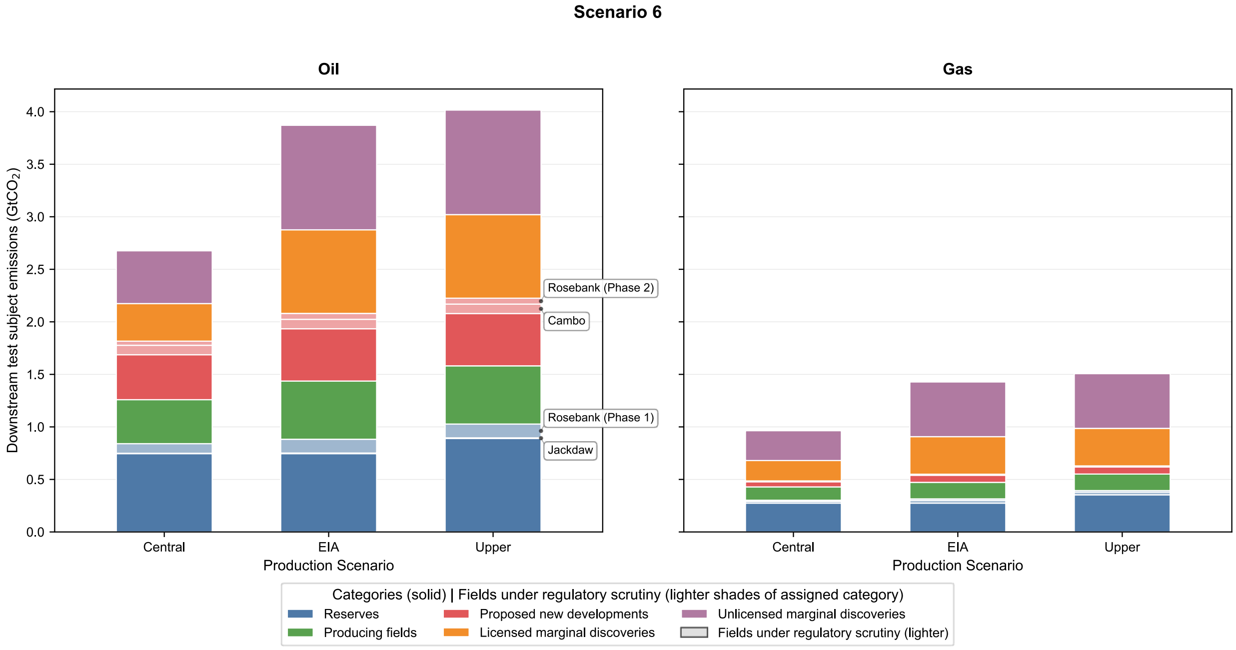
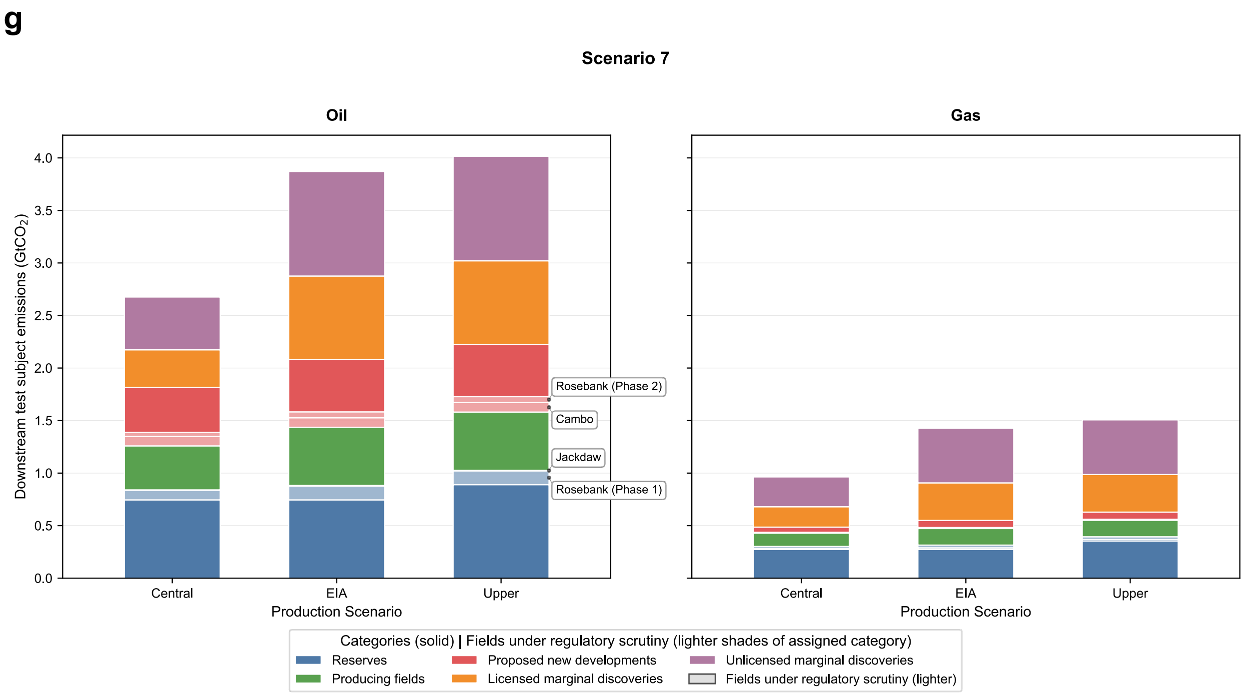

Scenario 4
Oil
Gas
Downstream test subject emissions (GtCO₂)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
Rosebank (Phase 2)
Rosebank (Phase 1)
Cambo
Jackdaw
Central
EIA
Upper
Production Scenario
Central
EIA
Upper
Production Scenario
Categories (solid) | Fields under regulatory scrutiny (lighter shades of assigned category)
Reserves
Producing fields
Proposed new developments
Licensed marginal discoveries
Unlicensed marginal discoveries
Fields under regulatory scrutiny (lighter)

e


Scenario 5
Oil
Gas
Downstream test subject emissions (GtCO$_2$)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
Rosebank (Phase 2)
Cambo
Jackdaw
Rosebank (Phase 1)
Central
EIA
Upper
Production Scenario
Categories (solid) | Fields under regulatory scrutiny (lighter shades of assigned category)
Reserves
Producing fields
Proposed new developments
Licensed marginal discoveries
Unlicensed marginal discoveries
Fields under regulatory scrutiny (lighter)

f


Scenario 6
Oil
Gas
Downstream test subject emissions (GtCO$_2$)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
Rosebank (Phase 2)
Cambo
Rosebank (Phase 1)
Jackdaw
Central
EIA
Upper
Production Scenario
Categories (solid) | Fields under regulatory scrutiny (lighter shades of assigned category)
Reserves
Producing fields
Proposed new developments
Licensed marginal discoveries
Unlicensed marginal discoveries
Fields under regulatory scrutiny (lighter)



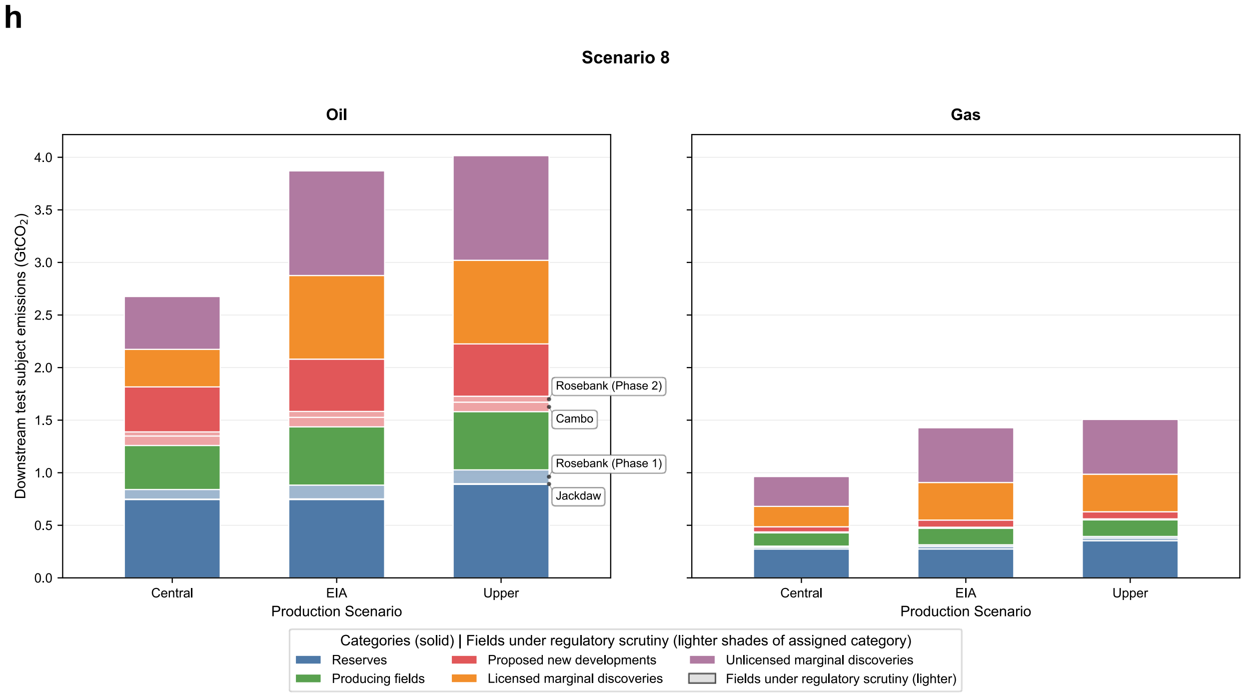
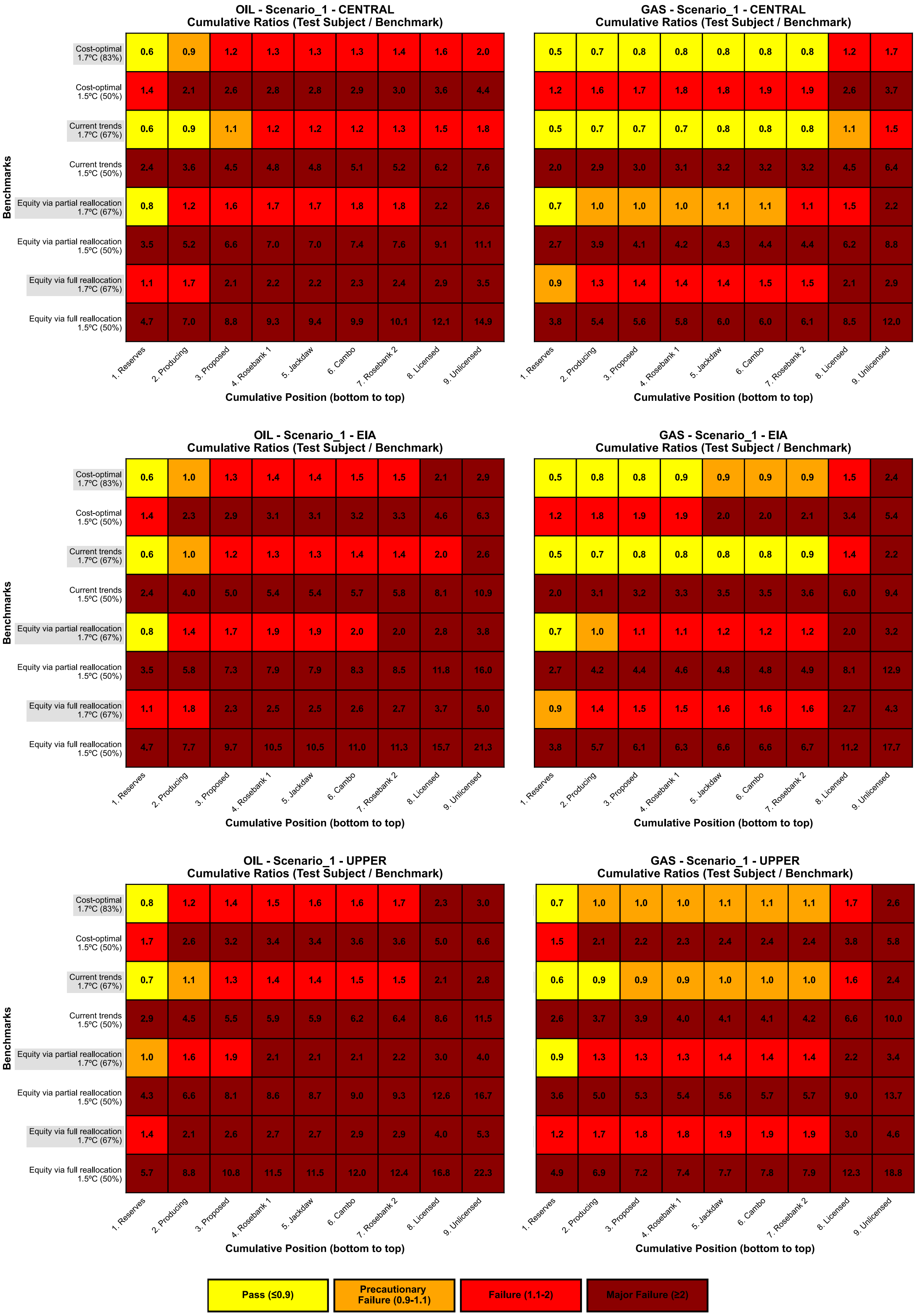


Figure S1 | UK oil and gas potential production for stacked test subjects with eight ordering scenarios (a-h). Ordering scenario 7 is used in the main results. Cumulative downstream combustion emissions for three production scenarios—Central, Environmental Impact Assessment (EIA), Upper—stacked in combinations of likelihood of extraction. Fields under regulatory scrutiny—Rosebank (Phase 1), Jackdaw, Cambo, and Rosebank (Phase 2)—are highlighted within their respective production categories (lighter shading). Contingent resources in producing fields and proposed new developments are abbreviated as “Producing fields” and “Proposed new developments”; licensed and unlicensed contingent resources are abbreviated accordingly. Production of resources is contingent on extraction of viable reserves.

a



OIL - Scenario_1 - CENTRAL
Cumulative Ratios (Test Subject / Benchmark)

Benchmarks	1. Reserves	2. Producing	3. Proposed	4. Rosebank 1	5. Jackdaw	6. Cambo	7. Rosebank 2	8. Licensed	9. Unlicensed
Cost-optimal 1.7°C (83%)	0.6	0.9	1.2	1.3	1.3	1.3	1.4	1.6	2.0
Cost-optimal 1.5°C (50%)	1.4	2.1	2.6	2.8	2.8	2.9	3.0	3.6	4.4
Current trends 1.7°C (67%)	0.6	0.9	1.1	1.2	1.2	1.2	1.3	1.5	1.8
Current trends 1.5°C (50%)	2.4	3.6	4.5	4.8	4.8	5.1	5.2	6.2	7.6
Equity via partial reallocation 1.7°C (67%)	0.8	1.2	1.6	1.7	1.7	1.8	1.8	2.2	2.6
Equity via partial reallocation 1.5°C (50%)	3.5	5.2	6.6	7.0	7.0	7.4	7.6	9.1	11.1
Equity via full reallocation 1.7°C (67%)	1.1	1.7	2.1	2.2	2.2	2.3	2.4	2.9	3.5
Equity via full reallocation 1.5°C (50%)	4.7	7.0	8.8	9.3	9.4	9.9	10.1	12.1	14.9

GAS - Scenario_1 - CENTRAL
Cumulative Ratios (Test Subject / Benchmark)

Benchmarks	1. Reserves	2. Producing	3. Proposed	4. Rosebank 1	5. Jackdaw	6. Cambo	7. Rosebank 2	8. Licensed	9. Unlicensed
Cost-optimal 1.7°C (83%)	0.5	0.7	0.8	0.8	0.8	0.8	0.8	1.2	1.7
Cost-optimal 1.5°C (50%)	1.2	1.6	1.7	1.8	1.8	1.9	1.9	2.6	3.7
Current trends 1.7°C (67%)	0.5	0.7	0.7	0.7	0.8	0.8	0.8	1.1	1.5
Current trends 1.5°C (50%)	2.0	2.9	3.0	3.1	3.2	3.2	3.2	4.5	6.4
Equity via partial reallocation 1.7°C (67%)	0.7	1.0	1.0	1.0	1.1	1.1	1.1	1.5	2.2
Equity via partial reallocation 1.5°C (50%)	2.7	3.9	4.1	4.2	4.3	4.4	4.4	6.2	8.8
Equity via full reallocation 1.7°C (67%)	0.9	1.3	1.4	1.4	1.4	1.5	1.5	2.1	2.9
Equity via full reallocation 1.5°C (50%)	3.8	5.4	5.6	5.8	6.0	6.0	6.1	8.5	12.0

OIL - Scenario_1 - EIA
Cumulative Ratios (Test Subject / Benchmark)

Benchmarks	1. Reserves	2. Producing	3. Proposed	4. Rosebank 1	5. Jackdaw	6. Cambo	7. Rosebank 2	8. Licensed	9. Unlicensed
Cost-optimal 1.7°C (83%)	0.6	1.0	1.3	1.4	1.4	1.5	1.5	2.1	2.9
Cost-optimal 1.5°C (50%)	1.4	2.3	2.9	3.1	3.1	3.2	3.3	4.6	6.3
Current trends 1.7°C (67%)	0.6	1.0	1.2	1.3	1.3	1.4	1.4	2.0	2.6
Current trends 1.5°C (50%)	2.4	4.0	5.0	5.4	5.4	5.7	5.8	8.1	10.9
Equity via partial reallocation 1.7°C (67%)	0.8	1.4	1.7	1.9	1.9	2.0	2.0	2.8	3.8
Equity via partial reallocation 1.5°C (50%)	3.5	5.8	7.3	7.9	7.9	8.3	8.5	11.8	16.0
Equity via full reallocation 1.7°C (67%)	1.1	1.8	2.3	2.5	2.5	2.6	2.7	3.7	5.0
Equity via full reallocation 1.5°C (50%)	4.7	7.7	9.7	10.5	10.5	11.0	11.3	15.7	21.3

GAS - Scenario_1 - EIA
Cumulative Ratios (Test Subject / Benchmark)

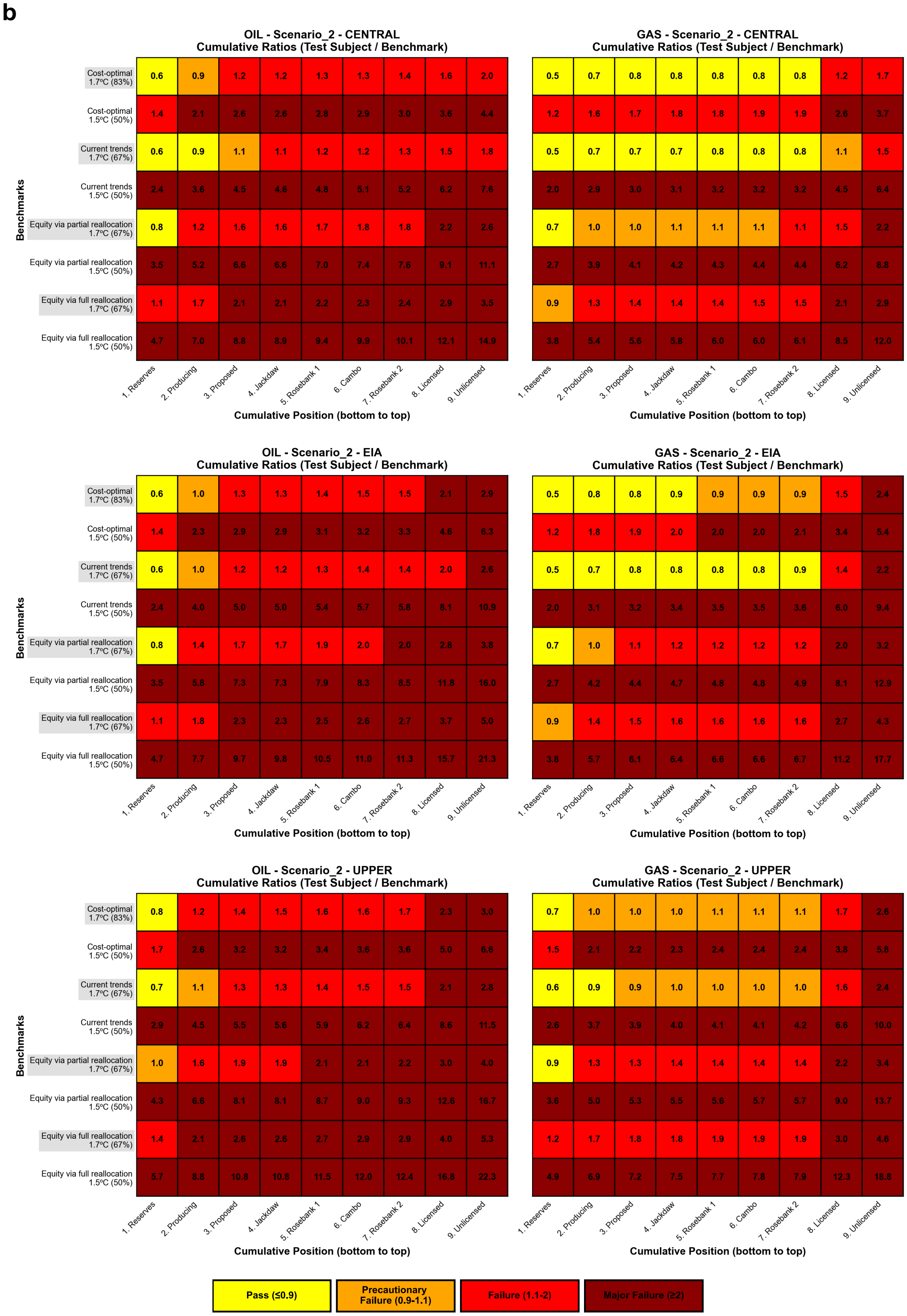
Benchmarks	1. Reserves	2. Producing	3. Proposed	4. Rosebank 1	5. Jackdaw	6. Cambo	7. Rosebank 2	8. Licensed	9. Unlicensed
Cost-optimal 1.7°C (83%)	0.5	0.8	0.8	0.9	0.9	0.9	0.9	1.5	2.4
Cost-optimal 1.5°C (50%)	1.2	1.8	1.9	1.9	2.0	2.0	2.1	3.4	5.4
Current trends 1.7°C (67%)	0.5	0.7	0.8	0.8	0.8	0.8	0.9	1.4	2.2
Current trends 1.5°C (50%)	2.0	3.1	3.2	3.3	3.5	3.5	3.6	6.0	9.4
Equity via partial reallocation 1.7°C (67%)	0.7	1.0	1.1	1.1	1.2	1.2	1.2	2.0	3.2
Equity via partial reallocation 1.5°C (50%)	2.7	4.2	4.4	4.6	4.8	4.8	4.9	8.1	12.9
Equity via full reallocation 1.7°C (67%)	0.9	1.4	1.5	1.5	1.6	1.6	1.6	2.7	4.3
Equity via full reallocation 1.5°C (50%)	3.8	5.7	6.1	6.3	6.6	6.6	6.7	11.2	17.7

OIL - Scenario_1 - UPPER
Cumulative Ratios (Test Subject / Benchmark)

Benchmarks	1. Reserves	2. Producing	3. Proposed	4. Rosebank 1	5. Jackdaw	6. Cambo	7. Rosebank 2	8. Licensed	9. Unlicensed
Cost-optimal 1.7°C (83%)	0.8	1.2	1.4	1.5	1.6	1.6	1.7	2.3	3.0
Cost-optimal 1.5°C (50%)	1.7	2.6	3.2	3.4	3.4	3.6	3.6	5.0	6.6
Current trends 1.7°C (67%)	0.7	1.1	1.3	1.4	1.4	1.5	1.5	2.1	2.8
Current trends 1.5°C (50%)	2.9	4.5	5.5	5.9	5.9	6.2	6.4	8.6	11.5
Equity via partial reallocation 1.7°C (67%)	1.0	1.6	1.9	2.1	2.1	2.1	2.2	3.0	4.0
Equity via partial reallocation 1.5°C (50%)	4.3	6.6	8.1	8.6	8.7	9.0	9.3	12.6	16.7
Equity via full reallocation 1.7°C (67%)	1.4	2.1	2.6	2.7	2.7	2.9	2.9	4.0	5.3
Equity via full reallocation 1.5°C (50%)	5.7	8.8	10.8	11.5	11.5	12.0	12.4	16.8	22.3

GAS - Scenario_1 - UPPER
Cumulative Ratios (Test Subject / Benchmark)

Benchmarks	1. Reserves	2. Producing	3. Proposed	4. Rosebank 1	5. Jackdaw	6. Cambo	7. Rosebank 2	8. Licensed	9. Unlicensed
Cost-optimal 1.7°C (83%)	0.7	1.0	1.0	1.0	1.1	1.1	1.1	1.7	2.6
Cost-optimal 1.5°C (50%)	1.5	2.1	2.2	2.3	2.4	2.4	2.4	3.8	5.8
Current trends 1.7°C (67%)	0.6	0.9	0.9	0.9	1.0	1.0	1.0	1.6	2.4
Current trends 1.5°C (50%)	2.6	3.7	3.9	4.0	4.1	4.1	4.2	6.6	10.0
Equity via partial reallocation 1.7°C (67%)	0.9	1.3	1.3	1.3	1.4	1.4	1.4	2.2	3.4
Equity via partial reallocation 1.5°C (50%)	3.6	5.0	5.3	5.4	5.6	5.7	5.7	9.0	13.7
Equity via full reallocation 1.7°C (67%)	1.2	1.7	1.8	1.8	1.9	1.9	1.9	3.0	4.6
Equity via full reallocation 1.5°C (50%)	4.9	6.9	7.2	7.4	7.7	7.8	7.9	12.3	18.8



OIL - Scenario_2 - CENTRAL
Cumulative Ratios (Test Subject / Benchmark)

Benchmarks	1. Reserves	2. Producing	3. Proposed	4. Jackdaw	5. Rosebank 1	6. Cambo	7. Rosebank 2	8. Licensed	9. Unlicensed
Cost-optimal 1.7°C (83%)	0.6	0.9	1.2	1.2	1.3	1.3	1.4	1.6	2.0
Cost-optimal 1.5°C (50%)	1.4	2.1	2.6	2.6	2.8	2.9	3.0	3.6	4.4
Current trends 1.7°C (67%)	0.6	0.9	1.1	1.1	1.2	1.2	1.3	1.5	1.8
Current trends 1.5°C (50%)	2.4	3.6	4.5	4.6	4.8	5.1	5.2	6.2	7.6
Equity via partial reallocation 1.7°C (67%)	0.8	1.2	1.6	1.6	1.7	1.8	1.8	2.2	2.6
Equity via partial reallocation 1.5°C (50%)	3.5	5.2	6.6	6.6	7.0	7.4	7.6	9.1	11.1
Equity via full reallocation 1.7°C (67%)	1.1	1.7	2.1	2.1	2.2	2.3	2.4	2.9	3.5
Equity via full reallocation 1.5°C (50%)	4.7	7.0	8.8	8.9	9.4	9.9	10.1	12.1	14.9

GAS - Scenario_2 - CENTRAL
Cumulative Ratios (Test Subject / Benchmark)

Benchmarks	1. Reserves	2. Producing	3. Proposed	4. Jackdaw	5. Rosebank 1	6. Cambo	7. Rosebank 2	8. Licensed	9. Unlicensed
Cost-optimal 1.7°C (83%)	0.5	0.7	0.8	0.8	0.8	0.8	0.8	1.2	1.7
Cost-optimal 1.5°C (50%)	1.2	1.6	1.7	1.8	1.8	1.9	1.9	2.6	3.7
Current trends 1.7°C (67%)	0.5	0.7	0.7	0.7	0.8	0.8	0.8	1.1	1.5
Current trends 1.5°C (50%)	2.0	2.9	3.0	3.1	3.2	3.2	3.2	4.5	6.4
Equity via partial reallocation 1.7°C (67%)	0.7	1.0	1.0	1.1	1.1	1.1	1.1	1.5	2.2
Equity via partial reallocation 1.5°C (50%)	2.7	3.9	4.1	4.2	4.3	4.4	4.4	6.2	8.8
Equity via full reallocation 1.7°C (67%)	0.9	1.3	1.4	1.4	1.4	1.5	1.5	2.1	2.9
Equity via full reallocation 1.5°C (50%)	3.8	5.4	5.6	5.8	6.0	6.0	6.1	8.5	12.0

OIL - Scenario_2 - EIA
Cumulative Ratios (Test Subject / Benchmark)

Benchmarks	1. Reserves	2. Producing	3. Proposed	4. Jackdaw	5. Rosebank 1	6. Cambo	7. Rosebank 2	8. Licensed	9. Unlicensed
Cost-optimal 1.7°C (83%)	0.6	1.0	1.3	1.3	1.4	1.5	1.5	2.1	2.9
Cost-optimal 1.5°C (50%)	1.4	2.3	2.9	2.9	3.1	3.2	3.3	4.6	6.3
Current trends 1.7°C (67%)	0.6	1.0	1.2	1.2	1.3	1.4	1.4	2.0	2.6
Current trends 1.5°C (50%)	2.4	4.0	5.0	5.0	5.4	5.7	5.8	8.1	10.9
Equity via partial reallocation 1.7°C (67%)	0.8	1.4	1.7	1.7	1.9	2.0	2.0	2.8	3.8
Equity via partial reallocation 1.5°C (50%)	3.5	5.8	7.3	7.3	7.9	8.3	8.5	11.8	16.0
Equity via full reallocation 1.7°C (67%)	1.1	1.8	2.3	2.3	2.5	2.6	2.7	3.7	5.0
Equity via full reallocation 1.5°C (50%)	4.7	7.7	9.7	9.8	10.5	11.0	11.3	15.7	21.3

GAS - Scenario_2 - EIA
Cumulative Ratios (Test Subject / Benchmark)

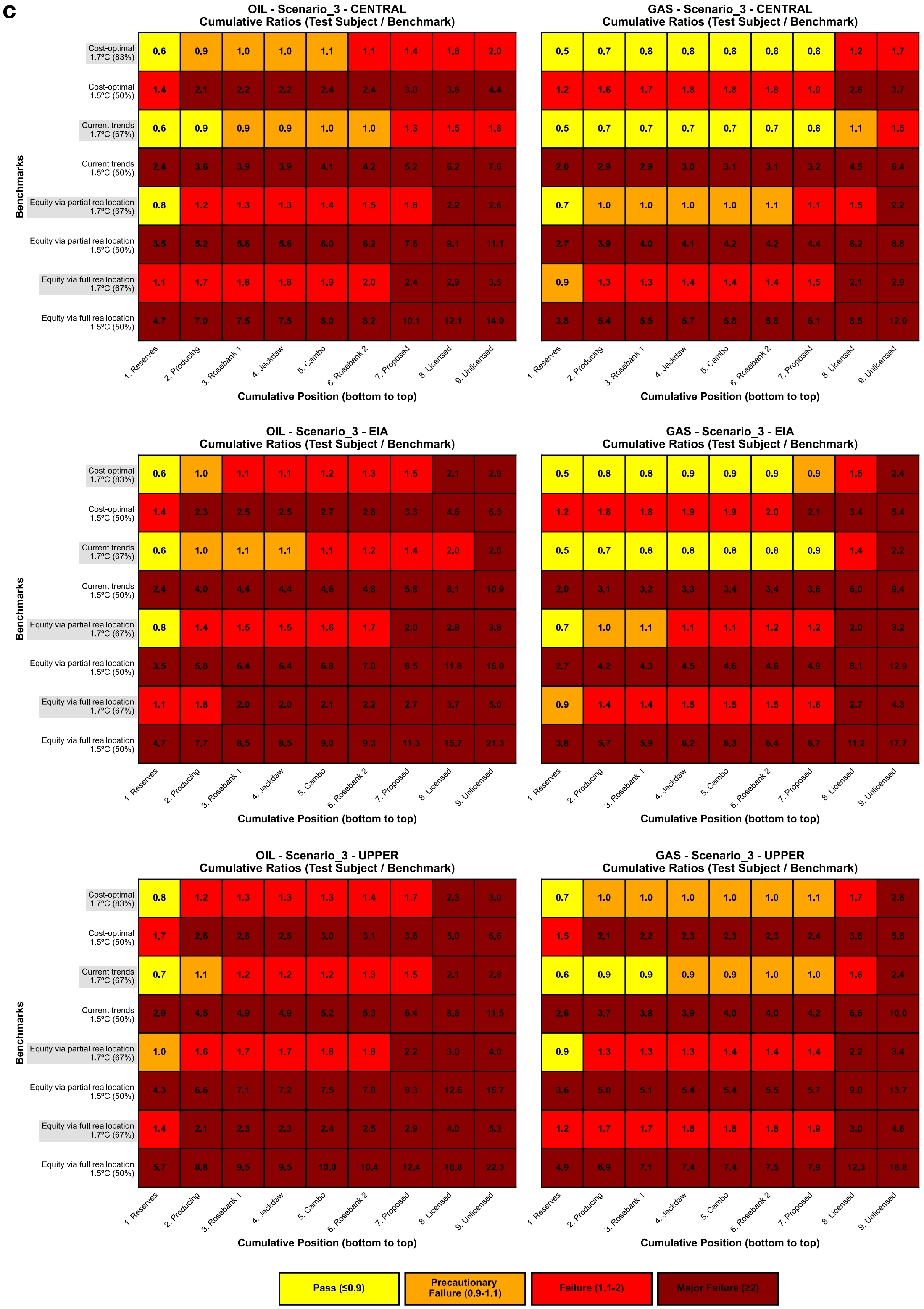
Benchmarks	1. Reserves	2. Producing	3. Proposed	4. Jackdaw	5. Rosebank 1	6. Cambo	7. Rosebank 2	8. Licensed	9. Unlicensed
Cost-optimal 1.7°C (83%)	0.5	0.8	0.8	0.9	0.9	0.9	0.9	1.5	2.4
Cost-optimal 1.5°C (50%)	1.2	1.8	1.9	2.0	2.0	2.0	2.1	3.4	5.4
Current trends 1.7°C (67%)	0.5	0.7	0.8	0.8	0.8	0.8	0.9	1.4	2.2
Current trends 1.5°C (50%)	2.0	3.1	3.2	3.4	3.5	3.5	3.6	6.0	9.4
Equity via partial reallocation 1.7°C (67%)	0.7	1.0	1.1	1.2	1.2	1.2	1.2	2.0	3.2
Equity via partial reallocation 1.5°C (50%)	2.7	4.2	4.4	4.7	4.8	4.8	4.9	8.1	12.9
Equity via full reallocation 1.7°C (67%)	0.9	1.4	1.5	1.6	1.6	1.6	1.6	2.7	4.3
Equity via full reallocation 1.5°C (50%)	3.8	5.7	6.1	6.4	6.6	6.6	6.7	11.2	17.7

OIL - Scenario_2 - UPPER
Cumulative Ratios (Test Subject / Benchmark)

Benchmarks	1. Reserves	2. Producing	3. Proposed	4. Jackdaw	5. Rosebank 1	6. Cambo	7. Rosebank 2	8. Licensed	9. Unlicensed
Cost-optimal 1.7°C (83%)	0.8	1.2	1.4	1.5	1.6	1.6	1.7	2.3	3.0
Cost-optimal 1.5°C (50%)	1.7	2.6	3.2	3.2	3.4	3.6	3.6	5.0	6.6
Current trends 1.7°C (67%)	0.7	1.1	1.3	1.3	1.4	1.5	1.5	2.1	2.8
Current trends 1.5°C (50%)	2.9	4.5	5.5	5.6	5.9	6.2	6.4	8.6	11.5
Equity via partial reallocation 1.7°C (67%)	1.0	1.6	1.9	1.9	2.1	2.1	2.2	3.0	4.0
Equity via partial reallocation 1.5°C (50%)	4.3	6.6	8.1	8.1	8.7	9.0	9.3	12.6	16.7
Equity via full reallocation 1.7°C (67%)	1.4	2.1	2.6	2.6	2.7	2.9	2.9	4.0	5.3
Equity via full reallocation 1.5°C (50%)	5.7	8.8	10.8	10.8	11.5	12.0	12.4	16.8	22.3

GAS - Scenario_2 - UPPER
Cumulative Ratios (Test Subject / Benchmark)

Benchmarks	1. Reserves	2. Producing	3. Proposed	4. Jackdaw	5. Rosebank 1	6. Cambo	7. Rosebank 2	8. Licensed	9. Unlicensed
Cost-optimal 1.7°C (83%)	0.7	1.0	1.0	1.0	1.1	1.1	1.1	1.7	2.6
Cost-optimal 1.5°C (50%)	1.5	2.1	2.2	2.3	2.4	2.4	2.4	3.8	5.8
Current trends 1.7°C (67%)	0.6	0.9	0.9	1.0	1.0	1.0	1.0	1.6	2.4
Current trends 1.5°C (50%)	2.6	3.7	3.9	4.0	4.1	4.1	4.2	6.6	10.0
Equity via partial reallocation 1.7°C (67%)	0.9	1.3	1.3	1.4	1.4	1.4	1.4	2.2	3.4
Equity via partial reallocation 1.5°C (50%)	3.6	5.0	5.3	5.5	5.6	5.7	5.7	9.0	13.7
Equity via full reallocation 1.7°C (67%)	1.2	1.7	1.8	1.8	1.9	1.9	1.9	3.0	4.6
Equity via full reallocation 1.5°C (50%)	4.9	6.9	7.2	7.5	7.7	7.8	7.9	12.3	18.8



OIL - Scenario_3 - CENTRAL
Cumulative Ratios (Test Subject / Benchmark)

Benchmarks	1. Reserves	2. Producing	3. Rosebank 1	4. Jackdaw	5. Cambo	6. Rosebank 2	7. Proposed	8. Licensed	9. Unlicensed
Cost-optimal 1.7ºC (83%)	0.6	0.9	1.0	1.0	1.1	1.1	1.4	1.6	2.0
Cost-optimal 1.5ºC (50%)	1.4	2.1	2.2	2.2	2.4	2.4	3.0	3.6	4.4
Current trends 1.7ºC (67%)	0.6	0.9	0.9	0.9	1.0	1.0	1.3	1.5	1.8
Current trends 1.5ºC (50%)	2.4	3.6	3.9	3.9	4.1	4.2	5.2	6.2	7.6
Equity via partial reallocation 1.7ºC (67%)	0.8	1.2	1.3	1.3	1.4	1.5	1.8	2.2	2.6
Equity via partial reallocation 1.5ºC (50%)	3.5	5.2	5.6	5.6	6.0	6.2	7.6	9.1	11.1
Equity via full reallocation 1.7ºC (67%)	1.1	1.7	1.8	1.8	1.9	2.0	2.4	2.9	3.5
Equity via full reallocation 1.5ºC (50%)	4.7	7.0	7.5	7.5	8.0	8.2	10.1	12.1	14.9

GAS - Scenario_3 - CENTRAL
Cumulative Ratios (Test Subject / Benchmark)

Benchmarks	1. Reserves	2. Producing	3. Rosebank 1	4. Jackdaw	5. Cambo	6. Rosebank 2	7. Proposed	8. Licensed	9. Unlicensed
Cost-optimal 1.7ºC (83%)	0.5	0.7	0.8	0.8	0.8	0.8	0.8	1.2	1.7
Cost-optimal 1.5ºC (50%)	1.2	1.6	1.7	1.8	1.8	1.8	1.9	2.6	3.7
Current trends 1.7ºC (67%)	0.5	0.7	0.7	0.7	0.7	0.7	0.8	1.1	1.5
Current trends 1.5ºC (50%)	2.0	2.9	2.9	3.0	3.1	3.1	3.2	4.5	6.4
Equity via partial reallocation 1.7ºC (67%)	0.7	1.0	1.0	1.0	1.0	1.1	1.1	1.5	2.2
Equity via partial reallocation 1.5ºC (50%)	2.7	3.9	4.0	4.1	4.2	4.2	4.4	6.2	8.8
Equity via full reallocation 1.7ºC (67%)	0.9	1.3	1.3	1.4	1.4	1.4	1.5	2.1	2.9
Equity via full reallocation 1.5ºC (50%)	3.8	5.4	5.5	5.7	5.8	5.8	6.1	8.5	12.0

OIL - Scenario_3 - EIA
Cumulative Ratios (Test Subject / Benchmark)

Benchmarks	1. Reserves	2. Producing	3. Rosebank 1	4. Jackdaw	5. Cambo	6. Rosebank 2	7. Proposed	8. Licensed	9. Unlicensed
Cost-optimal 1.7ºC (83%)	0.6	1.0	1.1	1.1	1.2	1.3	1.5	2.1	2.9
Cost-optimal 1.5ºC (50%)	1.4	2.3	2.5	2.5	2.7	2.8	3.3	4.6	6.3
Current trends 1.7ºC (67%)	0.6	1.0	1.1	1.1	1.1	1.2	1.4	2.0	2.6
Current trends 1.5ºC (50%)	2.4	4.0	4.4	4.4	4.6	4.8	5.8	8.1	10.9
Equity via partial reallocation 1.7ºC (67%)	0.8	1.4	1.5	1.5	1.6	1.7	2.0	2.8	3.8
Equity via partial reallocation 1.5ºC (50%)	3.5	5.8	6.4	6.4	6.8	7.0	8.5	11.8	16.0
Equity via full reallocation 1.7ºC (67%)	1.1	1.8	2.0	2.0	2.1	2.2	2.7	3.7	5.0
Equity via full reallocation 1.5ºC (50%)	4.7	7.7	8.5	8.5	9.0	9.3	11.3	15.7	21.3

GAS - Scenario_3 - EIA
Cumulative Ratios (Test Subject / Benchmark)

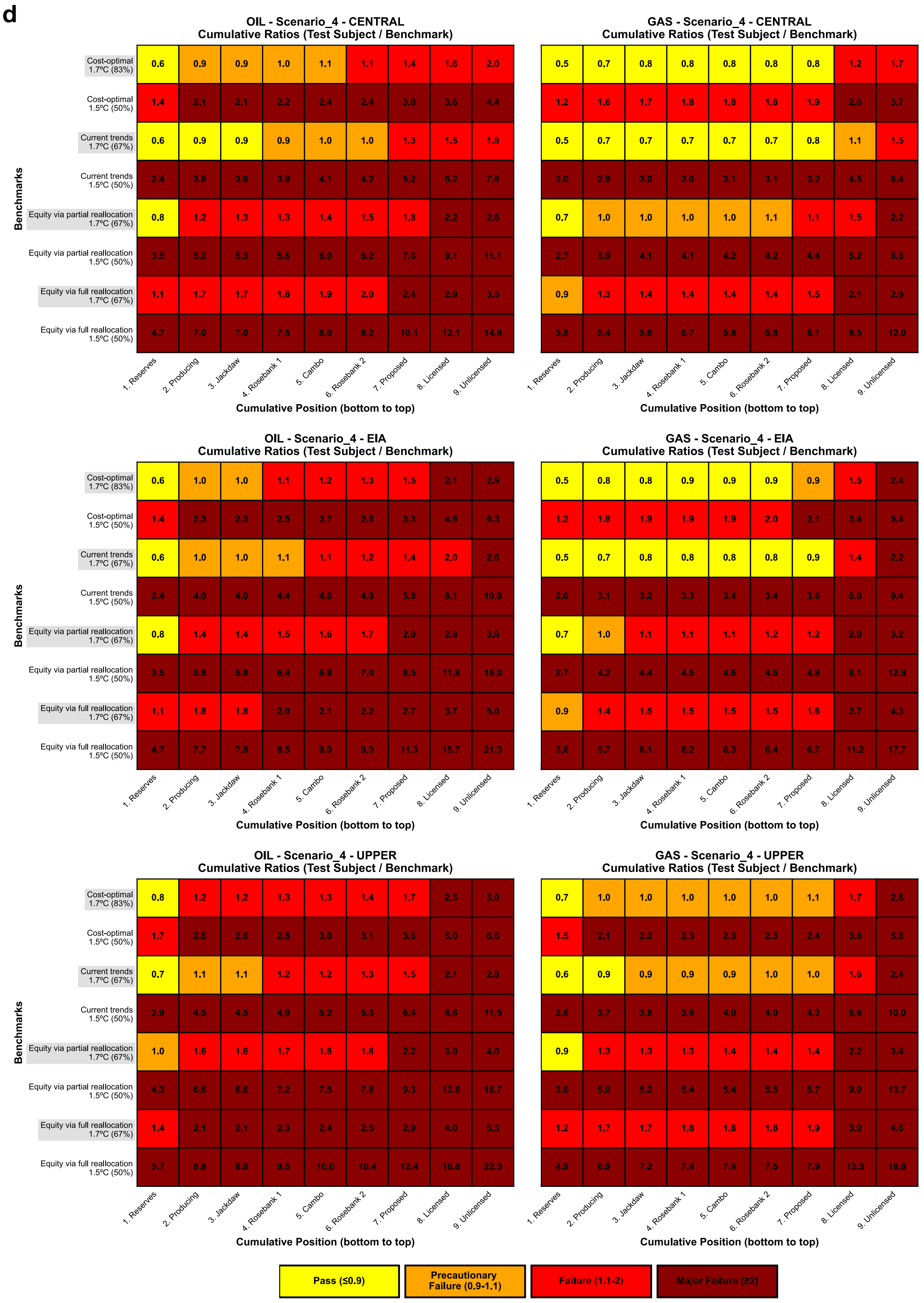
Benchmarks	1. Reserves	2. Producing	3. Rosebank 1	4. Jackdaw	5. Cambo	6. Rosebank 2	7. Proposed	8. Licensed	9. Unlicensed
Cost-optimal 1.7ºC (83%)	0.5	0.8	0.8	0.9	0.9	0.9	0.9	1.5	2.4
Cost-optimal 1.5ºC (50%)	1.2	1.8	1.8	1.9	1.9	2.0	2.1	3.4	5.4
Current trends 1.7ºC (67%)	0.5	0.7	0.8	0.8	0.8	0.8	0.9	1.4	2.2
Current trends 1.5ºC (50%)	2.0	3.1	3.2	3.3	3.4	3.4	3.6	6.0	9.4
Equity via partial reallocation 1.7ºC (67%)	0.7	1.0	1.1	1.1	1.1	1.2	1.2	2.0	3.2
Equity via partial reallocation 1.5ºC (50%)	2.7	4.2	4.3	4.5	4.6	4.6	4.9	8.1	12.9
Equity via full reallocation 1.7ºC (67%)	0.9	1.4	1.4	1.5	1.5	1.5	1.6	2.7	4.3
Equity via full reallocation 1.5ºC (50%)	3.8	5.7	5.9	6.2	6.3	6.4	6.7	11.2	17.7

OIL - Scenario_3 - UPPER
Cumulative Ratios (Test Subject / Benchmark)

Benchmarks	1. Reserves	2. Producing	3. Rosebank 1	4. Jackdaw	5. Cambo	6. Rosebank 2	7. Proposed	8. Licensed	9. Unlicensed
Cost-optimal 1.7ºC (83%)	0.8	1.2	1.3	1.3	1.3	1.4	1.7	2.3	3.0
Cost-optimal 1.5ºC (50%)	1.7	2.6	2.8	2.8	3.0	3.1	3.6	5.0	6.6
Current trends 1.7ºC (67%)	0.7	1.1	1.2	1.2	1.2	1.3	1.5	2.1	2.8
Current trends 1.5ºC (50%)	2.9	4.5	4.9	4.9	5.2	5.3	6.4	8.6	11.5
Equity via partial reallocation 1.7ºC (67%)	1.0	1.6	1.7	1.7	1.8	1.8	2.2	3.0	4.0
Equity via partial reallocation 1.5ºC (50%)	4.3	6.6	7.1	7.2	7.5	7.8	9.3	12.6	16.7
Equity via full reallocation 1.7ºC (67%)	1.4	2.1	2.3	2.3	2.4	2.5	2.9	4.0	5.3
Equity via full reallocation 1.5ºC (50%)	5.7	8.8	9.5	9.5	10.0	10.4	12.4	16.8	22.3

GAS - Scenario_3 - UPPER
Cumulative Ratios (Test Subject / Benchmark)

Benchmarks	1. Reserves	2. Producing	3. Rosebank 1	4. Jackdaw	5. Cambo	6. Rosebank 2	7. Proposed	8. Licensed	9. Unlicensed
Cost-optimal 1.7ºC (83%)	0.7	1.0	1.0	1.0	1.0	1.0	1.1	1.7	2.6
Cost-optimal 1.5ºC (50%)	1.5	2.1	2.2	2.3	2.3	2.3	2.4	3.8	5.8
Current trends 1.7ºC (67%)	0.6	0.9	0.9	0.9	0.9	1.0	1.0	1.6	2.4
Current trends 1.5ºC (50%)	2.6	3.7	3.8	3.9	4.0	4.0	4.2	6.6	10.0
Equity via partial reallocation 1.7ºC (67%)	0.9	1.3	1.3	1.3	1.4	1.4	1.4	2.2	3.4
Equity via partial reallocation 1.5ºC (50%)	3.6	5.0	5.1	5.4	5.4	5.5	5.7	9.0	13.7
Equity via full reallocation 1.7ºC (67%)	1.2	1.7	1.7	1.8	1.8	1.8	1.9	3.0	4.6
Equity via full reallocation 1.5ºC (50%)	4.9	6.9	7.1	7.4	7.4	7.5	7.9	12.3	18.8



OIL - Scenario_4 - CENTRAL
Cumulative Ratios (Test Subject / Benchmark)

Benchmarks	1. Reserves	2. Producing	3. Jackdaw	4. Rosebank 1	5. Cambo	6. Rosebank 2	7. Proposed	8. Licensed	9. Unlicensed
Cost-optimal 1.7ºC (83%)	0.6	0.9	0.9	1.0	1.1	1.1	1.4	1.6	2.0
Cost-optimal 1.5ºC (50%)	1.4	2.1	2.1	2.2	2.4	2.4	3.0	3.6	4.4
Current trends 1.7ºC (67%)	0.6	0.9	0.9	0.9	1.0	1.0	1.3	1.5	1.8
Current trends 1.5ºC (50%)	2.4	3.6	3.6	3.9	4.1	4.2	5.2	6.2	7.6
Equity via partial reallocation 1.7ºC (67%)	0.8	1.2	1.3	1.3	1.4	1.5	1.8	2.2	2.6
Equity via partial reallocation 1.5ºC (50%)	3.5	5.2	5.3	5.6	6.0	6.2	7.6	9.1	11.1
Equity via full reallocation 1.7ºC (67%)	1.1	1.7	1.7	1.8	1.9	2.0	2.4	2.9	3.5
Equity via full reallocation 1.5ºC (50%)	4.7	7.0	7.0	7.5	8.0	8.2	10.1	12.1	14.9

GAS - Scenario_4 - CENTRAL
Cumulative Ratios (Test Subject / Benchmark)

Benchmarks	1. Reserves	2. Producing	3. Jackdaw	4. Rosebank 1	5. Cambo	6. Rosebank 2	7. Proposed	8. Licensed	9. Unlicensed
Cost-optimal 1.7ºC (83%)	0.5	0.7	0.8	0.8	0.8	0.8	0.8	1.2	1.7
Cost-optimal 1.5ºC (50%)	1.2	1.6	1.7	1.8	1.8	1.8	1.9	2.6	3.7
Current trends 1.7ºC (67%)	0.5	0.7	0.7	0.7	0.7	0.7	0.8	1.1	1.5
Current trends 1.5ºC (50%)	2.0	2.9	3.0	3.0	3.1	3.1	3.2	4.5	6.4
Equity via partial reallocation 1.7ºC (67%)	0.7	1.0	1.0	1.0	1.0	1.1	1.1	1.5	2.2
Equity via partial reallocation 1.5ºC (50%)	2.7	3.9	4.1	4.1	4.2	4.2	4.4	6.2	8.8
Equity via full reallocation 1.7ºC (67%)	0.9	1.3	1.4	1.4	1.4	1.4	1.5	2.1	2.9
Equity via full reallocation 1.5ºC (50%)	3.8	5.4	5.6	5.7	5.8	5.8	6.1	8.5	12.0

OIL - Scenario_4 - EIA
Cumulative Ratios (Test Subject / Benchmark)

Benchmarks	1. Reserves	2. Producing	3. Jackdaw	4. Rosebank 1	5. Cambo	6. Rosebank 2	7. Proposed	8. Licensed	9. Unlicensed
Cost-optimal 1.7ºC (83%)	0.6	1.0	1.0	1.1	1.2	1.3	1.5	2.1	2.9
Cost-optimal 1.5ºC (50%)	1.4	2.3	2.3	2.5	2.7	2.8	3.3	4.6	6.3
Current trends 1.7ºC (67%)	0.6	1.0	1.0	1.1	1.1	1.2	1.4	2.0	2.6
Current trends 1.5ºC (50%)	2.4	4.0	4.0	4.4	4.6	4.8	5.8	8.1	10.9
Equity via partial reallocation 1.7ºC (67%)	0.8	1.4	1.4	1.5	1.6	1.7	2.0	2.8	3.8
Equity via partial reallocation 1.5ºC (50%)	3.5	5.8	5.8	6.4	6.8	7.0	8.5	11.8	16.0
Equity via full reallocation 1.7ºC (67%)	1.1	1.8	1.8	2.0	2.1	2.2	2.7	3.7	5.0
Equity via full reallocation 1.5ºC (50%)	4.7	7.7	7.8	8.5	9.0	9.3	11.3	15.7	21.3

GAS - Scenario_4 - EIA
Cumulative Ratios (Test Subject / Benchmark)

Benchmarks	1. Reserves	2. Producing	3. Jackdaw	4. Rosebank 1	5. Cambo	6. Rosebank 2	7. Proposed	8. Licensed	9. Unlicensed
Cost-optimal 1.7ºC (83%)	0.5	0.8	0.8	0.9	0.9	0.9	0.9	1.5	2.4
Cost-optimal 1.5ºC (50%)	1.2	1.8	1.9	1.9	1.9	2.0	2.1	3.4	5.4
Current trends 1.7ºC (67%)	0.5	0.7	0.8	0.8	0.8	0.8	0.9	1.4	2.2
Current trends 1.5ºC (50%)	2.0	3.1	3.2	3.3	3.4	3.4	3.6	6.0	9.4
Equity via partial reallocation 1.7ºC (67%)	0.7	1.0	1.1	1.1	1.1	1.2	1.2	2.0	3.2
Equity via partial reallocation 1.5ºC (50%)	2.7	4.2	4.4	4.5	4.6	4.6	4.9	8.1	12.9
Equity via full reallocation 1.7ºC (67%)	0.9	1.4	1.5	1.5	1.5	1.5	1.6	2.7	4.3
Equity via full reallocation 1.5ºC (50%)	3.8	5.7	6.1	6.2	6.3	6.4	6.7	11.2	17.7

OIL - Scenario_4 - UPPER
Cumulative Ratios (Test Subject / Benchmark)

Benchmarks	1. Reserves	2. Producing	3. Jackdaw	4. Rosebank 1	5. Cambo	6. Rosebank 2	7. Proposed	8. Licensed	9. Unlicensed
Cost-optimal 1.7ºC (83%)	0.8	1.2	1.2	1.3	1.3	1.4	1.7	2.3	3.0
Cost-optimal 1.5ºC (50%)	1.7	2.6	2.6	2.8	3.0	3.1	3.6	5.0	6.6
Current trends 1.7ºC (67%)	0.7	1.1	1.1	1.2	1.2	1.3	1.5	2.1	2.8
Current trends 1.5ºC (50%)	2.9	4.5	4.5	4.9	5.2	5.3	6.4	8.6	11.5
Equity via partial reallocation 1.7ºC (67%)	1.0	1.6	1.6	1.7	1.8	1.8	2.2	3.0	4.0
Equity via partial reallocation 1.5ºC (50%)	4.3	6.6	6.6	7.2	7.5	7.8	9.3	12.6	16.7
Equity via full reallocation 1.7ºC (67%)	1.4	2.1	2.1	2.3	2.4	2.5	2.9	4.0	5.3
Equity via full reallocation 1.5ºC (50%)	5.7	8.8	8.8	9.5	10.0	10.4	12.4	16.8	22.3

GAS - Scenario_4 - UPPER
Cumulative Ratios (Test Subject / Benchmark)

Benchmarks	1. Reserves	2. Producing	3. Jackdaw	4. Rosebank 1	5. Cambo	6. Rosebank 2	7. Proposed	8. Licensed	9. Unlicensed
Cost-optimal 1.7ºC (83%)	0.7	1.0	1.0	1.0	1.0	1.0	1.1	1.7	2.6
Cost-optimal 1.5ºC (50%)	1.5	2.1	2.2	2.3	2.3	2.3	2.4	3.8	5.8
Current trends 1.7ºC (67%)	0.6	0.9	0.9	0.9	0.9	1.0	1.0	1.6	2.4
Current trends 1.5ºC (50%)	2.6	3.7	3.8	3.9	4.0	4.0	4.2	6.6	10.0
Equity via partial reallocation 1.7ºC (67%)	0.9	1.3	1.3	1.3	1.4	1.4	1.4	2.2	3.4
Equity via partial reallocation 1.5ºC (50%)	3.6	5.0	5.2	5.4	5.4	5.5	5.7	9.0	13.7
Equity via full reallocation 1.7ºC (67%)	1.2	1.7	1.7	1.8	1.8	1.8	1.9	3.0	4.6
Equity via full reallocation 1.5ºC (50%)	4.9	6.9	7.2	7.4	7.4	7.5	7.9	12.3	18.8

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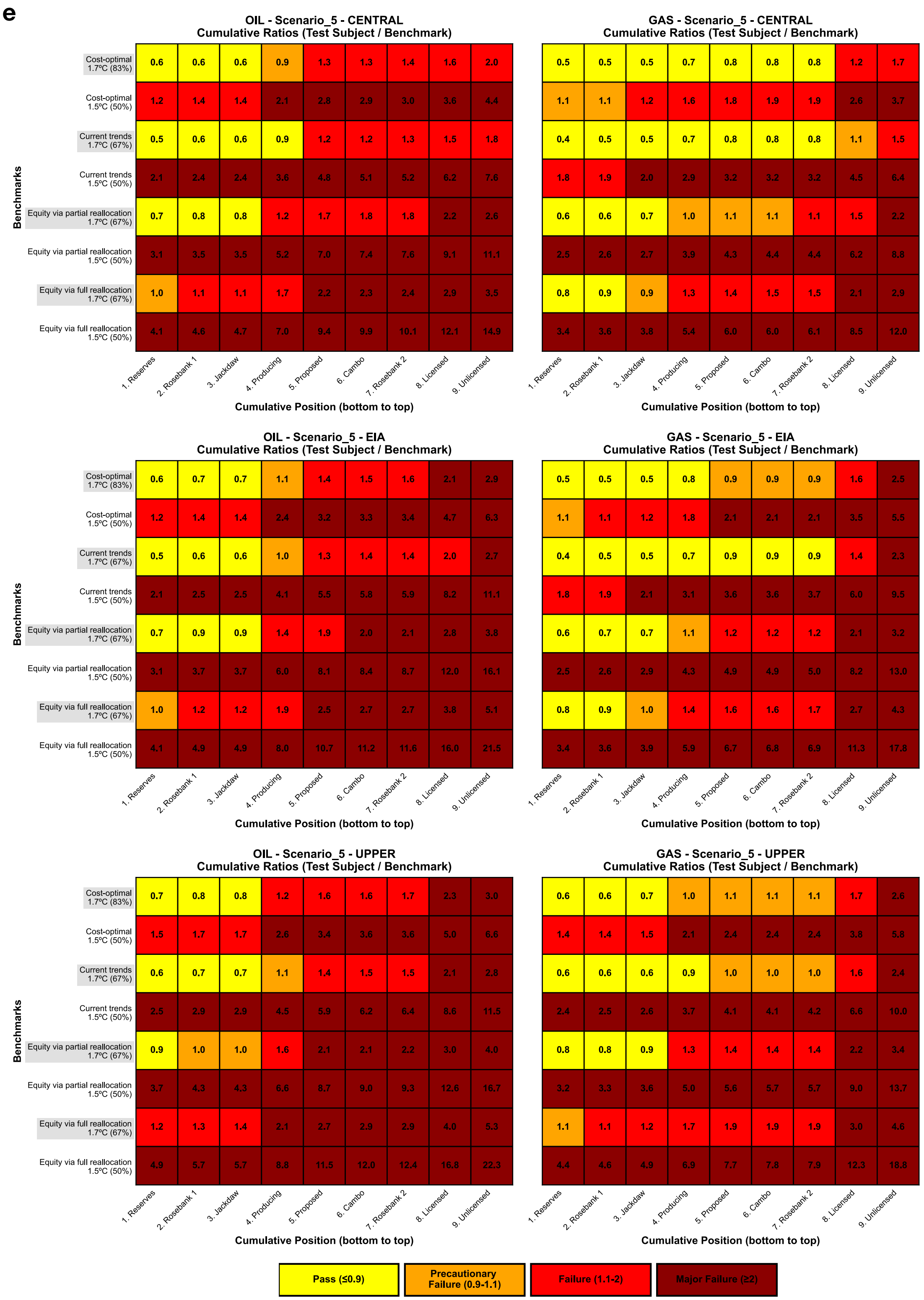

OIL - Scenario_5 - CENTRAL
Cumulative Ratios (Test Subject / Benchmark)

Benchmarks	1. Reserves	2. Rosebank 1	3. Jackdaw	4. Producing	5. Proposed	6. Cambo	7. Rosebank 2	8. Licensed	9. Unlicensed
Cost-optimal 1.7°C (83%)	0.6	0.6	0.6	0.9	1.3	1.3	1.4	1.6	2.0
Cost-optimal 1.5°C (50%)	1.2	1.4	1.4	2.1	2.8	2.9	3.0	3.6	4.4
Current trends 1.7°C (67%)	0.5	0.6	0.6	0.9	1.2	1.2	1.3	1.5	1.8
Current trends 1.5°C (50%)	2.1	2.4	2.4	3.6	4.8	5.1	5.2	6.2	7.6
Equity via partial reallocation 1.7°C (67%)	0.7	0.8	0.8	1.2	1.7	1.8	1.8	2.2	2.6
Equity via partial reallocation 1.5°C (50%)	3.1	3.5	3.5	5.2	7.0	7.4	7.6	9.1	11.1
Equity via full reallocation 1.7°C (67%)	1.0	1.1	1.1	1.7	2.2	2.3	2.4	2.9	3.5
Equity via full reallocation 1.5°C (50%)	4.1	4.6	4.7	7.0	9.4	9.9	10.1	12.1	14.9

Cumulative Position (bottom to top)

GAS - Scenario_5 - CENTRAL
Cumulative Ratios (Test Subject / Benchmark)

Benchmarks	1. Reserves	2. Rosebank 1	3. Jackdaw	4. Producing	5. Proposed	6. Cambo	7. Rosebank 2	8. Licensed	9. Unlicensed
Cost-optimal 1.7°C (83%)	0.5	0.5	0.5	0.7	0.8	0.8	0.8	1.2	1.7
Cost-optimal 1.5°C (50%)	1.1	1.1	1.2	1.6	1.8	1.9	1.9	2.6	3.7
Current trends 1.7°C (67%)	0.4	0.5	0.5	0.7	0.8	0.8	0.8	1.1	1.5
Current trends 1.5°C (50%)	1.8	1.9	2.0	2.9	3.2	3.2	3.2	4.5	6.4
Equity via partial reallocation 1.7°C (67%)	0.6	0.6	0.7	1.0	1.1	1.1	1.1	1.5	2.2
Equity via partial reallocation 1.5°C (50%)	2.5	2.6	2.7	3.9	4.3	4.4	4.4	6.2	8.8
Equity via full reallocation 1.7°C (67%)	0.8	0.9	0.9	1.3	1.4	1.5	1.5	2.1	2.9
Equity via full reallocation 1.5°C (50%)	3.4	3.6	3.8	5.4	6.0	6.0	6.1	8.5	12.0

Cumulative Position (bottom to top)

OIL - Scenario_5 - EIA
Cumulative Ratios (Test Subject / Benchmark)

Benchmarks	1. Reserves	2. Rosebank 1	3. Jackdaw	4. Producing	5. Proposed	6. Cambo	7. Rosebank 2	8. Licensed	9. Unlicensed
Cost-optimal 1.7°C (83%)	0.6	0.7	0.7	1.1	1.4	1.5	1.6	2.1	2.9
Cost-optimal 1.5°C (50%)	1.2	1.4	1.4	2.4	3.2	3.3	3.4	4.7	6.3
Current trends 1.7°C (67%)	0.5	0.6	0.6	1.0	1.3	1.4	1.4	2.0	2.7
Current trends 1.5°C (50%)	2.1	2.5	2.5	4.1	5.5	5.8	5.9	8.2	11.1
Equity via partial reallocation 1.7°C (67%)	0.7	0.9	0.9	1.4	1.9	2.0	2.1	2.8	3.8
Equity via partial reallocation 1.5°C (50%)	3.1	3.7	3.7	6.0	8.1	8.4	8.7	12.0	16.1
Equity via full reallocation 1.7°C (67%)	1.0	1.2	1.2	1.9	2.5	2.7	2.7	3.8	5.1
Equity via full reallocation 1.5°C (50%)	4.1	4.9	4.9	8.0	10.7	11.2	11.6	16.0	21.5

Cumulative Position (bottom to top)

GAS - Scenario_5 - EIA
Cumulative Ratios (Test Subject / Benchmark)

Benchmarks	1. Reserves	2. Rosebank 1	3. Jackdaw	4. Producing	5. Proposed	6. Cambo	7. Rosebank 2	8. Licensed	9. Unlicensed
Cost-optimal 1.7°C (83%)	0.5	0.5	0.5	0.8	0.9	0.9	0.9	1.6	2.5
Cost-optimal 1.5°C (50%)	1.1	1.1	1.2	1.8	2.1	2.1	2.1	3.5	5.5
Current trends 1.7°C (67%)	0.4	0.5	0.5	0.7	0.9	0.9	0.9	1.4	2.3
Current trends 1.5°C (50%)	1.8	1.9	2.1	3.1	3.6	3.6	3.7	6.0	9.5
Equity via partial reallocation 1.7°C (67%)	0.6	0.7	0.7	1.1	1.2	1.2	1.2	2.1	3.2
Equity via partial reallocation 1.5°C (50%)	2.5	2.6	2.9	4.3	4.9	4.9	5.0	8.2	13.0
Equity via full reallocation 1.7°C (67%)	0.8	0.9	1.0	1.4	1.6	1.6	1.7	2.7	4.3
Equity via full reallocation 1.5°C (50%)	3.4	3.6	3.9	5.9	6.7	6.8	6.9	11.3	17.8

Cumulative Position (bottom to top)

OIL - Scenario_5 - UPPER
Cumulative Ratios (Test Subject / Benchmark)

Benchmarks	1. Reserves	2. Rosebank 1	3. Jackdaw	4. Producing	5. Proposed	6. Cambo	7. Rosebank 2	8. Licensed	9. Unlicensed
Cost-optimal 1.7°C (83%)	0.7	0.8	0.8	1.2	1.6	1.6	1.7	2.3	3.0
Cost-optimal 1.5°C (50%)	1.5	1.7	1.7	2.6	3.4	3.6	3.6	5.0	6.6
Current trends 1.7°C (67%)	0.6	0.7	0.7	1.1	1.4	1.5	1.5	2.1	2.8
Current trends 1.5°C (50%)	2.5	2.9	2.9	4.5	5.9	6.2	6.4	8.6	11.5
Equity via partial reallocation 1.7°C (67%)	0.9	1.0	1.0	1.6	2.1	2.1	2.2	3.0	4.0
Equity via partial reallocation 1.5°C (50%)	3.7	4.3	4.3	6.6	8.7	9.0	9.3	12.6	16.7
Equity via full reallocation 1.7°C (67%)	1.2	1.3	1.4	2.1	2.7	2.9	2.9	4.0	5.3
Equity via full reallocation 1.5°C (50%)	4.9	5.7	5.7	8.8	11.5	12.0	12.4	16.8	22.3

Cumulative Position (bottom to top)

GAS - Scenario_5 - UPPER
Cumulative Ratios (Test Subject / Benchmark)

Benchmarks	1. Reserves	2. Rosebank 1	3. Jackdaw	4. Producing	5. Proposed	6. Cambo	7. Rosebank 2	8. Licensed	9. Unlicensed
Cost-optimal 1.7°C (83%)	0.6	0.6	0.7	1.0	1.1	1.1	1.1	1.7	2.6
Cost-optimal 1.5°C (50%)	1.4	1.4	1.5	2.1	2.4	2.4	2.4	3.8	5.8
Current trends 1.7°C (67%)	0.6	0.6	0.6	0.9	1.0	1.0	1.0	1.6	2.4
Current trends 1.5°C (50%)	2.4	2.5	2.6	3.7	4.1	4.1	4.2	6.6	10.0
Equity via partial reallocation 1.7°C (67%)	0.8	0.8	0.9	1.3	1.4	1.4	1.4	2.2	3.4
Equity via partial reallocation 1.5°C (50%)	3.2	3.3	3.6	5.0	5.6	5.7	5.7	9.0	13.7
Equity via full reallocation 1.7°C (67%)	1.1	1.1	1.2	1.7	1.9	1.9	1.9	3.0	4.6
Equity via full reallocation 1.5°C (50%)	4.4	4.6	4.9	6.9	7.7	7.8	7.9	12.3	18.8

Cumulative Position (bottom to top)

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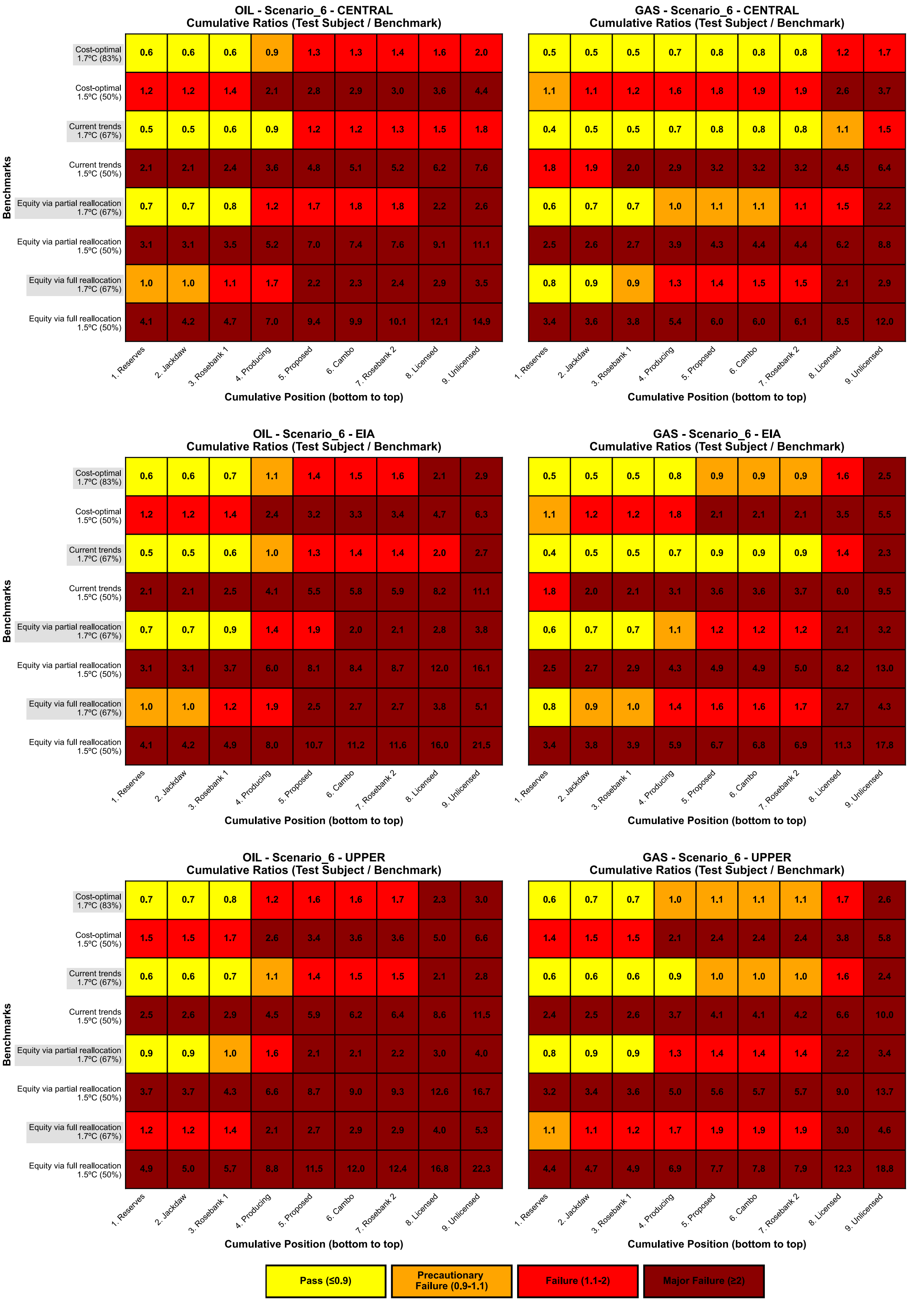

OIL - Scenario_6 - CENTRAL
Cumulative Ratios (Test Subject / Benchmark)

Benchmarks	1. Reserves	2. Jackdaw	3. Rosebank 1	4. Producing	5. Proposed	6. Cambo	7. Rosebank 2	8. Licensed	9. Unlicensed
Cost-optimal 1.7ºC (83%)	0.6	0.6	0.6	0.9	1.3	1.3	1.4	1.6	2.0
Cost-optimal 1.5ºC (50%)	1.2	1.2	1.4	2.1	2.8	2.9	3.0	3.6	4.4
Current trends 1.7ºC (67%)	0.5	0.5	0.6	0.9	1.2	1.2	1.3	1.5	1.8
Current trends 1.5ºC (50%)	2.1	2.1	2.4	3.6	4.8	5.1	5.2	6.2	7.6
Equity via partial reallocation 1.7ºC (67%)	0.7	0.7	0.8	1.2	1.7	1.8	1.8	2.2	2.6
Equity via partial reallocation 1.5ºC (50%)	3.1	3.1	3.5	5.2	7.0	7.4	7.6	9.1	11.1
Equity via full reallocation 1.7ºC (67%)	1.0	1.0	1.1	1.7	2.2	2.3	2.4	2.9	3.5
Equity via full reallocation 1.5ºC (50%)	4.1	4.2	4.7	7.0	9.4	9.9	10.1	12.1	14.9

GAS - Scenario_6 - CENTRAL
Cumulative Ratios (Test Subject / Benchmark)

Benchmarks	1. Reserves	2. Jackdaw	3. Rosebank 1	4. Producing	5. Proposed	6. Cambo	7. Rosebank 2	8. Licensed	9. Unlicensed
Cost-optimal 1.7ºC (83%)	0.5	0.5	0.5	0.7	0.8	0.8	0.8	1.2	1.7
Cost-optimal 1.5ºC (50%)	1.1	1.1	1.2	1.6	1.8	1.9	1.9	2.6	3.7
Current trends 1.7ºC (67%)	0.4	0.5	0.5	0.7	0.8	0.8	0.8	1.1	1.5
Current trends 1.5ºC (50%)	1.8	1.9	2.0	2.9	3.2	3.2	3.2	4.5	6.4
Equity via partial reallocation 1.7ºC (67%)	0.6	0.7	0.7	1.0	1.1	1.1	1.1	1.5	2.2
Equity via partial reallocation 1.5ºC (50%)	2.5	2.6	2.7	3.9	4.3	4.4	4.4	6.2	8.8
Equity via full reallocation 1.7ºC (67%)	0.8	0.9	0.9	1.3	1.4	1.5	1.5	2.1	2.9
Equity via full reallocation 1.5ºC (50%)	3.4	3.6	3.8	5.4	6.0	6.0	6.1	8.5	12.0

OIL - Scenario_6 - EIA
Cumulative Ratios (Test Subject / Benchmark)

Benchmarks	1. Reserves	2. Jackdaw	3. Rosebank 1	4. Producing	5. Proposed	6. Cambo	7. Rosebank 2	8. Licensed	9. Unlicensed
Cost-optimal 1.7ºC (83%)	0.6	0.6	0.7	1.1	1.4	1.5	1.6	2.1	2.9
Cost-optimal 1.5ºC (50%)	1.2	1.2	1.4	2.4	3.2	3.3	3.4	4.7	6.3
Current trends 1.7ºC (67%)	0.5	0.5	0.6	1.0	1.3	1.4	1.4	2.0	2.7
Current trends 1.5ºC (50%)	2.1	2.1	2.5	4.1	5.5	5.8	5.9	8.2	11.1
Equity via partial reallocation 1.7ºC (67%)	0.7	0.7	0.9	1.4	1.9	2.0	2.1	2.8	3.8
Equity via partial reallocation 1.5ºC (50%)	3.1	3.1	3.7	6.0	8.1	8.4	8.7	12.0	16.1
Equity via full reallocation 1.7ºC (67%)	1.0	1.0	1.2	1.9	2.5	2.7	2.7	3.8	5.1
Equity via full reallocation 1.5ºC (50%)	4.1	4.2	4.9	8.0	10.7	11.2	11.6	16.0	21.5

GAS - Scenario_6 - EIA
Cumulative Ratios (Test Subject / Benchmark)

Benchmarks	1. Reserves	2. Jackdaw	3. Rosebank 1	4. Producing	5. Proposed	6. Cambo	7. Rosebank 2	8. Licensed	9. Unlicensed
Cost-optimal 1.7ºC (83%)	0.5	0.5	0.5	0.8	0.9	0.9	0.9	1.6	2.5
Cost-optimal 1.5ºC (50%)	1.1	1.2	1.2	1.8	2.1	2.1	2.1	3.5	5.5
Current trends 1.7ºC (67%)	0.4	0.5	0.5	0.7	0.9	0.9	0.9	1.4	2.3
Current trends 1.5ºC (50%)	1.8	2.0	2.1	3.1	3.6	3.6	3.7	6.0	9.5
Equity via partial reallocation 1.7ºC (67%)	0.6	0.7	0.7	1.1	1.2	1.2	1.2	2.1	3.2
Equity via partial reallocation 1.5ºC (50%)	2.5	2.7	2.9	4.3	4.9	4.9	5.0	8.2	13.0
Equity via full reallocation 1.7ºC (67%)	0.8	0.9	1.0	1.4	1.6	1.6	1.7	2.7	4.3
Equity via full reallocation 1.5ºC (50%)	3.4	3.8	3.9	5.9	6.7	6.8	6.9	11.3	17.8

OIL - Scenario_6 - UPPER
Cumulative Ratios (Test Subject / Benchmark)

Benchmarks	1. Reserves	2. Jackdaw	3. Rosebank 1	4. Producing	5. Proposed	6. Cambo	7. Rosebank 2	8. Licensed	9. Unlicensed
Cost-optimal 1.7ºC (83%)	0.7	0.7	0.8	1.2	1.6	1.6	1.7	2.3	3.0
Cost-optimal 1.5ºC (50%)	1.5	1.5	1.7	2.6	3.4	3.6	3.6	5.0	6.6
Current trends 1.7ºC (67%)	0.6	0.6	0.7	1.1	1.4	1.5	1.5	2.1	2.8
Current trends 1.5ºC (50%)	2.5	2.6	2.9	4.5	5.9	6.2	6.4	8.6	11.5
Equity via partial reallocation 1.7ºC (67%)	0.9	0.9	1.0	1.6	2.1	2.1	2.2	3.0	4.0
Equity via partial reallocation 1.5ºC (50%)	3.7	3.7	4.3	6.6	8.7	9.0	9.3	12.6	16.7
Equity via full reallocation 1.7ºC (67%)	1.2	1.2	1.4	2.1	2.7	2.9	2.9	4.0	5.3
Equity via full reallocation 1.5ºC (50%)	4.9	5.0	5.7	8.8	11.5	12.0	12.4	16.8	22.3

GAS - Scenario_6 - UPPER
Cumulative Ratios (Test Subject / Benchmark)

Benchmarks	1. Reserves	2. Jackdaw	3. Rosebank 1	4. Producing	5. Proposed	6. Cambo	7. Rosebank 2	8. Licensed	9. Unlicensed
Cost-optimal 1.7ºC (83%)	0.6	0.7	0.7	1.0	1.1	1.1	1.1	1.7	2.6
Cost-optimal 1.5ºC (50%)	1.4	1.5	1.5	2.1	2.4	2.4	2.4	3.8	5.8
Current trends 1.7ºC (67%)	0.6	0.6	0.6	0.9	1.0	1.0	1.0	1.6	2.4
Current trends 1.5ºC (50%)	2.4	2.5	2.6	3.7	4.1	4.1	4.2	6.6	10.0
Equity via partial reallocation 1.7ºC (67%)	0.8	0.9	0.9	1.3	1.4	1.4	1.4	2.2	3.4
Equity via partial reallocation 1.5ºC (50%)	3.2	3.4	3.6	5.0	5.6	5.7	5.7	9.0	13.7
Equity via full reallocation 1.7ºC (67%)	1.1	1.1	1.2	1.7	1.9	1.9	1.9	3.0	4.6
Equity via full reallocation 1.5ºC (50%)	4.4	4.7	4.9	6.9	7.7	7.8	7.9	12.3	18.8

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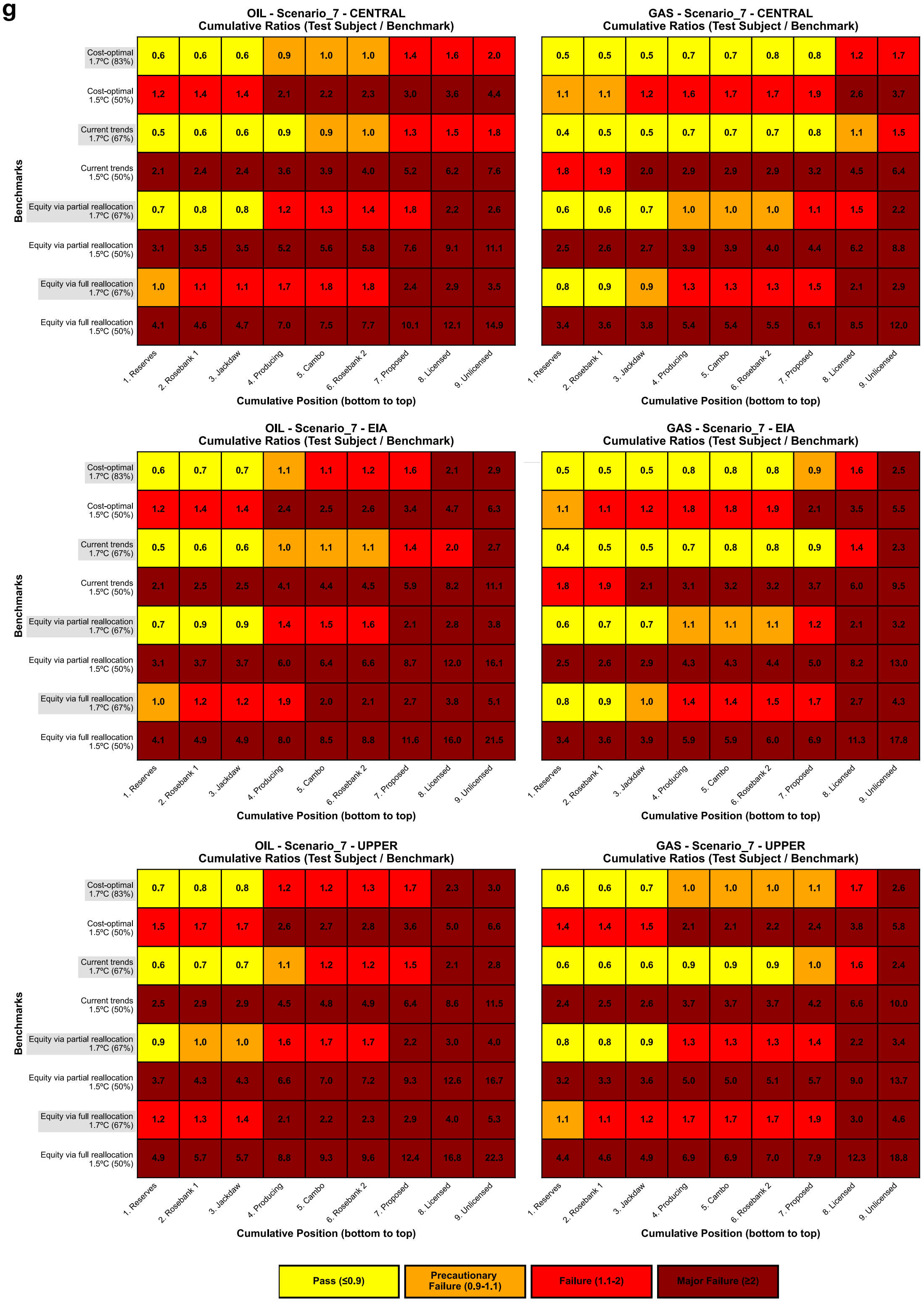

OIL - Scenario_7 - CENTRAL
Cumulative Ratios (Test Subject / Benchmark)

Benchmarks	1. Reserves	2. Rosebank 1	3. Jackdaw	4. Producing	5. Cambo	6. Rosebank 2	7. Proposed	8. Licensed	9. Unlicensed
Cost-optimal 1.7°C (83%)	0.6	0.6	0.6	0.9	1.0	1.0	1.4	1.6	2.0
Cost-optimal 1.5°C (50%)	1.2	1.4	1.4	2.1	2.2	2.3	3.0	3.6	4.4
Current trends 1.7°C (67%)	0.5	0.6	0.6	0.9	0.9	1.0	1.3	1.5	1.8
Current trends 1.5°C (50%)	2.1	2.4	2.4	3.6	3.9	4.0	5.2	6.2	7.6
Equity via partial reallocation 1.7°C (67%)	0.7	0.8	0.8	1.2	1.3	1.4	1.8	2.2	2.6
Equity via partial reallocation 1.5°C (50%)	3.1	3.5	3.5	5.2	5.6	5.8	7.6	9.1	11.1
Equity via full reallocation 1.7°C (67%)	1.0	1.1	1.1	1.7	1.8	1.8	2.4	2.9	3.5
Equity via full reallocation 1.5°C (50%)	4.1	4.6	4.7	7.0	7.5	7.7	10.1	12.1	14.9

Cumulative Position (bottom to top)

GAS - Scenario_7 - CENTRAL
Cumulative Ratios (Test Subject / Benchmark)

Benchmarks	1. Reserves	2. Rosebank 1	3. Jackdaw	4. Producing	5. Cambo	6. Rosebank 2	7. Proposed	8. Licensed	9. Unlicensed
Cost-optimal 1.7°C (83%)	0.5	0.5	0.5	0.7	0.7	0.8	0.8	1.2	1.7
Cost-optimal 1.5°C (50%)	1.1	1.1	1.2	1.6	1.7	1.7	1.9	2.6	3.7
Current trends 1.7°C (67%)	0.4	0.5	0.5	0.7	0.7	0.7	0.8	1.1	1.5
Current trends 1.5°C (50%)	1.8	1.9	2.0	2.9	2.9	2.9	3.2	4.5	6.4
Equity via partial reallocation 1.7°C (67%)	0.6	0.6	0.7	1.0	1.0	1.0	1.1	1.5	2.2
Equity via partial reallocation 1.5°C (50%)	2.5	2.6	2.7	3.9	3.9	4.0	4.4	6.2	8.8
Equity via full reallocation 1.7°C (67%)	0.8	0.9	0.9	1.3	1.3	1.3	1.5	2.1	2.9
Equity via full reallocation 1.5°C (50%)	3.4	3.6	3.8	5.4	5.4	5.5	6.1	8.5	12.0

Cumulative Position (bottom to top)

OIL - Scenario_7 - EIA
Cumulative Ratios (Test Subject / Benchmark)

Benchmarks	1. Reserves	2. Rosebank 1	3. Jackdaw	4. Producing	5. Cambo	6. Rosebank 2	7. Proposed	8. Licensed	9. Unlicensed
Cost-optimal 1.7°C (83%)	0.6	0.7	0.7	1.1	1.1	1.2	1.6	2.1	2.9
Cost-optimal 1.5°C (50%)	1.2	1.4	1.4	2.4	2.5	2.6	3.4	4.7	6.3
Current trends 1.7°C (67%)	0.5	0.6	0.6	1.0	1.1	1.1	1.4	2.0	2.7
Current trends 1.5°C (50%)	2.1	2.5	2.5	4.1	4.4	4.5	5.9	8.2	11.1
Equity via partial reallocation 1.7°C (67%)	0.7	0.9	0.9	1.4	1.5	1.6	2.1	2.8	3.8
Equity via partial reallocation 1.5°C (50%)	3.1	3.7	3.7	6.0	6.4	6.6	8.7	12.0	16.1
Equity via full reallocation 1.7°C (67%)	1.0	1.2	1.2	1.9	2.0	2.1	2.7	3.8	5.1
Equity via full reallocation 1.5°C (50%)	4.1	4.9	4.9	8.0	8.5	8.8	11.6	16.0	21.5

Cumulative Position (bottom to top)

GAS - Scenario_7 - EIA
Cumulative Ratios (Test Subject / Benchmark)

Benchmarks	1. Reserves	2. Rosebank 1	3. Jackdaw	4. Producing	5. Cambo	6. Rosebank 2	7. Proposed	8. Licensed	9. Unlicensed
Cost-optimal 1.7°C (83%)	0.5	0.5	0.5	0.8	0.8	0.8	0.9	1.6	2.5
Cost-optimal 1.5°C (50%)	1.1	1.1	1.2	1.8	1.8	1.9	2.1	3.5	5.5
Current trends 1.7°C (67%)	0.4	0.5	0.5	0.7	0.8	0.8	0.9	1.4	2.3
Current trends 1.5°C (50%)	1.8	1.9	2.1	3.1	3.2	3.2	3.7	6.0	9.5
Equity via partial reallocation 1.7°C (67%)	0.6	0.7	0.7	1.1	1.1	1.1	1.2	2.1	3.2
Equity via partial reallocation 1.5°C (50%)	2.5	2.6	2.9	4.3	4.3	4.4	5.0	8.2	13.0
Equity via full reallocation 1.7°C (67%)	0.8	0.9	1.0	1.4	1.4	1.5	1.7	2.7	4.3
Equity via full reallocation 1.5°C (50%)	3.4	3.6	3.9	5.9	5.9	6.0	6.9	11.3	17.8

Cumulative Position (bottom to top)

OIL - Scenario_7 - UPPER
Cumulative Ratios (Test Subject / Benchmark)

Benchmarks	1. Reserves	2. Rosebank 1	3. Jackdaw	4. Producing	5. Cambo	6. Rosebank 2	7. Proposed	8. Licensed	9. Unlicensed
Cost-optimal 1.7°C (83%)	0.7	0.8	0.8	1.2	1.2	1.3	1.7	2.3	3.0
Cost-optimal 1.5°C (50%)	1.5	1.7	1.7	2.6	2.7	2.8	3.6	5.0	6.6
Current trends 1.7°C (67%)	0.6	0.7	0.7	1.1	1.2	1.2	1.5	2.1	2.8
Current trends 1.5°C (50%)	2.5	2.9	2.9	4.5	4.8	4.9	6.4	8.6	11.5
Equity via partial reallocation 1.7°C (67%)	0.9	1.0	1.0	1.6	1.7	1.7	2.2	3.0	4.0
Equity via partial reallocation 1.5°C (50%)	3.7	4.3	4.3	6.6	7.0	7.2	9.3	12.6	16.7
Equity via full reallocation 1.7°C (67%)	1.2	1.3	1.4	2.1	2.2	2.3	2.9	4.0	5.3
Equity via full reallocation 1.5°C (50%)	4.9	5.7	5.7	8.8	9.3	9.6	12.4	16.8	22.3

Cumulative Position (bottom to top)

GAS - Scenario_7 - UPPER
Cumulative Ratios (Test Subject / Benchmark)

Benchmarks	1. Reserves	2. Rosebank 1	3. Jackdaw	4. Producing	5. Cambo	6. Rosebank 2	7. Proposed	8. Licensed	9. Unlicensed
Cost-optimal 1.7°C (83%)	0.6	0.6	0.7	1.0	1.0	1.0	1.1	1.7	2.6
Cost-optimal 1.5°C (50%)	1.4	1.4	1.5	2.1	2.1	2.2	2.4	3.8	5.8
Current trends 1.7°C (67%)	0.6	0.6	0.6	0.9	0.9	0.9	1.0	1.6	2.4
Current trends 1.5°C (50%)	2.4	2.5	2.6	3.7	3.7	3.7	4.2	6.6	10.0
Equity via partial reallocation 1.7°C (67%)	0.8	0.8	0.9	1.3	1.3	1.3	1.4	2.2	3.4
Equity via partial reallocation 1.5°C (50%)	3.2	3.3	3.6	5.0	5.0	5.1	5.7	9.0	13.7
Equity via full reallocation 1.7°C (67%)	1.1	1.1	1.2	1.7	1.7	1.7	1.9	3.0	4.6
Equity via full reallocation 1.5°C (50%)	4.4	4.6	4.9	6.9	6.9	7.0	7.9	12.3	18.8

Cumulative Position (bottom to top)

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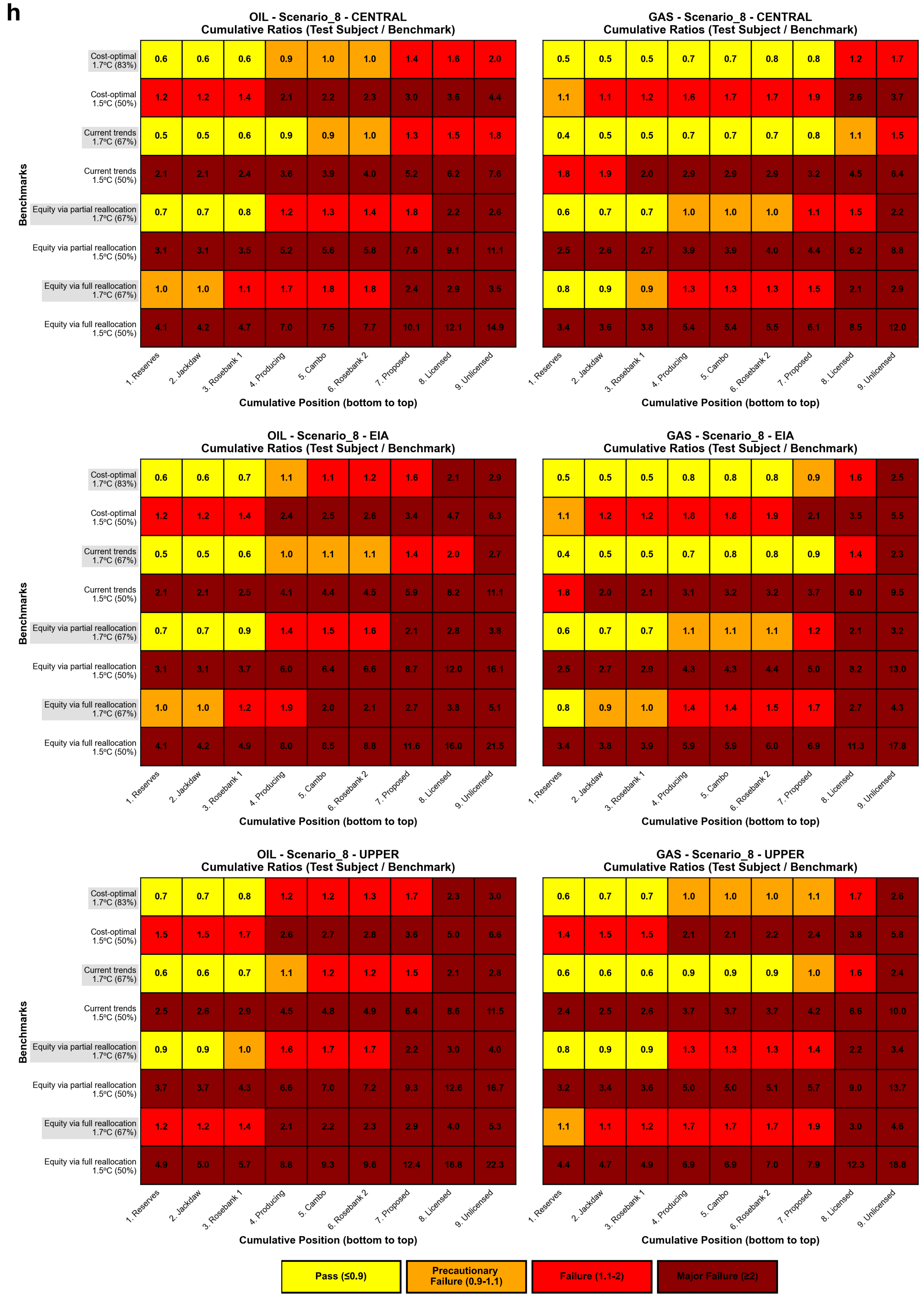

OIL - Scenario_8 - CENTRAL
Cumulative Ratios (Test Subject / Benchmark)

Benchmarks	1. Reserves	2. Jackdaw	3. Rosebank 1	4. Producing	5. Cambo	6. Rosebank 2	7. Proposed	8. Licensed	9. Unlicensed
Cost-optimal 1.7ºC (83%)	0.6	0.6	0.6	0.9	1.0	1.0	1.4	1.6	2.0
Cost-optimal 1.5ºC (50%)	1.2	1.2	1.4	2.1	2.2	2.3	3.0	3.6	4.4
Current trends 1.7ºC (67%)	0.5	0.5	0.6	0.9	0.9	1.0	1.3	1.5	1.8
Current trends 1.5ºC (50%)	2.1	2.1	2.4	3.6	3.9	4.0	5.2	6.2	7.6
Equity via partial reallocation 1.7ºC (67%)	0.7	0.7	0.8	1.2	1.3	1.4	1.8	2.2	2.6
Equity via partial reallocation 1.5ºC (50%)	3.1	3.1	3.5	5.2	5.6	5.8	7.6	9.1	11.1
Equity via full reallocation 1.7ºC (67%)	1.0	1.0	1.1	1.7	1.8	1.8	2.4	2.9	3.5
Equity via full reallocation 1.5ºC (50%)	4.1	4.2	4.7	7.0	7.5	7.7	10.1	12.1	14.9

GAS - Scenario_8 - CENTRAL
Cumulative Ratios (Test Subject / Benchmark)

Benchmarks	1. Reserves	2. Jackdaw	3. Rosebank 1	4. Producing	5. Cambo	6. Rosebank 2	7. Proposed	8. Licensed	9. Unlicensed
Cost-optimal 1.7ºC (83%)	0.5	0.5	0.5	0.7	0.7	0.8	0.8	1.2	1.7
Cost-optimal 1.5ºC (50%)	1.1	1.1	1.2	1.6	1.7	1.7	1.9	2.6	3.7
Current trends 1.7ºC (67%)	0.4	0.5	0.5	0.7	0.7	0.7	0.8	1.1	1.5
Current trends 1.5ºC (50%)	1.8	1.9	2.0	2.9	2.9	2.9	3.2	4.5	6.4
Equity via partial reallocation 1.7ºC (67%)	0.6	0.7	0.7	1.0	1.0	1.0	1.1	1.5	2.2
Equity via partial reallocation 1.5ºC (50%)	2.5	2.6	2.7	3.9	3.9	4.0	4.4	6.2	8.8
Equity via full reallocation 1.7ºC (67%)	0.8	0.9	0.9	1.3	1.3	1.3	1.5	2.1	2.9
Equity via full reallocation 1.5ºC (50%)	3.4	3.6	3.8	5.4	5.4	5.5	6.1	8.5	12.0

OIL - Scenario_8 - EIA
Cumulative Ratios (Test Subject / Benchmark)

Benchmarks	1. Reserves	2. Jackdaw	3. Rosebank 1	4. Producing	5. Cambo	6. Rosebank 2	7. Proposed	8. Licensed	9. Unlicensed
Cost-optimal 1.7ºC (83%)	0.6	0.6	0.7	1.1	1.1	1.2	1.6	2.1	2.9
Cost-optimal 1.5ºC (50%)	1.2	1.2	1.4	2.4	2.5	2.6	3.4	4.7	6.3
Current trends 1.7ºC (67%)	0.5	0.5	0.6	1.0	1.1	1.1	1.4	2.0	2.7
Current trends 1.5ºC (50%)	2.1	2.1	2.5	4.1	4.4	4.5	5.9	8.2	11.1
Equity via partial reallocation 1.7ºC (67%)	0.7	0.7	0.9	1.4	1.5	1.6	2.1	2.8	3.8
Equity via partial reallocation 1.5ºC (50%)	3.1	3.1	3.7	6.0	6.4	6.6	8.7	12.0	16.1
Equity via full reallocation 1.7ºC (67%)	1.0	1.0	1.2	1.9	2.0	2.1	2.7	3.8	5.1
Equity via full reallocation 1.5ºC (50%)	4.1	4.2	4.9	8.0	8.5	8.8	11.6	16.0	21.5

GAS - Scenario_8 - EIA
Cumulative Ratios (Test Subject / Benchmark)

Benchmarks	1. Reserves	2. Jackdaw	3. Rosebank 1	4. Producing	5. Cambo	6. Rosebank 2	7. Proposed	8. Licensed	9. Unlicensed
Cost-optimal 1.7ºC (83%)	0.5	0.5	0.5	0.8	0.8	0.8	0.9	1.6	2.5
Cost-optimal 1.5ºC (50%)	1.1	1.2	1.2	1.8	1.8	1.9	2.1	3.5	5.5
Current trends 1.7ºC (67%)	0.4	0.5	0.5	0.7	0.8	0.8	0.9	1.4	2.3
Current trends 1.5ºC (50%)	1.8	2.0	2.1	3.1	3.2	3.2	3.7	6.0	9.5
Equity via partial reallocation 1.7ºC (67%)	0.6	0.7	0.7	1.1	1.1	1.1	1.2	2.1	3.2
Equity via partial reallocation 1.5ºC (50%)	2.5	2.7	2.9	4.3	4.3	4.4	5.0	8.2	13.0
Equity via full reallocation 1.7ºC (67%)	0.8	0.9	1.0	1.4	1.4	1.5	1.7	2.7	4.3
Equity via full reallocation 1.5ºC (50%)	3.4	3.8	3.9	5.9	5.9	6.0	6.9	11.3	17.8

OIL - Scenario_8 - UPPER
Cumulative Ratios (Test Subject / Benchmark)

Benchmarks	1. Reserves	2. Jackdaw	3. Rosebank 1	4. Producing	5. Cambo	6. Rosebank 2	7. Proposed	8. Licensed	9. Unlicensed
Cost-optimal 1.7ºC (83%)	0.7	0.7	0.8	1.2	1.2	1.3	1.7	2.3	3.0
Cost-optimal 1.5ºC (50%)	1.5	1.5	1.7	2.6	2.7	2.8	3.6	5.0	6.6
Current trends 1.7ºC (67%)	0.6	0.6	0.7	1.1	1.2	1.2	1.5	2.1	2.8
Current trends 1.5ºC (50%)	2.5	2.6	2.9	4.5	4.8	4.9	6.4	8.6	11.5
Equity via partial reallocation 1.7ºC (67%)	0.9	0.9	1.0	1.6	1.7	1.7	2.2	3.0	4.0
Equity via partial reallocation 1.5ºC (50%)	3.7	3.7	4.3	6.6	7.0	7.2	9.3	12.6	16.7
Equity via full reallocation 1.7ºC (67%)	1.2	1.2	1.4	2.1	2.2	2.3	2.9	4.0	5.3
Equity via full reallocation 1.5ºC (50%)	4.9	5.0	5.7	8.8	9.3	9.6	12.4	16.8	22.3

GAS - Scenario_8 - UPPER
Cumulative Ratios (Test Subject / Benchmark)

Benchmarks	1. Reserves	2. Jackdaw	3. Rosebank 1	4. Producing	5. Cambo	6. Rosebank 2	7. Proposed	8. Licensed	9. Unlicensed
Cost-optimal 1.7ºC (83%)	0.6	0.7	0.7	1.0	1.0	1.0	1.1	1.7	2.6
Cost-optimal 1.5ºC (50%)	1.4	1.5	1.5	2.1	2.1	2.2	2.4	3.8	5.8
Current trends 1.7ºC (67%)	0.6	0.6	0.6	0.9	0.9	0.9	1.0	1.6	2.4
Current trends 1.5ºC (50%)	2.4	2.5	2.6	3.7	3.7	3.7	4.2	6.6	10.0
Equity via partial reallocation 1.7ºC (67%)	0.8	0.9	0.9	1.3	1.3	1.3	1.4	2.2	3.4
Equity via partial reallocation 1.5ºC (50%)	3.2	3.4	3.6	5.0	5.0	5.1	5.7	9.0	13.7
Equity via full reallocation 1.7ºC (67%)	1.1	1.1	1.2	1.7	1.7	1.7	1.9	3.0	4.6
Equity via full reallocation 1.5ºC (50%)	4.4	4.7	4.9	6.9	6.9	7.0	7.9	12.3	18.8

Figure S2 | Supplementary climate test results for UK oil and gas (a–h). Cell values show γ (test subject emissions / benchmark emissions) for all test subjects under two temperature targets (1.5°C and 1.7°C) at varying confidence levels, using all combinations of test subject ordering and emissions scenarios. Note that the cost-optimal benchmark uses 1.7°C at 83% confidence, while all other benchmarks use 67%; 1.5°C is shown at 50% throughout. Colour coding follows the legend; note that Pass is defined as $\gamma \leq 0.9$ to reflect a precautionary margin given uncertainties in all assessments. 1.7°C ("well below 2°C") benchmark rows are indicated by grey labels. Test subjects are stacked cumulatively; numbered labels correspond to full definitions in Table 2. We do not show coproduction failures as in Figure 3, however they occur wherever the primary product fails (oil for all except Jackdaw). Note that Figure 3 uses Scenario 7 (g). Rounding may result in minor categorical discrepancies.

Table S2 | Remaining carbon budget comparisons

Study	Temp	2011	2018	2020	2025	2026	Correction using Forster et al. (2025)
Welsby et al. (2021)	*1.5ºC (50%)*	870	580	496	287	245	45%
IPCC AR6 (2021)	*1.7ºC (50%)*	1224	934	850	640	598	77%
	1.5ºC (50%)	874	584	500	290	248	45%
	1.5ºC (67%)	774	484	400	190	148	42%
IEA NZE	*1.5ºC (50%)*	834	544	460	250	208	52%
Forster et al. (2025)	*1.7ºC (50%)*	1073	783	700	490	448	--
	1.7ºC (67%)	973	683	600	390	348	--
	1.7ºC (83%)	873	583	500	290	248	--
	1.5ºC (50%)	713	423	340	130	88	--
	1.5ºC (67%)	663	373	290	80	38	--

Remaining carbon budget (RCB) from the start of quoted year ($GtCO_2$) with emissions adjustments and scaling factors. Dark grey indicates inferred historical RCB adding total fossil fuel and land use CO_2 emissions and light grey indicates projected by adding ensuing emissions.

Table S3 | Committed emissions γ values (Climate test 1)

Study	Temp	low	med	high
IPCC AR6 (2021)	1.7ºC (50%)	0.9	1.0	1.1
	1.5ºC (50%)	1.5	1.6	1.7
	1.5ºC (67%)	1.8	1.9	2.1
IEA NZE	1.5ºC (50%)	1.6	1.7	1.8
Forster et al. (2025)	1.7ºC (50%)	1.1	1.2	1.3
	1.7ºC (67%)	1.3	1.4	1.5
	1.7ºC (83%)	1.5	1.6	1.7
	1.5ºC (50%)	2.1	2.2	2.3
	1.5ºC (67%)	2.4	2.5	2.7

Values equal committed emissions / remaining carbon budget in year 2018.
Committed emissions values are for all fossil fuel reserves from Trout et al. (2022).

Supplementary Discussion

The fugitive emissions caveat fundamentally alters gas compatibility

Our combustion-only accounting dramatically understates gas's climate impact. Fugitive methane (CH_4) emissions—unintended CH_4 losses during extraction, processing, storage, and transport, particularly for natural gas—are likely the largest and most consequential exclusion from our emissions accounting. Life-cycle greenhouse gas emissions from gas extraction are substantially higher when upstream methane losses are included. Recent studies using aircraft measurements, satellite observations, and bottom-up facility surveys estimate fugitive emissions rates of ~2.3% of gas produced for North American industry averages,[1] while unconventional gas may have loss rate of over ~1-2 p.p. higher.[2,3] Systematic underreporting of methane emissions across the global industry[4,5] suggests official inventories likely underestimate true losses.

We cite the best available North Sea studies in the main text for context. The most comprehensive study to date found that 2.3% of gross production was lost (1.9% during extraction), 60% higher than reported by government inventories.[1] UK production, dominated by offshore extraction, likely has different loss rates. While there is no study for UK North Sea oil and gas production as comprehensive as for the US, recent top-down estimates suggest methane losses to be substantially underreported, and that losses during extraction are usually ~1.0% of gross product or about five times higher than official reporting,[6,7] with super-emitter events resulting in annual losses of 3.1% for affected platforms.[7]

Converting fugitive methane to CO_2-equivalent using a 100-year global warming potential ($GWP_{100} = 29.8$ per IPCC AR6; Ref.[8]) increases life-cycle emissions by approximately at least a quarter, depending on loss rates (Author's calc.). Over 20-year timescales more relevant for near-term climate tipping points, methane's higher radiative efficiency ($GWP_{20} = 82.5$; Ref.[8]) increases life-cycle emissions by at least two-thirds,[i] potentially making gas's total climate impact comparable to or exceeding coal per unit energy delivered.[2,9] Our combustion-only approach thus provides a lower bound on gas incompatibility. Including fugitive emissions at rates observed in other major producing regions would cause existing gas reserves to fail additional equity and feasibility tests that currently depict possible compatibility. We discuss these implications extensively in the main text.

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[i] Converting methane to CO_2-equivalent using a 100-year global warming potential ($GWP_{100} = 29.8$) increases life-cycle emissions by approximately 9-28% for 1.0-3.1% loss rates. Over 20-year timescales more relevant for near-term climate tipping points, methane's higher potency (GWP_{20}) increases life-cycle emissions by 25-79% over this loss rate range.

Integrated assessment modelling limitations and caveats

Real-world energy systems deviate substantially from assumptions used in integrated assessment modelling used to quantify a cost-optimal benchmark. Producer cartels manipulate supply to maintain prices, with OPEC coordinating production levels among members to stabilize oil prices around target levels.[10] Energy security concerns override cost considerations, exemplified by Europe's rejection of cheaper Russian gas following geopolitical tensions despite industrial gas prices remaining over four times higher than alternatives.[11,12] Political capture by fossil fuel interests props up production, with revolving door appointments and lobbying expenditures vastly exceeding climate advocacy spending in multiple jurisdictions.[13–15] First-mover disadvantages discourage early phaseout, as powerful countries use their influence mainly to obstruct coordination while pathways face unprecedented governance challenges requiring institutional breakthroughs beyond current abilities.[16,17] These realities suggest cost-optimal benchmarks overestimate compatible extraction by assuming coordination and efficiency that is unlikely to materialize.

Moreover, the TIMES Integrated Assessment Model at University College London (TIAM-UCL) model used to estimate the cost-optimal benchmarks has known limitations for country-level analysis. The model aggregates UK with European producers, limiting granularity. Model architecture struggles with rapid transitions, requiring gradual phaseout trajectories that may rely excessively on negative emissions technologies to compensate for delayed action.[18,19] The authors themselves caution against prescriptive interpretation of exact country-level values (J. Price & S. Pye, personal communication, November 2024). Cost-optimal tests should therefore be interpreted as upper bounds on possible compatibility under idealized conditions, not as recommendations that such extraction should occur.

Uncertainty and sensitivity

Key uncertainties include: (1) Carbon budget estimates, which vary by ±50-100 $GtCO_2$ depending on climate sensitivity assumptions, Earth system feedbacks, and permissible temporary overshoot.[20,21] (2) Reserve and resource volume estimates, with P10-P90 ranges spanning factors of 1.5-2.5 for many fields. (3) Emissions conversion factors, which vary by ±5-10% depending on fuel composition and refining pathways. (4) Model-based benchmark allocations, which carry the limitations discussed above regarding country-level granularity and assumed transition feasibility. (5) Future production rates and field development timing, which affect temporal distribution but not cumulative totals.

We address these through: (1) Testing three production scenarios (Central, Upper, EIA) spanning probability ranges from P90 to P10. (2) Using three temperature targets with different confidence levels (1.5°C at 67% and 50%, 1.7°C at 67%). (3) Employing multiple equity frameworks rather than relying on a single approach, revealing sensitivity to operationalization choices. (4) Reporting γ values across scenarios and benchmarks rather than single point estimates. (5) Focusing on cumulative emissions over project lifetimes rather than annual rates, which are more robust to timing uncertainties.

Qualitative findings—that oil fails most tests while gas shows mixed results depending on equity stringency and accounting scope—are robust across these uncertainty dimensions. The most consequential sensitivity is inclusion of fugitive methane emissions for gas (see above), as this can increase life-cycle emissions by 25-100% depending on loss rates and GWP timescales.

Supplementary Methods

Carbon budget derivation

We derive fossil fuel combustion carbon budgets by subtracting projected cement process emissions (non-combustion CO_2 from clinker calcination) from total remaining carbon budgets (RCBs). Following Calverley & Anderson,[22] we use overhead estimates accounting for cement demand trajectories under different decarbonization pathways. The original study estimated cumulative cement emissions of 60 $GtCO_2$ for 1.5°C scenarios (2022–2050) and 100 $GtCO_2$ for 2°C scenarios (2022–2075). We adjust these from a 2022 baseline to a 2025 start date by subtracting three years of cement emissions at approximately 1.6 $GtCO_2$/year,[23] yielding adjusted overheads of 55 $GtCO_2$ for 1.5°C pathways and 95 $GtCO_2$ for 1.7°C pathways. Subtracting these from total RCBs yields fossil fuel combustion budgets of approximately 75 $GtCO_2$ for 1.5°C (50%) and 295 $GtCO_2$ for 1.7°C (67%).

We partition these budgets by fuel type using proportions from IPCC AR6 1.5°C and 1.7°C mitigation scenarios[24] as compiled by Calverley & Anderson:[22] 38% oil, 21% gas, and 41% coal for 1.5°C scenarios; 41% oil, 22% gas, and 37% coal for 1.7°C scenarios. These proportions reflect differential phase-out rates in Paris-compliant pathways, with coal declining fastest and gas slowest. Land-use emissions are omitted from budget adjustments as they transition from net source to net sink over the course of 1.5–1.7°C pathways, roughly cancelling on a cumulative basis.

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