Capstone Project

Strategic Leadership in the Energy Transition
Balancing Financial and Sustainability Goals

COLUMBIA SIPA
School of International and Public Affairs

equinor

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Content Overview

1. Context
2. Takeaways
3. Approaches
4. Observations
5. Insights

Context

Macro Context

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The Transition Profitability Challenge

Global energy companies are investing more in renewables, but making money from these projects has been difficult. Higher costs, policy uncertainty, and project delays have made companies more selective about where they deploy capital.

Capital Discipline

Higher interest rates, inflation, supply-chain pressure, and weaker renewable returns have made clean-energy deployment more selective. The era of investing on ambition alone is giving way to a more disciplined phase: investors now expect returns alongside impact.

Distilling the Investment Signal

Our framework distills market, technology, policy, and financial conditions into a clear signal of **where, when, and under what conditions** transition investment becomes financially rational.

Equinor: Ambition Vs. Financial Reality

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Equinor's transition ambition is clear, but the financial gap remains: renewables are still early-stage and loss-making, while core E&P continues to generate strong returns.

Transition Ambition

Renewable Power Generation
2.4 GW → 10–12 GW by 2030

CO_2 Transport & Storage (CCS)
2.3 mtpa → 30–50 mtpa by 2035

Net Carbon Intensity Reduction
30–40% by 2035 • Net Zero by 2050

Source: Equinor's Energy Transition Plan 2025

2025 Financial Reality

E&P Norway – Operating Income
$24.1B

MMP – Operating Income
$1.7B

REN – Revenue (0.2% of group total)
$192M

REN – Operating Loss
–$1.6B

Write-downs (REN, 2025)
–$1.35B

Source: Equinor Annual Report 2025

Key Question

Under what structural conditions

do sustainability objectives become

financially rational capital allocation decisions?

Takeaways

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Investable Momentum Remain Moderate Through 2035

Over the next 10 years, investable momentum will be in the moderate zone across most analyzed countries, signaling a more focused investment strategy in clean energy projects

Investable Momentum

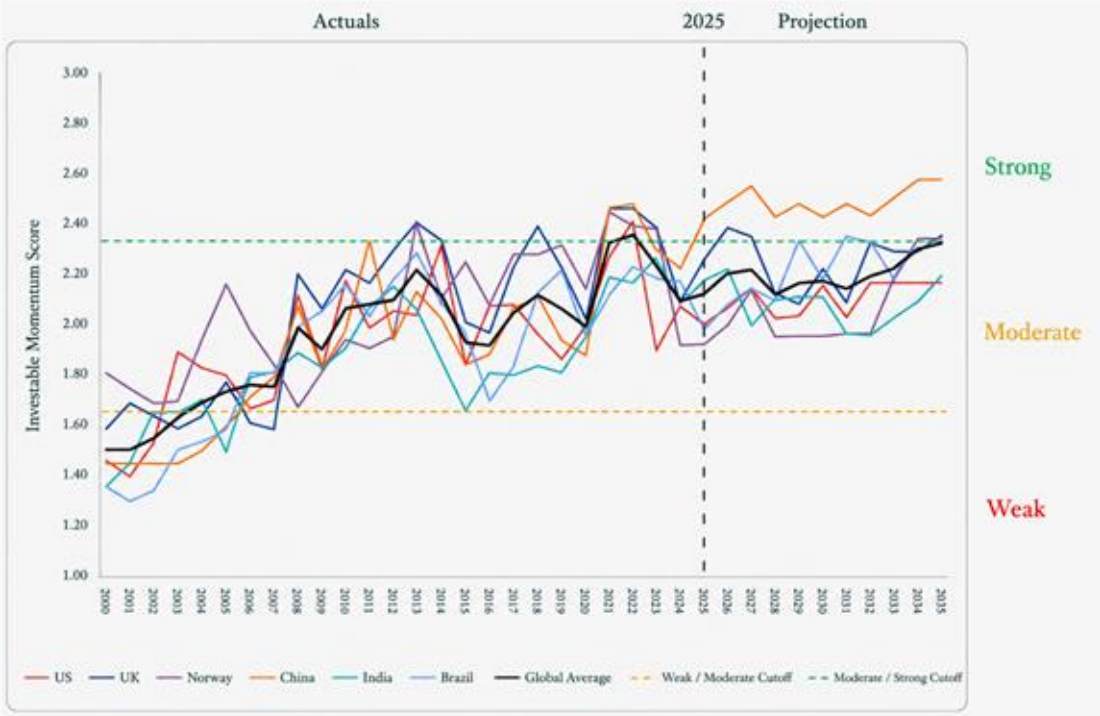
Calculated based on 7 different pillars, investable momentum is **a signal for how favorable the environment is for clean investment.**

Seven Pillars: Policy, Macroeconomic Conditions, Market Prices, Demand, Technology Feasibility, Public Sentiment, CO_2 Emissions

Insights

Historical data shows **a sharp decline** in investable momentum during the **post COVID shock**

In the short term, **most countries remain in the mid to upper moderate zone**, with fluctuating recovery from the post COVID decline



Investable Momentum Drives Two Strategic Paths

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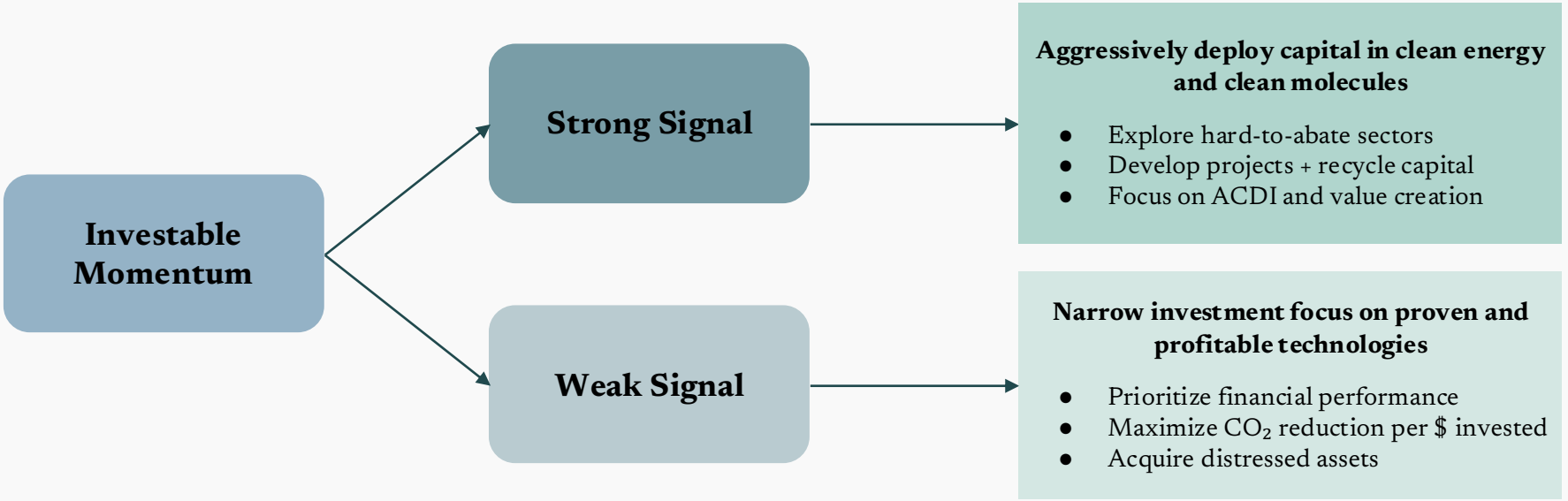
Based on overarching "investable momentum", Equinor can either deploy capital ambitiously in clean technologies or narrow its focus on more strategic assets.



Moderate Momentum Points to CCS

Given moderate investable momentum outlook – layered with risk, technology costs, and Equinor's portfolio – CCS is the most advantageous technology to invest in over the next decade.

Moderate investable momentum zone → **Narrow energy transition deployment and focus on CO_2 reduction per $ invested**

Recommendation: CCS

Compliments Core Business

- Equinor is a pioneer in CCS – familiar with the technology
- CCS paired with gas
- Especially advantageous in a high gas demand environment

Advantage for future hydrogen markets

- Investable momentum is in the upper moderate zone
  - Natural progression from CCS and gas
- Competitive advantage in upstream LNG + CCS flows into blue hydrogen

Constraints and Limitations

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This analysis acknowledges key data, methodological, and scope limitations - findings should be read as strategic guidance on market selection, investment timing, and technology prioritisation.

Data completeness is limited, particularly for granular hourly datasets across key markets for 2000–2035.

Projection methodology varies across macroeconomic, policy, and demand pillars.

Policy and regulatory data access was limited in certain jurisdictions.

Approach

Methodology

Scope – Countries & Technologies

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We assess a broad universe of markets and technologies, including six countries and five technology pathways.

Countries of Interest

Equinor strong presence

Norway

UK

United States

Brazil

High interest emerging markets

India

China

Technology Selection

Core renewable universe

Solar

Offshore Wind

Carbon Capture, and Storage (CCS)

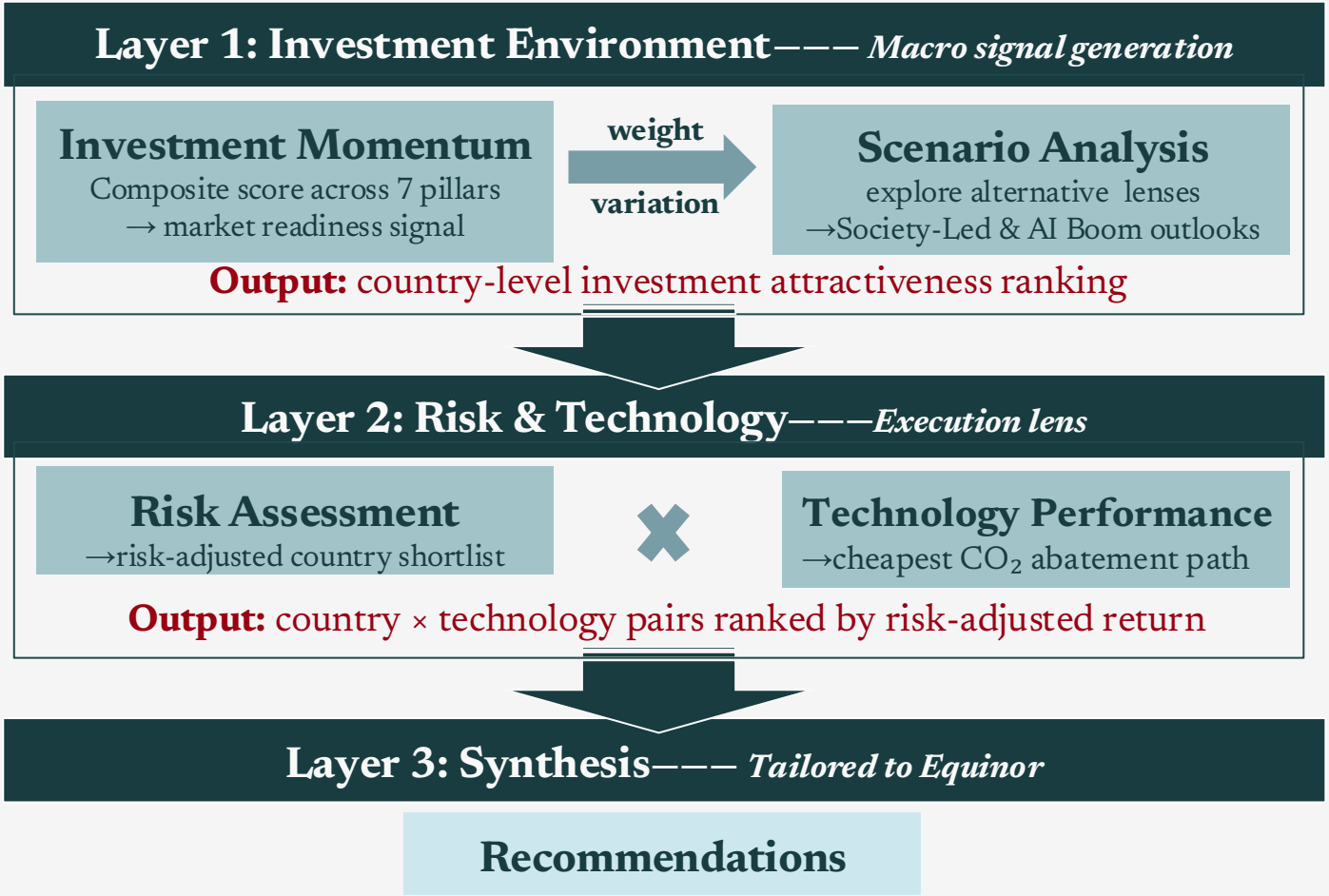
Combined Cycle Gas Turbine (CCGT)

Country-specific application

Biofuels

Methodology

Overall:
We read the macro, re-rank markets as priorities shift, assess country risk and find the cheapest decarbonization plays. Then filter everything through Equinor's portfolio to surface the bets worth making.



Methodology

Lay 1: Investment Environment- The same 7 pillars/indicators, reweighted three different ways depending on different investment worldviews.

	#Base Case - Profitability		#Scenario 1 - Society-Led Transition	#Scenario 2 - AI Boom
	Pillars	***Indicators***		
Tier 1 60%	**Macroeconomics: 20%**	Interest Rate - 75% Inflation - 25%	**Public Sentiment: 20%**	**Demand: 35%**
	Policy: 20%	Gov. Support -70% Clim. Comm. - 30%	**Policy: 20%**	**Technical Feasibility: 25%**
	Market Price: 20%	Power Price - 40% NG Price - 35% Oil Price - 25%	**CO2 Emissions: 20%**	
Tier 2 30%	**Demand: 15%**	Power Demand-35% Gas Consum. - 30% Oil Consum. - 25% ...	**Demand: 15%**	**Macroeconomics: 10%**
	Technical Feasibility: 15%	Mfg. Maturity -30% Res. Potential - 30% SC Stability- 25% ...	**Technical Feasibility: 15%**	**Policy: 10%** **Market Price: 10%**
Tier 3 10%	**Public Sentiment: 5%**	Clim. Concern -50% Env. Priority - 50%	**Macroeconomics: 5%**	**Public Sentiment: 5%**
	CO2 Emissions: 5%	CO2 per Capita -50% Carbon Intensity-50%	**Market Price: 5%**	**CO2 Emissions: 5%**

Methodology

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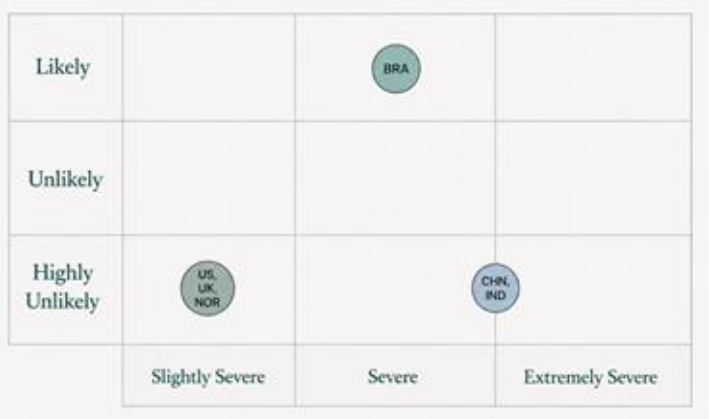
Lay 2: Risk & Technology- We map each country's risk exposure and each technology's cost and CO_2 efficiency. Then cross-reference them into ranked country-technology pairs that tell us where capital creates the most impact, at the lowest risk.

Risk Matrix



Institutional Risk: Political Risk and Access (Money Out)

Tech Matrix

- **Levelized Cost Of Electricity (LCOE)**

LCOE ($/MWh) = Total Lifetime Cost / Total Lifetime Electricity Generated
– *which technologies are most cost-competitive*

- **Avoided CO2 per Dollar Invested (ACDI)**

ACDI ($tCO_2/\$$) = Total Lifetime Avoided CO_2 / Total Lifetime Capital Invested
– *which investments deliver the greatest CO2 avoided impact*

- **Marginal Abatement Cost Curve (MACC)**

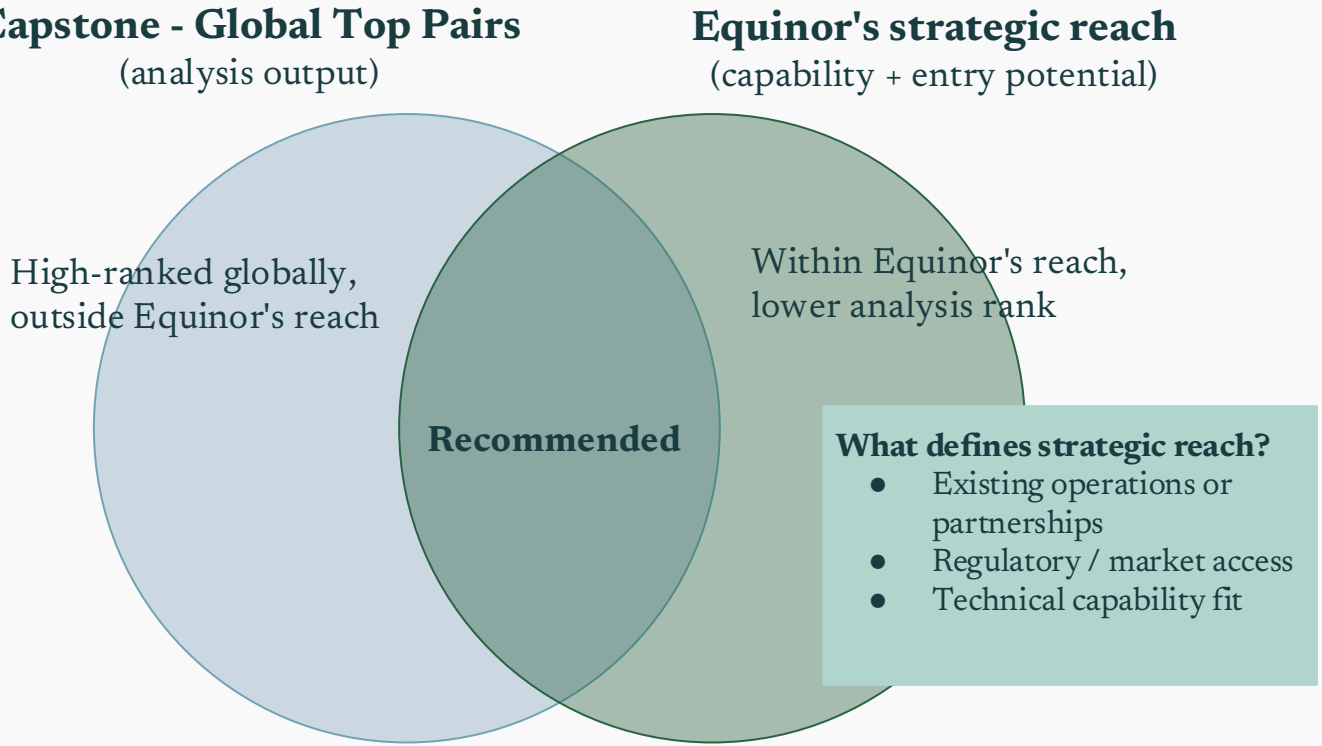
MACC ($\$/tCO_2e$) = (LCOE_tech – LCOE_fossil_baseline) / Emissions_Intensity_displaced
– *which options have the lowest cost per ton avoid*

Layer 1 - Investable Momentum Base Case (A)	Layer 2a - Risk Assess. (B)	Layer 2b - LCOE & ACDI Analysis		Layer 3 - Final Result Location (E) = (A+B+C) Lowest Total = Best	Layer 3 - Final Order (Country + Tech) (G) = (E)+(D) Lowest Total = Best
		Countries (C)	Tech. (Emission Reduction Impact, Policy Support & Market Saturation) (D)		

Methodology

Lay 3: Synthesis – Analysis Results vs. Equinor's Portfolio

The intersection is where our analysis and Equinor's strengths converge – these are the bets worth making.



Observations

China is the only market reaching Strong investment momentum; country selection matters more than scenario betting

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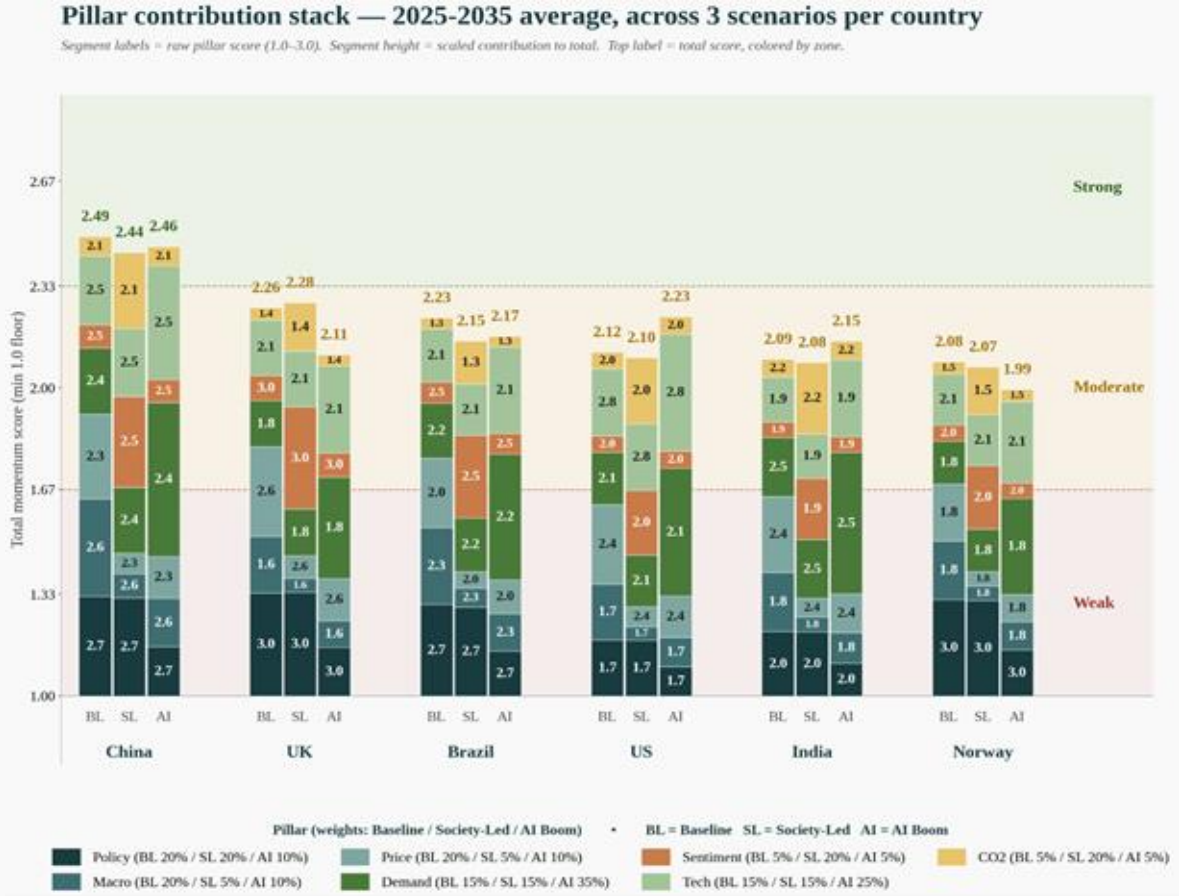

- **Most countries cluster in the upper Moderate zone** – five of six markets sit between 2.05 and 2.28 across all scenarios, with no broad-based "all-in" case for any single one
- **Scenario assumptions don't shift country bands** – max spread within any country is only 0.15 (US BL 2.12 → AI 2.23), reinforcing that country selection matters more than scenario betting
- **China stands alone in the Strong zone** – the only market with all three scenarios above 2.33 (BL 2.49, SL 2.44, AI 2.46), with broad-based pillar strength across Macro, Demand, and Tech

Investment Momentum Archetypes Across Six Markets

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Archetype	Country	Character
Strong-zone Outlier	China 	Only market above the Strong threshold across all scenarios; high-growth potential with broad pillar strength led by Demand and Tech
Mature Stable Markets	UK, Norway  	Maxed Policy credibility, but momentum capped by slow Demand and Price growth typical of mature markets
Scenario-conditional	US 	Mid-Moderate Baseline; lifts only under AI Boom on Tech-pillar strength, dragged by structurally weakening Policy
Improving but Fragile	Brazil 	Strongest upward trajectory driven by Macro recovery; low decarbonization pressure keeps the CO2 pillar low across scenarios
Demand-led but Deteriorating	India 	Short-term Demand support fades as Macro collapses across the period; only declining country in the framework

Risk Landscape

China leads in investment momentum in medium-risk countries; U.S. leads in low-risk countries.

- US has the highest investment momentum of all low-risk countries.
- China presents a nuanced opportunity – medium risk profile, yet the highest momentum across all six markets.
- No markets classified as high risk.
- Since all countries fall within the low- to medium-risk category, technology performance is the key factor in investment decisions.

Cost Competitiveness

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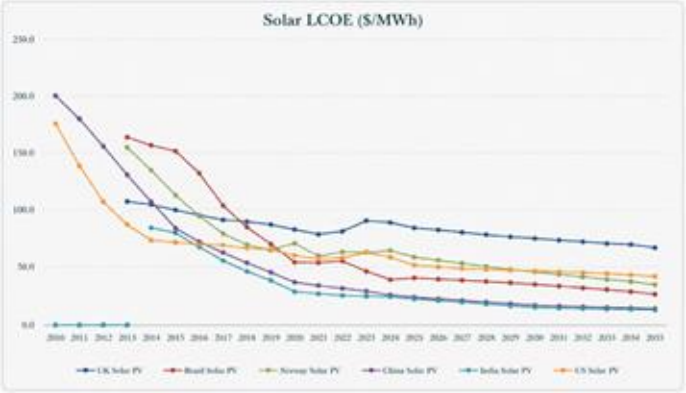
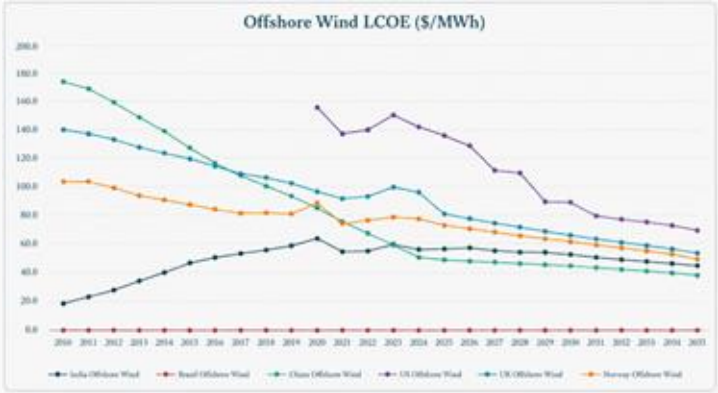
Solar is winning the cost race globally, but LCOE (Levelized Cost of Energy) alone does not determine where and when Equinor should invest.





Solar and Offshore Wind LCOE across country, 2010-2035

- Solar and offshore wind will be lower than CCGT in the long run. However, Offshore Wind will still be higher than CCGT in the U.S. in 2035.
- Solar power will be the cheapest option overall. In 2035, India and China (<$20/MWh), Brazil and Norway ($30–40/MWh), U.S. and UK (>$40/MWh).
- CCGT tends to remain stable, with slight increases in some countries.

Carbon Efficiency

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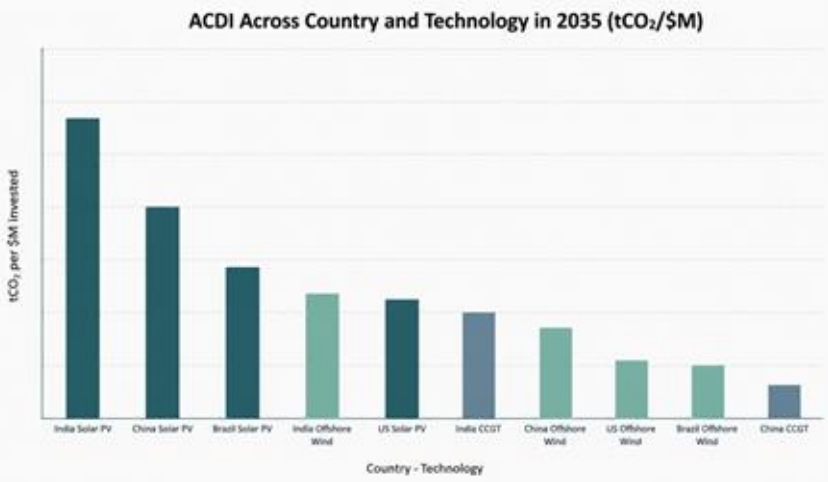
On a carbon-per-dollar basis, solar PV in coal-heavy markets outperforms offshore wind, CCGT, and CCS, making it the most capital-efficient technology for carbon reduction through 2035.



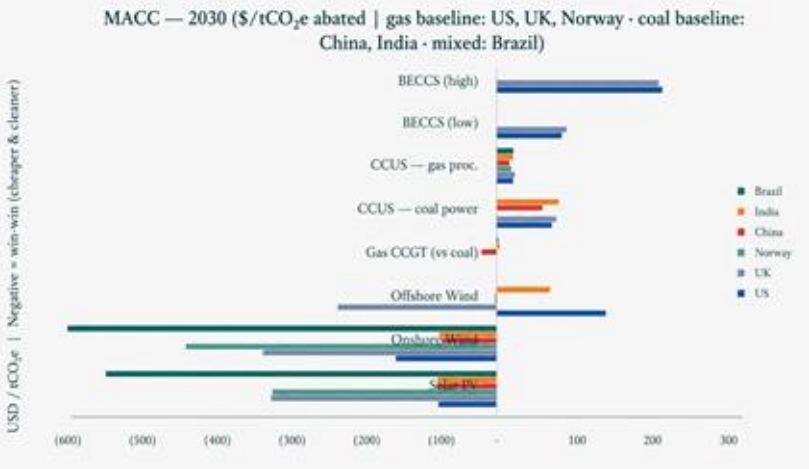
Avoided Carbon per Dollar Invested (tCO2/$M)across country & technology in 2035.

- India Solar PV tops 2035 rankings. India's coal-heavy grid decarbonizes only partially by 2035, preserving large displacement opportunities.
- China Solar PV holds strong but declines relatively.
- CCGT collapses across all markets by 2035.
- Norway offers minimal ACDI potential. Its hydro-dominated grid leaves no significant carbon-intensive generation to displace.

Cost vs Carbon Trade-off

Renewables lead on cost efficiency and scale, but CCS addresses the emissions no renewable can reach, making it the irreplaceable complement to any credible decarbonisation portfolio.

- Brazil, India, and China deliver the greatest carbon reduction per dollar, these are the priority markets for renewable deployment.
- Norway and the UK offer limited additional climate value as their grids are already largely clean.
- Offshore wind becomes cost-competitive in the UK and China by 2030, but remains expensive elsewhere until 2035.
- CCS is never the cheapest option, but it is the only solution for cement, steel, and industries where renewables cannot reach, and the only technology that generates net negative emissions.



Marginal Abatement Cost Curve ($/tCO2) across country & technology

Synthesis Results (Base Case)

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Layer 1 - Investable Momentum Base Case (A)	Layer 2a - Risk Assess. (B)	Layer 2b - LCOE & ACDI Analysis		Layer 3 - Final Result Location (E) = (A+B+C) Lowest Total = Best	Layer 3 - Final Order (Country + Tech) (F) = (E)+(D) Lowest Total = Best
		Countries (C)	Technology Performance (Emission Reduction Impact, Policy Support & Market Saturation) (D)		
China (1)	Norway (1)	China (1)	China: Solar (1); Wind (2); CCS (3)	China (8)	China + Solar (9); China + Offshore Wind (10); China + CCS (11)
UK (2)	UK (2)	India (2)	India: Solar (1); Wind (2); CCS (3)	UK (8)	UK + Offshore Wind (9); UK + CCS (10); UK + Solar (11)
Brazil (3)	US (3)	Brazil (3)	Brazil: Solar (1); Wind (2); CCS (3)	Brazil (10)	Brazil + Solar PV (11); Brazil + Offshore Wind (12); Brazil + CCS (13)
US (4)	Brazil (4)	UK (4)	UK: CCS (1); Solar (2); Wind (3)	US (12)	US + Solar PV (13); US + Offshore Wind (14); US + CCS (15)
India (5)	India (5)	US (5)	US: Solar (1); Wind (2); CCS (3)	India (12)	India + Solar PV (13); India + Offshore Wind (14); India + CCS (15)
Norway (6)	China (6)	Norway (6)	Norway: CCS (1); Wind (2); Solar (3)	Norway (13)	Norway + CCS (14); Norway + Offshore Wind (15); Norway + Solar (16)

Synthesis Results

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Based on the methodology: investment momentum, risk assessment, and carbon-per-dollar analysis, China Solar PV and UK Offshore Wind lead every scenario.

Base Case **Final Order (Country + Tech)** Lowest Total = Best	**Scenario #1 – Society-Led** **Final Order (Country + Tech)** Lowest Total = Best	**Scenario #2 – AI Boom** **Final Order (Country + Tech)** Lowest Total = Best
China + Solar PV (9)	China + Solar PV (9)	China + Solar PV (9)
UK + Offshore Wind (9)	UK + Offshore Wind (9)	China + Offshore Wind (10)
China + Offshore Wind (10)	China + Offshore Wind (10)	US + Solar PV (11)
UK + CCS (10)	UK + CCS (10)	Brazil + Solar PV (11)
Brazil + Solar PV (11)	Brazil + Solar PV (11)	US + Offshore Wind (12)
Brazil + Offshore Wind (12)	Brazil + Offshore Wind (12)	Brazil + Offshore Wind (12)
US + Solar PV (13)	US + Solar PV (13)	India + Solar PV (12)
India + Solar PV (13)	India + Solar PV (13)	UK + Offshore Wind (12)
Norway + CCS (14)	Norway + CCS (14)	UK + CCS (13)

Equinor's portfolio translates global opportunities into actionable investment priorities

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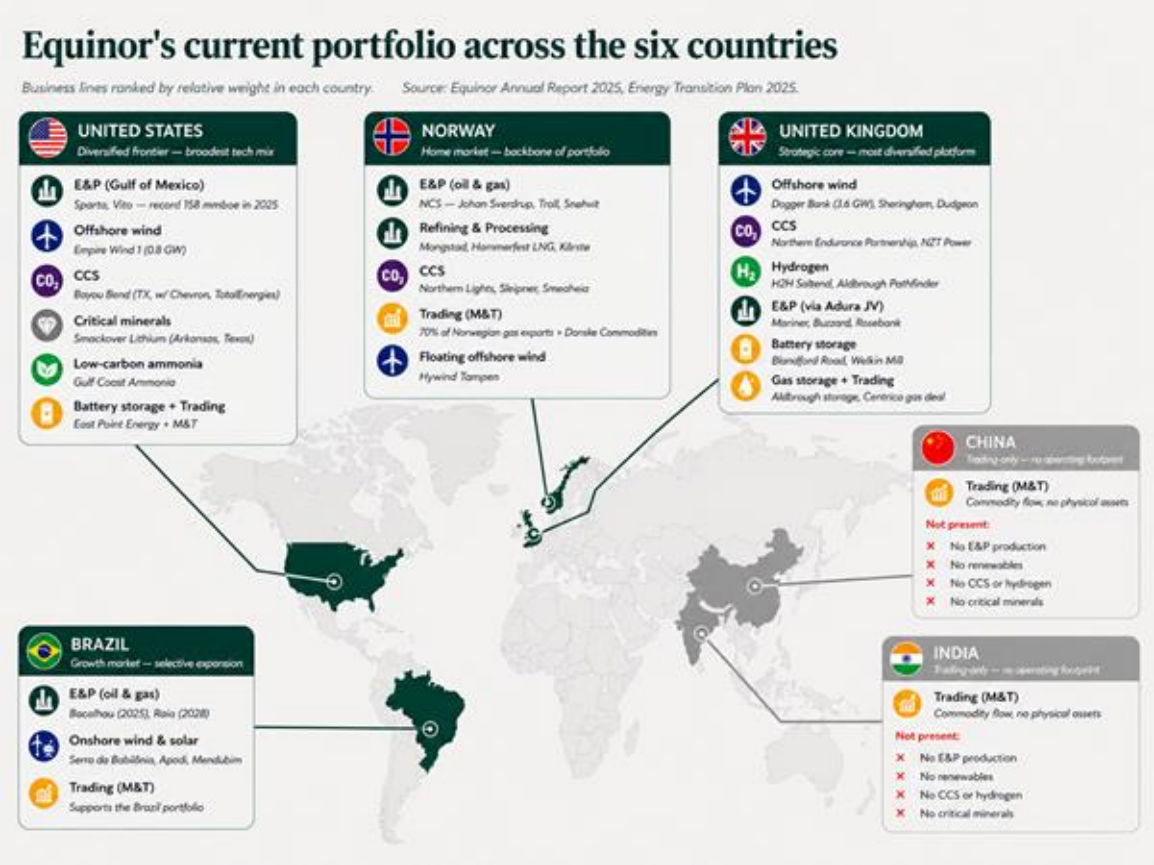

- Equinor has deep operating platforms in Norway, the UK, the US, and Brazil, while China and India remain trading-only markets.
- Norway and the UK are strongest for CCS, hydrogen, offshore wind, and brownfield decarbonization; the US supports selective power, storage, and CCS opportunities; Brazil fits low-emission oil & gas plus onshore renewables.
- Globally attractive country-tech pairs should be prioritized only when they can leverage Equinor's existing assets, partnerships, technical capabilities, and execution capacity.

Results Calibration

When calibrated against Equinor's existing portfolio, UK Offshore Wind and CCS in the UK and Norway lead every scenario.

Base Case **Final Order (Country + Tech)** Lowest Total = Best	**Scenario #1 – Society-Led** **Final Order (Country + Tech)** Lowest Total = Best	**Scenario #2 – AI Boom** **Final Order (Country + Tech)** Lowest Total = Best
UK + Offshore Wind (9)	UK + Offshore Wind (9)	Brazil + Solar PV (11)
UK + CCS (10)	UK + CCS (10)	US + Offshore Wind (12)
Brazil + Solar PV (11)	Brazil + Solar PV (11)	UK + Offshore Wind (12)
Norway + CCS (14)	Norway + CCS (14)	US + CCS (13)
US + Offshore Wind (14)	US + Offshore Wind (14)	UK + CCS (13)
US + CCS (15)	US + CCS (15)	Norway + CCS (14)
Norway + Offshore Wind (15)	Norway + Offshore Wind (15)	Norway + Offshore Wind (15)

Carbon Capture & Storage

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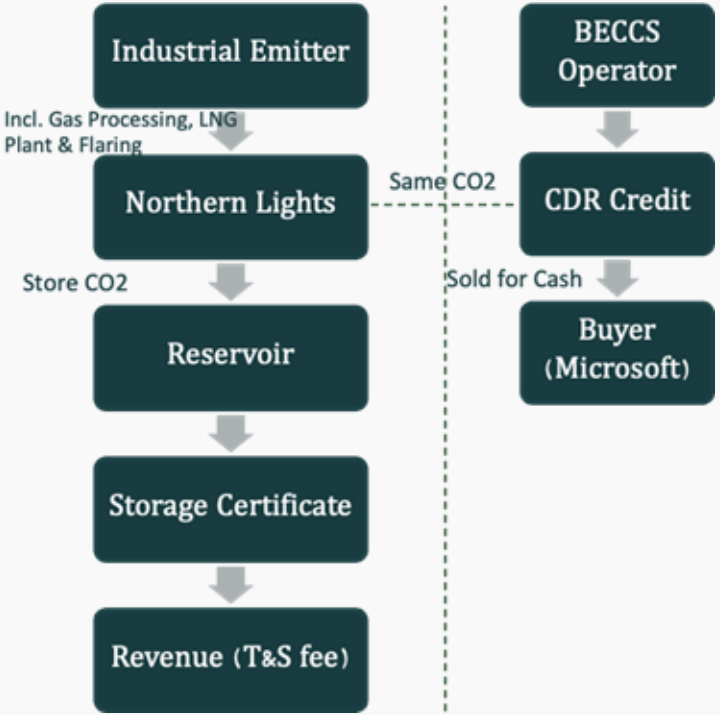
Northern Lights converts growing regulatory pressure into long-term contracted revenue — backed by government policy, industrial demand, and the only storage infrastructure of its kind.



- Growing demand across gas and hard-to-abate industries creates a clear and expanding market for CCS.
- Government backing across Norway, the UK, and the US provides the policy foundation for long-term CCS investment.
- Rising corporate demand for high-quality CDR credits creates an additional and growing revenue opportunity for CCS infrastructure providers.

Carbon Capture & Storage

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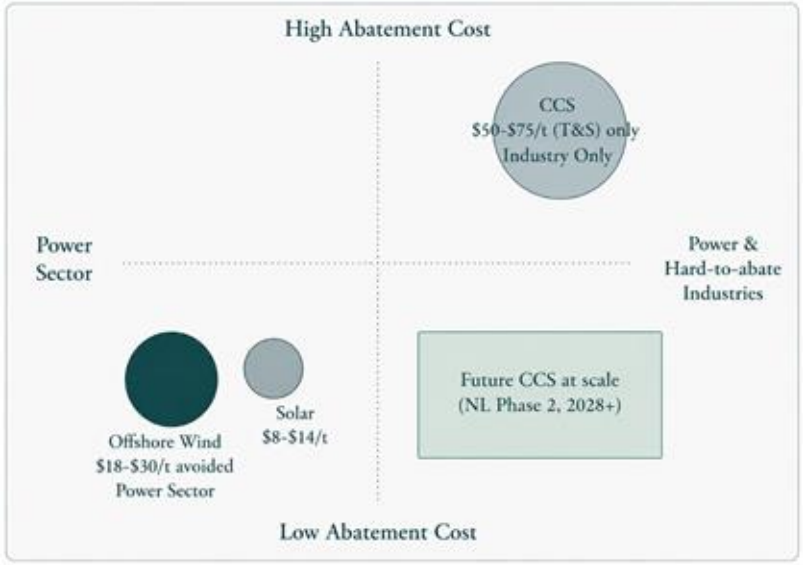
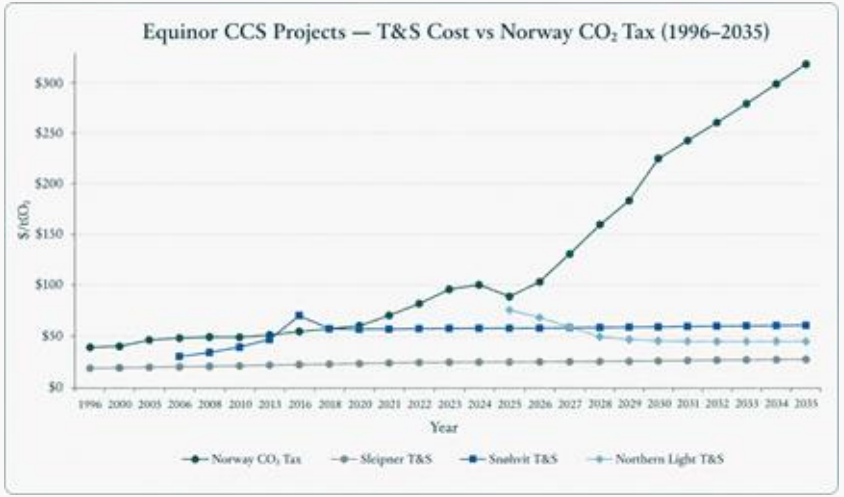
CCS does what wind cannot, and Equinor owns the only infrastructure to deliver it.



Sector x Abatement Cost Matrix

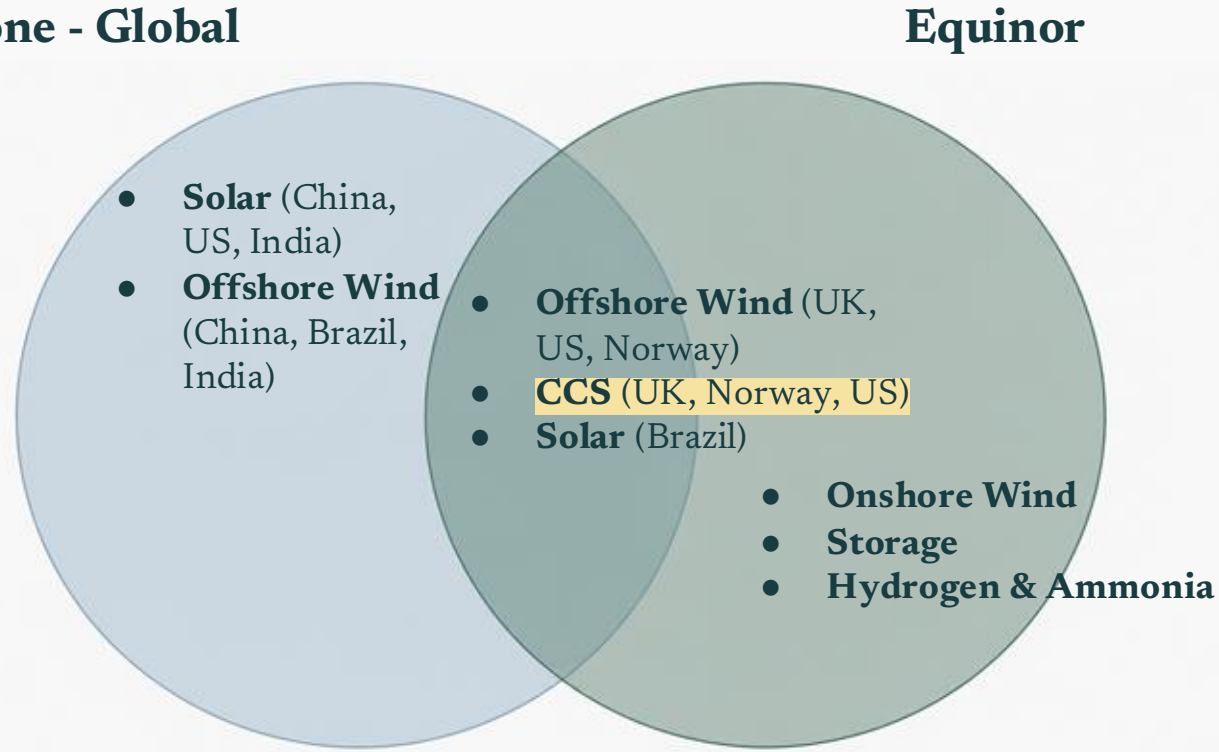


Rising carbon tax creates captive demand. Northern Lights is already capturing the spread. The strategic imperative now is to scale fast enough that no competitor can build a viable alternative.

Insights

Equinor-Ready Country-Tech Plays

Portfolio calibration validates CCS and Offshore Wind as Equinor-ready opportunities, with CCS emerging as the strongest strategic anchor due to policy-backed demand and hard-to-abate decarbonization value.



Recommended Investment Timeline

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Complete offshore wind commitments by 2030, scale CCS as the structural anchor, and evaluate China, US & India Solar as the highest-impact frontier for future portfolio consideration.

	2026 -2030			2030-2035	
Location	**US, UK**	**Norway**	**UK**	**Norway**	**China, US & India**
Type of Tech.	**Offshore Wind***	**CCS - NL Phase 2**	**CCS - NEP**	**CCS - Smeaheia**	**Solar****

* All offshore wind projects subject to execution risk
** Indicative recommendation only. Market entry subject to favourable conditions, risk assessment, and strategic fit evaluation.

A Repeatable Playbook for Rational Transition Capital Allocation

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Our recommendation is not a fixed answer, but a decision playbook – when market conditions change, Equinor can re-run the framework to identify where sustainability investment becomes financially rational.

Diagnose Investment Environment	Choose Capital Posture	Screen Technology Opportunities	Prioritize Strategic Plays
Use key market drivers to assess whether market conditions support transition investment · For this project: 7 pillars → investable momentum score · For Equinor: customize drivers based on internal strategy and project pipeline	Translate investment momentum into action: aggressive expansion or defensive discipline. · Strong momentum → deploy / scale / develop · Weak or moderate momentum → narrow / retreat / preserve	Evaluate technologies by cost-adjusted decarbonization impact. · ACDI / MACC → carbon abatement efficiency * ACDI = Lifetime avoided CO_2 / total capital invested	Prioritize opportunities that are cost-effective, CO_2-impactful, and aligned with Equinor's portfolio. · Final decision = market momentum + carbon abatement efficiency + Equinor portfolio fit

Running this playbook today points Equinor toward CCS as the strongest strategic anchor over the next decade, but the value of the framework is that it can be re-run as markets, policies, costs, and Equinor's project pipeline evolve.

Thank You

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Methodology

Investable Momentum

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Translation

- This capstone project translates real-world complexity into a structured analytical framework by organizing key drivers into distinc
  dimensions (pillar) .

Framework logic

- Each dimension (pillar) represents a critical aspect of the investment environment, ensuring a comprehensive and balanced assessm

Data & Reference

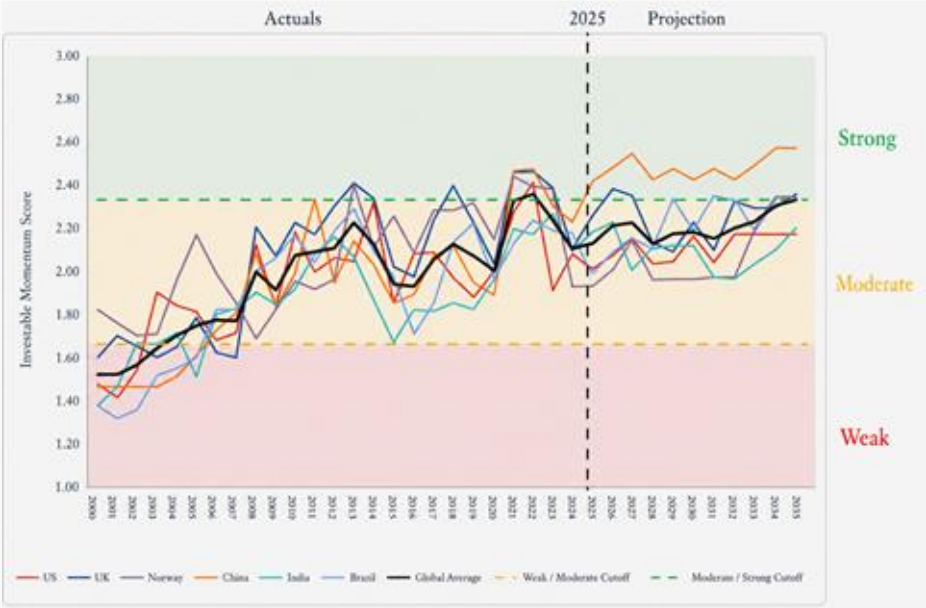
The framework integrates a combination of:

- Publicly available datasets
- National statistics
- Academic research
- Proxy indicators where direct data is unavailable

Objective

- Provide a structured and consistent way to assess energy transition investment environments
- Capture both market dynamics and structural drivers across countries
- Translate complex, multi-dimensional factors into an interpretable investment signal

Investable Momentum



Investment Momentum over Time

Three Momentum Zones

- Red (0–1): Weak
- Yellow (1–2): Moderate
- Green (2–3): Strong

Actuals vs Projection

- Vertical cutoff (2025)
- Allows comparison of historical credibility vs forward expectations

Scoring Logic Interpretation

- Horizontal cutoffs reflect scoring logic
- Black line is the six-country average, giving a sense of the global cycle

Investable Momentum

The 7 Pillars of the Investable Momentum:

Policy

Evaluates policy support and regulatory certainty that affect profitability (e.g., targets and laws).

Macroeconomics conditions

Captures interest rates, inflation to determine the cost of capital and market volatility.

Market Price

Evaluates energy prices through their influence on project profitability, market competitiveness, and capital flow to the energy sector.

Demand

Assesses sector-level consumption trends across power, oil, gas, and biofuels to evaluate revenue durability and adoption momentum.

Tech Feasibility

Assesses complexity across the full value chain: manufacturing independence, resource extractability, supply chain resilience, and grid integration readiness.

Public Sentiment

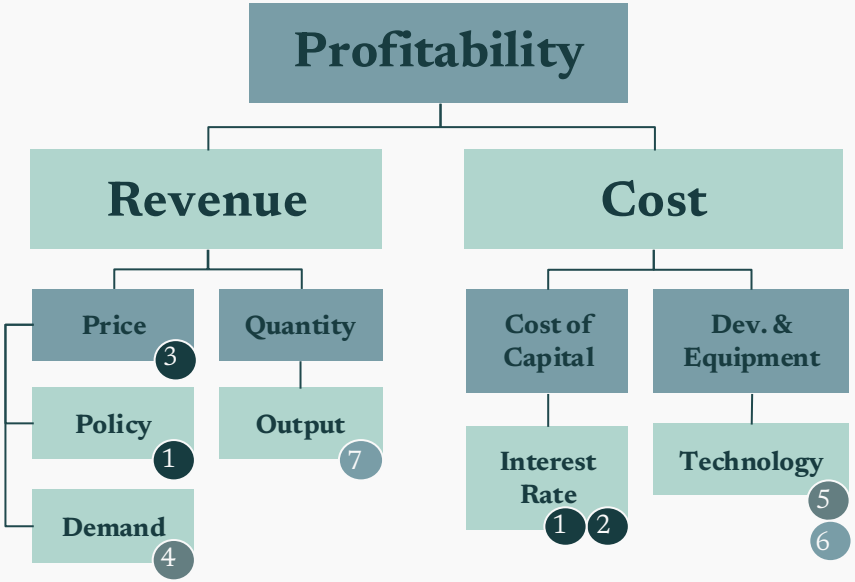
Captures political and social support for energy transition policies, indicating risk of policy reversal or acceleration.

CO2 Emission

Measures the environment impact of energy production.

Investable Momentum

Investment Logic Framework



The pillars:

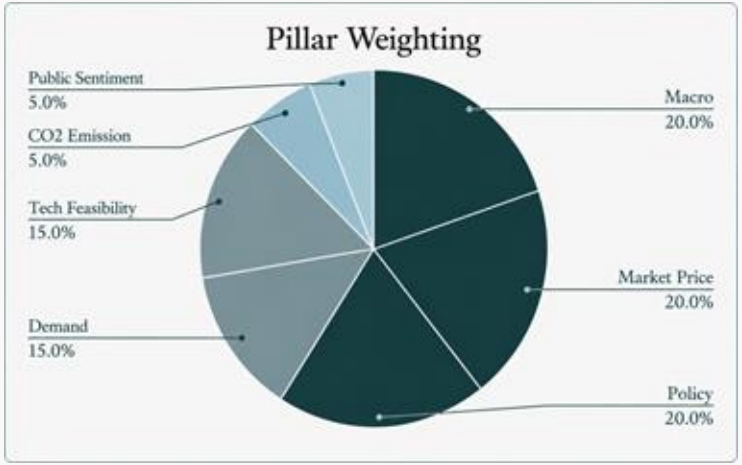
1. Policy
2. Macroeconomics
3. Market Prices
4. Demand
5. Technical Feasibility
6. Public Sentiment
7. CO2 Emission

Tier 1 - 60%
Direct (Structural) Impacts
Policy | Macroeconomics | Market Price

Tier 2 - 30%
Intermediate (Operational) Impacts
Demand | Technical Feasibility

Tier 3 - 10%
Indirect (Contextual) Impacts
Public Sentiment | CO2 Emissions

Pillar Weighting Structure



Investable Momentum

Indicators and Scoring

Pillar 1 - Policy

Pillar weight: 20%
(Evaluates policy support and regulatory certainty that affect profitability (e.g., targets and laws)

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70%
Government Support

Scoring:
- Score = 3: Economy-wide: law/national plan with sustained support across all major sectors
- Score = 2: Sector-specific: law/national plan with sustained support for specific sectors only
- Score = 1: No sustained support or single-year budget measure only

30%
International Climate Commitment

Scoring:
- Score = 3: (2015-)(Since the adoption of the Paris Agreement)Countries with legally binding net-zero targets enshrined in domestic law
- Score = 2: (2000-2014)Countries with legally binding emission reduction targets under the Kyoto Protocol
  (2015-)(Since the adoption of the Paris Agreement)Countries with net-zero targets as policy goals (non-legally binding)
- Score = 1: (2000-2014)Countries without binding targets, or those that did not participate in the Kyoto Protocol.
  (2015-)(Since the adoption of the Paris Agreement)Countries with no official net-zero target

Pillar: Policy

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Definition: Policy support and regulatory certainty affecting profitability (e.g., targets, laws).

Output: Composite score (1–3) per country-year from 2 indicators, weighted 70/30. Higher score = Stronger policy support for renewable energy = Greater investment suitability.

Government Support

70%

Definition: Share of the population reporting they are worried about climate change, used as a direct proxy for societal concern and support for climate action.

Weighting Rationale: Greater weight is assigned to this factor, as government support directly affects whether investments generate returns.

Scoring Rationale: Where long-term commitments to emissions reduction support measures are established by law or government plans, investments are more likely to generate returns for firms and are associated with greater predictability. Economy-wide support is more effective at stimulating corporate investment than sector-specific support. In the absence of such support, investments are less likely to be profitable for firms. Even where support exists, if it is limited to single-year measures, firms may find it difficult to undertake long-term investments.

Projection: Since policy changes are difficult to predict, it is assumed that the current score will remain unchanged.

Sources: IEA Policies database

International Climate Commitment

30%

Definition: Countries are evaluated based on whether they have made international commitments to emissions reductions. During the Kyoto Protocol era, developed countries subject to emission reduction obligations receive higher scores. Because the Kyoto Protocol did not target net-zero, the maximum score is 2. Since the adoption of the Paris Agreement in 2015, countries that participate in the agreement are considered to have set emissions reduction as a policy goal. Further assessment is made of whether countries have made these targets legally binding under domestic law.

Weighting Rationale: Since Climate Commitment does not directly affect corporate revenues, it is assigned a lower weight than government support.

Scoring Rationale: Countries with emissions reduction targets are considered likely to actively invest in renewable energy. Countries with legally binding targets are expected to be more proactive in renewable energy investment than those with targets that are only policy-based.

Projection: Since policy changes are difficult to predict, it is assumed that the current score will remain unchanged.

Sources: UNFCCC (Kyoto Protocol, 1997; Paris Agreement, 2015)

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Indicators and Scoring

Pillar 2 - Macroeconomics Conditions

Pillar weight: 20%
(Captures interest rates, inflation to determine the cost of capital and market volatility)

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75% - Interest Rate

Scoring:
- Score = 3: Lowest third percentile of the data
- Score = 2: Middle third percentile of the data
- Score = 1: Highest third percentile of the data

25% - Inflation

Scoring:
- Score = 3: Lowest third percentile of the data
- Score = 2: Middle third percentile of the data
- Score = 1: Highest third percentile of the data

Pillar: Macroeconomics

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Definition: Real interest rate and CPI inflation, reflecting the cost of capital and financial feasibility of investments

Output: Composite score (1–3) per country-year from 2 indicators, weighted 75/25. Higher score = more favorable cost of capital environment for investment.

Real Interest Rates

75%

Definition: Real interest rate for each country was calculated using nominal policy interest rates and CPI inflation, using a simplified Fisher equation ($i = r + \pi$). The real interest rate reflects the true purchasing power gained/lost from an investment.

Weighting Rationale: Real interest rates are weighted at 75% within the pillar because critical project investment inputs such as the cost of debt and the equity hurdle rate are benchmarked against interest rates as well as assessment metrics such as NPV and IRR. Given that many clean energy technologies are capital intensive, the cost of capital, which is determined partial by interest rates, is extremely important in assessing project feasibility.

Scoring Rationale: Higher interest rates indicate a poorer investment environment. Higher interest rates sets a higher "floor" for lending rates, thus a higher cost of capital. The scoring is caterogized by the tertiles of the data set.

Projection: Forecasts of real interest rates were calculated again using the Fisher Equation using projected nominal policy rate targets and the forecasted inflation rates described under the CPI inflation projection section.

CPI Inflation

25%

Definition: The Rate of change in the Consumer Price Index (CPI) is a measure of how much the average price of a standardized "basket" of goods and services consumed by households changes over time.

Weighting Rationale: Inflation is weighted at 25% within the pillar because while it does directly affect clean energy investment – through input costs, PPA pricing, and debt erosion – its effects are partially offsetting and ambiguous in direction, reducing its standalone explanatory power.

Scoring Rationale: Higher inflation indicates a poorer investment environment. Although mainly tied through an increase in policy rates, higher present day inflation can lead to expectations of rate hikes, stagnating investment. High inflation also creates uncertainty in the costs and expenses of projects. The scoring is categorized by the tertiles of the data set.

Projection: Future inflation values were forecasted using using a Vector Autoregression (VAR) model estimated in Stata, drawing on annual data from 2000 to 2024. The model included six variables – CPI inflation, interest rate, M2 growth, GDP growth, and unemployment – with each variable tested for stationarity via Augmented Dickey-Fuller tests and differenced where necessary to ensure a stable system. Once the variables were determined to be stationary a VAR was used to generate a 10-year out-of-sample forecast.

Investable Momentum

Indicators and Scoring

Pillar 3 - Market Price

Pillar weight: 20%
(Evaluates energy prices through their influence on project profitability, market competitiveness, and capital flow to the energy sector)

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40%
(Retail) Power Price

Scoring:
- Score = 3: Highest third within that country's historical distribution (> 67th percentile)
- Score = 2: Middle third within that country's historical distribution (33rd–67th percentile)
- Score = 1: Lowest third within that country's historical distribution (≤ 33rd percentile)

35%
Natural Gas Price

Scoring:
- Score = 3: Highest third within that country's historical distribution (> 67th percentile)
- Score = 2: Middle third within that country's historical distribution (33rd–67th percentile)
- Score = 1: Lowest third within that country's historical distribution (≤ 33rd percentile)

25%
Crude Oil Price

Scoring:
- Score = 3: > $80/bbl (price spike)
- Score = 2: $50/bbl < price < $80/bbl
- Score = 1: < $50/bbl (breakeven price)

Pillar: Market Price

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Definition: Energy prices, including power prices, natural gas(NG) prices, and crude oil prices, used to indicate renewable energy investment trends through their influence on project profitability, market competitiveness, and capital allocation across the energy sector.

Output: Composite score (1–3) per country-year from 3 indicators, weighted 40/35/25. Higher score = higher energy price=stronger investable momentum.

Power Price (retail) — 40%

Definition: Annual average retail electricity price, used as a consistent cross-country proxy for power market conditions (since China does not have a fully comparable wholesale electricity price).

Weighting Rationale: Power price has **the most direct** impact on renewable energy project revenues, cash flow, and investment returns.

Scoring Rationale: Higher electricity prices improve the revenue potential of renewable energy projects, increasing expected returns and strengthening incentives for investment.

Missing Data & Projection: Those data were estimated using regression models based on the marginal fuel price of electricity generation (eg: NG/Hydro/coal) and other relevant variables (eg: electricity demand). Multiple model specifications were tested, and the regression with the strongest statistical fit (highest R^2 and economically reasonable coefficients) was selected for data imputation and forecasting.

The selected regression specifications can be summarized as follows:

1) US: Power price modeled as a function of natural gas prices and lagged electricity demand (t–1).
2) UK, Norway, Brazil: Power price modeled as a function of NG prices. *Although Norway's electricity generation is largely hydro-based, the observed relationship between historical power prices and reservoir level data was negative and economically inconsistent; therefore, the NG price specification was adopted instead.
1) China, India: Power price modeled as a function of coal prices. *Coal prices were projected using log-linear growth trends before being incorporated into the power price forecasts.

Nature Gas Price — 35%

Definition: US (Henry Hub); UK(NBP); Norway (TTF); China & India (JKM); Brazil: Brazil Average Reference Price: Natural Gas.

Weighting Rationale: It is **the second-highest weight** because it influences electricity prices in many markets. Higher natural gas prices also encourage electrification, improving long-term renewable energy prospects.

Scoring Rationale: Higher natural gas prices signal tighter supply, which will accelerate the trend toward renewable energy sources. Higher natural gas prices also raise the marginal cost of electricity generation, enhancing the relative competitiveness of renewable energy.

Missing Data & Projection: Brazil missing NG price = 11-14% Brent price

Sources: Goldman Sachs-Catching The Largest Ever LNG Supply Wave (Nov. 2025)

Crude Oil Price — 25%

Definition: US (WTI); UK & Norway & Brazil (Brent); China & India (Dubai).

Weighting Rationale: less directly linked to renewables revenues than power or gas prices. However, it remain an important signal of broader energy market sentiment and capital allocation trends across the energy sector.

Scoring Rationale: Higher crude oil prices mean strong cash flows for major oil and gas companies create excess capital that can be redirected toward renewable projects as firms respond to long-term energy transition pressures. Higher oil prices increase overall investor interest in the energy sector, where renewables become attractive as a lower-risk, long-duration investment.

Projection: Using the higher forecasted futures prices

Sources: Goldman Sachs-Oil Analyst, 2026 Outlook

Investable Momentum

Indicators and Scoring

Pillar 4 - Demand

Pillar weight: 15%
(Assesses sector-level consumption trends across power, oil, gas, and biofuels to evaluate
revenue durability and adoption momentum)

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35%
Electricity Demand

Scoring:
- Score = 3: 3-yr CAGR ≥ 2% (strong growth – electrification-driven expansion)
- Score = 2: 0% ≤ 3-yr CAGR < 2% (moderate growth – typical of advanced economies)
- Score = 1: 3-yr CAGR < 0% (negative growth – declining power market)

30%
Gas Consumption

Scoring:
- Score = 1: 3-yr CAGR ≥ 3% (strong growth – active coal-to-gas switching)
- Score = 2: 0% ≤ 3-yr CAGR < 3% (moderate growth – stable transition-fuel role)
- Score = 1: Resource unmapped or technically too complex to access; no viable extraction pathway

25%
Oil Consumption

Scoring:
- Score = 3: 3-yr CAGR < –1% (declining demand – structural transition underway)
- Score = 2: –1% ≤ 3-yr CAGR < 1% (roughly flat – approaching plateau)
- Score = 1: 3-yr CAGR ≥ 1% (demand still growing – transition not yet taking hold)

10%
Biofuel Consumption

Scoring:
- Score = 3: 3-yr CAGR ≥ 8% (accelerated adoption – strong market momentum)
- Score = 2: 3% ≤ 3-yr CAGR < 8% (moderate – steady policy-driven expansion)
- Score = 1: 3-yr CAGR < 3% (weak adoption – market stagnation or policy failure)

Pillar: Demand

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Definition: Sector-level consumption trends across power, oil, gas, and biofuels — used to assess revenue durability and adoption momentum for transition technologies.

Output: Composite score (1–3) per country-year from 4 indicators, weighted 35/30/25/10. Higher score = stronger demand-side investable momentum.

Electricity Demand

35%

Definition: 3-yr rolling CAGR of electricity demand (TWh → PJ; 1 TWh = 3.6 PJ).

Weighting Rationale: Highest weight — electrification underpins every transition pathway; rising power demand directly creates bankable offtake for new generation.

Threshold Rationale: Calibrated to IEA: advanced economies 0–3% (US ~2%); emerging markets >3% (China ~6%, India ~6.3%). EU 2022–23 decline confirms <0% as weak signal.

Sources: IEA Electricity 2025; Global Energy Review 2025.

Gas Consumption

30%

Definition: 3-yr rolling CAGR of natural gas consumption (bcm → PJ; 1 bcm = 35.17 PJ).

Weighting Rationale: Second-highest — gas is the critical bridge fuel from coal, and CCGT is a core Equinor business line.

Threshold Rationale: Global avg ~2% (2010–19); +2.7% in 2024; Asia EM +6%; EU gas fell 7% in 2023. ≥3% indicates active coal-to-gas switching.

Sources: IEA Gas 2025; Global Energy Review 2025.

Oil Consumption

25%

! INVERTED SCORING: decline = high score

Definition: 3-yr rolling CAGR of oil consumption (kbd → PJ/yr; 1 kbd = 2.2348 PJ/yr).

Weighting Rationale: Weighted below electricity — oil decline is a lagging confirmation of transition progress, not a leading investment signal.

Threshold Rationale: Global oil +0.8% in 2024 (approaching plateau); OECD projected to fall to 42.7 mb/d by 2030. Growth ≥1% = transition not yet taking hold.

Sources: IEA Oil 2025; Global Energy Review 2025.

Biofuel Consumption

10%

Definition: 3-yr rolling CAGR of biofuel consumption (kbd → PJ/yr; 1 kbd = 1.2906 PJ/yr).

Weighting Rationale: Lowest weight — small market vs. power/gas and heavily policy-dependent. When data missing, other 3 indicators rescale to sum = 1.0.

Threshold Rationale: Historical ~6%/yr over 5 yrs; ~14% in 2023 high-policy markets (IFPEN); mature-market growth slows to 0.3% by 2030.

Sources: IEA Renewables 2025 – Transport; IFPEN Biofuels Dashboard 2024.

Investable Momentum

Indicators and Scoring

Pillar 5 - Tech Feasibility

Pillar weight: 15%
(Assesses deployment complexity across the full value chain: manufacturing independence, resource extractability, supply chain resilience, and grid integration readiness)

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30%
Manufacturing Maturity

Scoring:

- Score = 3: Full vertical integration (raw material to finished product); domestic supply secured
- Score = 2: Robust domestic industry but lacks raw materials and/or main components for full independence
- Score = 1: No/basic domestic production; highly reliant on imports with no supply security

30%
Resource Potential

Scoring:

- "Anytime dispatchable"; high-yield sites fully accessible with no extraction barriers
- Score = 2: Tech is mature; site access and permitting are clear; some logistical constraints
- Score = 1: Resource unmapped or technically too complex to access; no viable extraction pathway

25%
Supply Chain Stability

Scoring:

- Score = 3: Domestic control of materials or total self-sufficiency; resilient supply network.
- Score = 2: Diversified suppliers; established domestic logistics; some vulnerabilities remain.
- Score = 1: High reliance on volatile foreign markets; few/no trade agreements; frequent disruptions

15%
Grid Readiness

Scoring:

- Score = 3: Rigid fossil-fuel grid; near-zero VRE capacity; no investment in grid modernization
- Score = 2: Active investment in storage/HVDC; some curtailment; grid transitioning to VRE
- Score = 1: Smart grid; high flexibility; minimal integration friction; optimised for VRE

Pillar: Tech Feasibility

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Definition: A measure of the degree to which a country can build, supply, and connect each energy technology, assessed across the manufacturing base, natural resources, supply chain resilience, and grid readiness to make deployment viable at scale.

Output: Composite score (1–3) per country-year from 4 indicators, weighted 30 / 30 / 25 / 15. Higher score = lower deployment complexity= stronger technology-side investable momentum

Manufacturing Maturity

30%

Definition: The scale and sophistication of domestic factories for each technology, assessing local content capability from raw material sourcing through to finished product.

Weighting Rationale: Highest weight alongside Resource Potential. Without domestic production capacity, deployment cannot scale regardless of policy or resource endowment. Manufacturing capability sets the industrial ceiling for any technology transition.

Resource Potential

30%

Definition: The raw natural endowment of each country per technology: solar irradiance (GHI), offshore wind speeds, proven gas reserves for CCGT, CO_2 geological storage for CCS, and bioenergy technical potential.

Weighting Rationale: Highest weight alongside Manufacturing. Natural resources are fixed and cannot be manufactured, purchased, or substituted. They set the long-run physical ceiling for competitiveness in each technology, permanently constraining or enabling investment returns.

Supply Chain Stability

25%

Definition: The resilience of logistics networks and critical raw material access, measuring a country's vulnerability to global trade disruptions, single-source dependencies, import concentration, and geopolitical supply risk.

Weighting Rationale: Second-highest. Even countries with strong manufacturing capacity and excellent resources can face deployment halt from supply chain disruption (e.g., polysilicon export controls, LNG price shocks).

Grid Readiness

15%

Definition: The physical capacity and digital intelligence of the national electricity grid to absorb variable and dispatchable energy sources – covering flexibility, storage, HVDC interconnection, and curtailment performance.

Weighting Rationale: Lowest weight. Grid constraints are a real deployment barrier but are more directly and predictably addressable through targeted capital investment than resource or manufacturing deficits. Functions as a lagging rather than leading constraint on technology-side investability.

Pillar: Tech Feasibility

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Manufacturing Maturity

30%

Scoring Rationale: Each of the 5 technologies is scored 1–3 independently for each country and year, based on the depth of domestic manufacturing capability for that specific technology: Score 1 = no meaningful domestic production, highly import-reliant. Score 2 = partial domestic base, missing key components or raw materials for full independence. Score 3 = full vertical integration from raw material to finished product. Score changes are triggered by verifiable milestones, policy programmes, factory commissions, and supply base developments (e.g. US Renewable Fuel Standard ethanol scaling, IRA 45X credits, India PLI scheme, China's 11th Five-Year Plan solar investment). The indicator score is the simple average of the 5 technology scores.

Projection (2026–2035): Based on announced investments with realistic policy to delivery lags, e.g US: IRA 45X credits lift Solar and Offshore Wind to Score 3 by 2032 (5–7 year factory build lag).

Resource Potential

30%

Scoring Rationale: Each of the 5 technologies is scored separately based on the country's natural endowment. Score 1 = resource unmapped or insufficient for commercial deployment. Score 2 = resource confirmed but with access or logistical constraints. Score 3 = world-class resource, fully characterised and accessible. The physical resource itself does not change, what changes is when a country formally maps and confirms it. Score transitions are therefore triggered by characterisation milestones. The indicator score is the simple average of the 5 technology scores.

Projection (2026–2035): Physical endowments are fixed, solar irradiance, offshore wind speeds, and geological formations do not change within any investment horizon. All 2025 scores are held flat; no new characterisation event is anticipated for any of the 6 countries in the 2026–2035 window.

Supply Chain Stability

25%

Scoring Rationale: Each technology is scored separately based on the resilience of its supply chain in that country and year. Score 1 = high reliance on volatile foreign markets, few trade agreements, frequent disruptions. Score 2 = diversified suppliers, established domestic logistics. Score 3 = domestic material control or full self-sufficiency, resilient network. Score changes are driven by specific verifiable events: US shale revolution secured the CCGT supply chain (upgrade, 2011); Section 201 tariffs disrupted US solar supply chain without a domestic alternative (downgrade, 2018); Brexit reduced UK offshore wind and biofuels scores (2023). The indicator score is the simple average of the 5 technology scores.

Projection (2026–2035): Scores held at 2025 levels unless a specific programme credibly changes the picture. US-China trade tensions, polysilicon and rare earth export controls, assumed to persist, capping US solar supply chain improvement through 2035.

Grid Readiness

15%

Scoring Rationale: Scored on the grid infrastructure each technology requires. Score 1 = rigid fossil-fuel grid, near-zero VRE capacity. Score 2 = grid in active transition. Score 3 = smart grid, minimal integration friction. Dispatchable technologies (CCGT, biofuels) are assessed on pipeline and blending maturity; renewables on interconnection capacity and grid absorption ability.

Projection (2026–2035): US: Policy reforms expected to materialise by 2029, reflecting realistic permitting and construction timelines. UK: Grid readiness already at maximum for most technologies. Norway: Offshore grid connections fully operational by 2029. China: Grid modernisation complete, scores held at maximum through 2035. India and Brazil: persistent grid constraints maintained through 2035.

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Indicators and Scoring

Pillar 6 - Public Sentiment

Pillar weight: 5%
(Captures political and social support for energy transition policies, indicating risk of policy reversal or acceleration)

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50%
Climate Concern

Scoring:
- Score = 3: Climate concern index > 75
- Score = 2: 65 <= Climate concern index <= 75
- Score = 1: Climate concern index < 65

50%
Environmental Priority

Scoring:
- Score = 3: Average score < 1.3
- Score = 2: 1.3 <= Average score <= 1.6
- Score = 1: Average score > 1.6

Pillar: Public Sentiment

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Definition: Measures societal and political support for the energy transition, capturing public acceptance of climate policies, permitting feasibility, and long-term policy durability.

Output: Composite score (1–3) per country-year from 2 indicators, weighted 50/50. Higher score = stronger public support = lower risk of policy reversal.

Climate Concern

50%

Definition: Share of the population reporting they are worried about climate change, used as a direct proxy for societal concern and support for climate action.

Weighting Rationale: Assigned 50% weight as public concern is a leading indicator of policy support and social acceptance of transition measures.

Scoring Rationale: Higher concern indicates stronger societal support for climate action and policy continuity.

Scoring is based on absolute thresholds: Score 1: <65, Score 2: 65–75, Score 3: >75.

Projection: Survey data is available only at discrete intervals. Missing years are estimated using linear interpolation, and forward values are extrapolated to maintain a continuous time series.

For countries without consistent coverage (e.g., China and Norway), comparable survey sources are harmonized to ensure consistency in measurement.

Sources: Pew Research Center, International Opinion on Global Threats (2025); Norwegian Citizen Panel, University of Bergen; Yale Program on Climate Change Communication; China Climate Communication Project Center (2017); UNDP China (Public Awareness of Climate Change).

Environmental Priority

50%

Definition: Measures willingness to prioritize environmental protection over economic growth, based on survey responses to environment-versus-growth trade-offs.

Weighting Rationale: Equally weighted (50%) as it captures willingness to accept economic trade-offs, complementing climate awareness.

Scoring Rationale: Lower values indicate stronger environmental prioritization.

Thresholds are set at: Score 1: >1.6, Score 2: 1.3–1.6, Score 3: <1.3.

These ranges group responses into strong environmental preference, mixed trade-offs, and economic prioritization.

Projection: Data is sourced from periodic survey waves (e.g., World Values Survey). Missing years are filled using linear interpolation to ensure comparability across time.

Sources: World Values Survey

! INVERTED SCORING: decline = high score

Investable Momentum

Indicators and Scoring

Pillar 7 - CO2 Emission

Pillar weight: 5%
(Measures the environment impact of energy production)

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50%
CO2 per Capita

Scoring:
Note: Final = 0.7×Level + 0.3×Trend (5-yr CAGR).
For both level and trend:
- Score = 3: Highest third of pooled country-year observations (>= 67th percentile)
- Score = 2: Middle third of pooled country-year observations (33rd–67th percentile)
- Score = 1: Lowest third of pooled country-year observations (<= 33rd percentile)

50%
Carbon Intensity

Scoring:
Note: Final = 0.7×Level + 0.3×Trend (5-yr CAGR).
For both level and trend:
- Score = 3: Highest third of pooled country-year observations (>=67th percentile)
- Score = 2: Middle third of pooled country-year observations (33rd–67th percentile)
- Score = 1: Lowest third of pooled country-year observations (<=33rd percentile)

Pillar: CO2 Emission

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Definition: Emissions context and decarbonization pressure that can drive transition urgency and regulation.

Output: Composite score (1–3) per country-year from 2 indicators, weighted 50/50. Higher score = Greater emissions pressure and decarbonization urgency = Stronger rationale for renewable energy investment.

CO2 per Capita

50%

Definition: Societal-level emissions burden measured as tonnes of CO2 per person. Used here as a proxy for the scale of decarbonization required on an economy-wide basis and the potential pace of transition-related investment needs.

Weighting Rationale: Equally weighted with carbon intensity because it captures economy-wide emissions pressure, complementing the power-system view from carbon intensity.

Scoring Rationale: Higher CO2 per capita indicates greater emissions pressure. The indicator is scored using all country-year observations. CO2 per capita levels are converted into a level score from 1 to 3, where higher values receive higher scores. A 5-year CAGR is also calculated and converted into a trend score from 1 to 3, where a more positive CAGR receives a higher score. The final CO2 per capita score is calculated as 70% level score + 30% trend score.

Projection: CO2 emission forecasts from BP Energy Outlook (2025, 2030, 2035); population forecasts from World Bank. Intermediate years filled via linear interpolation.

Carbon Intensity

50%

Definition: Power-sector carbon dependency measured as grams of CO2 per kWh generated. Captures the carbon intensity of the electricity system and the scale of abatement opportunity available to clean power, electrification, and related technologies.

Weighting Rationale: Equally weighted with CO2 per Capita because it provides the supply-side view of emissions pressure and directly reflects how carbon-intensive the power mix remains.

Scoring Rationale: Higher carbon intensity indicates greater abatement need. The indicator is scored using all country-year observations. Carbon intensity levels are converted into a level score from 1 to 3, where higher values receive higher scores. A 5-year CAGR is also calculated and converted into a trend score from 1 to 3, where a more positive CAGR receives a higher score. The final carbon intensity score is calculated as 70% level score + 30% trend score.

Projection: 2020–2024 historical CAGR applied to 2024 actual value, with anchor nodes at 2025/2030/2035; intermediate years filled via linear interpolation.

Risk Assessment

Methodology

- For each category—Political Risk, FX, and Access (Money Out)—countries are ranked and scored

Scoring Thresholds	
FX Score 1 (Low)	avg. annual volatility < 5%
FX Score 2 (Medium)	avg. annual volatility 5–8%
FX Score 3 (High)	avg. annual volatility > 8%
WGI RQ Score 1 (Low)	RQ avg. > +1.0
WGI RQ Score 2 (Medium)	RQ avg. −1.0 to +1.0
WGI RQ Score 3 (High)	RQ avg. < −1.0
Chinn-Ito Score 1 (Low)	KAOPEN ≥ +2.28 (Global top 25%)
Chinn-Ito Score 2 (Medium)	KAOPEN −1.25 to +2.28 (Global middle 50%)
Chinn-Ito Score 3 (High)	KAOPEN < −1.25 (Global bottom 25%)

Indicators

- Political Risk : Worldwide Governance Indicators (World Bank)
- FX: Effective exchange rates (Bank for International Settlements(BIS))
- Access (Money Out): The Chinn-Ito Index

Sources: Worldwide Governance Indicators (World Bank), Effective exchange rates (BIS), The Chinn-Ito Index

Risk Assessment

Risk Matrix

Institutional Risk: Political Risk and Access (Money Out)

[Country Risk Premium(Damodaran Country Risk Premium)]

United States: 0.23%, United Kingdom: 0.78%,

Norway: 0.00%, China: 0.91%, Brazil: 3.24%, India: 2.85%

[Note]

Although exchange rate volatility is low in China and India, unlike in the United States, the United Kingdom, and Norway where capital flows are fully liberalized, exchange rate movements are constrained by government intervention and regulatory controls.

Sources: Country Default Spreads and Risk Premiums (NYU Stern)

Analysis

In terms of FX Risk, China and India are rated “Unlikely / Highly Unlikely,” similar to the United States and the United Kingdom. However, “Extremely Severe” Institutional Risk keeps overall risk high. China’s relatively low Country Risk Premium suggests investment potential if Political Risk and Money Out are well managed.

LCOE Analysis

Definition

A measure of the average net present cost of electricity generation for a generating asset over its lifetime. It is expressed in dollars per megawatt-hour ($/MWh) and is calculated by dividing the total lifetime costs of the asset, including capital expenditure, financing, and operations and maintenance by the total lifetime energy output.

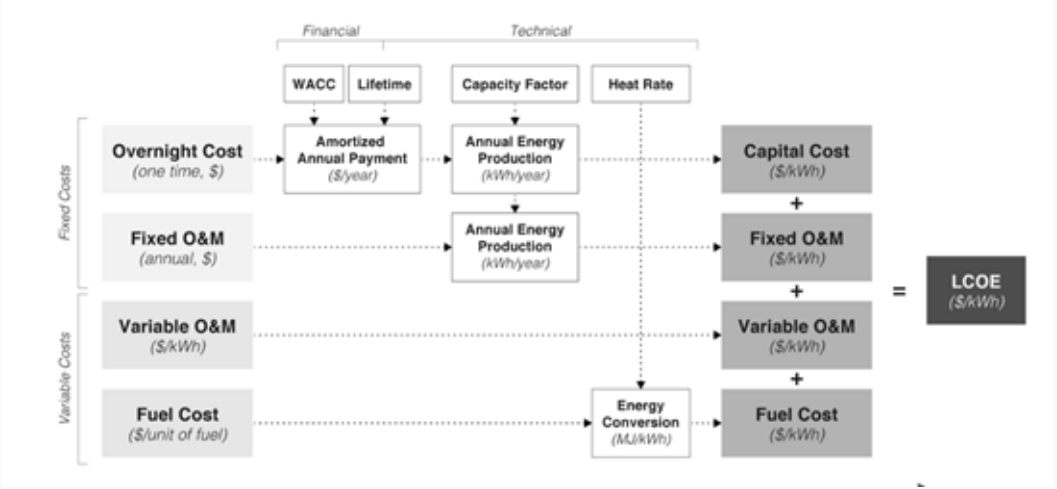
Calculation Methodology

LCOE ($/MWh) = **Total Lifetime Cost / Total Lifetime Electricity Generated**

= (CAPEX × CRF + Fixed O&M) / (8,760 × CF) + Variable O&M + Fuel Cost

Objective

Identify which technologies are most cost-competitive in each country by converting all costs into a single comparable metric.



LCOE Analysis

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Modelling

Technologies: Solar PV, Offshore Wind & CCGT

Countries: US, UK, Norway, China, India & Brazil

Period: 2010-2035

Solar Parameter	Unit	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
US																											
CAPEX	$/kW	4,900	3,800	2,900	2,400	2,000	1,973	1,947	1,920	1,893	1,867	1,840	1,814	1,787	1,760	1,671	1,497	1,466	1,441	1,445	1,443	1,444	1,436	1,430	1,416	1,406	1,387
ITC / Capital Support	%	30.00%	30.00%	30.00%	30.00%	30.00%	30.00%	30.00%	30.00%	30.00%	30.00%	30.00%	30.00%	30.00%	30.00%	30.00%	30.00%	30.00%	30.00%	30.00%	30.00%	30.00%	30.00%	30.00%	30.00%	30.00%	30.00%
CAPEX (effective)	$/kW	3,430	2,660	2,030	1,680	1,400	1,381	1,363	1,344	1,325	1,307	1,288	1,269	1,251	1,232	1,170	1,048	1,026	1,009	1,012	1,010	1,011	1,005	1,001	991	984	971
WACC	%	5.15%	5.25%	5.23%	5.05%	5.07%	5.08%	5.05%	5.62%	5.47%	5.80%	4.96%	4.82%	5.53%	7.08%	7.17%	6.76%	6.69%	6.63%	6.58%	6.53%	6.49%	6.45%	6.42%	6.38%	6.36%	6.10%
Project Life	years	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
CRF	%	7.20%	7.28%	7.26%	7.13%	7.15%	7.15%	7.13%	7.54%	7.44%	7.67%	7.07%	6.97%	7.48%	8.64%	8.72%	8.39%	8.34%	8.30%	8.26%	8.22%	8.19%	8.16%	8.13%	8.11%	8.09%	7.90%
Capacity Factor	%	19.90%	20.10%	20.40%	20.70%	21.00%	21.50%	22.00%	22.50%	23.00%	23.50%	24.00%	24.50%	25.00%	25.50%	26.00%	26.30%	26.50%	26.80%	27.10%	27.40%	27.60%	27.90%	28.20%	28.50%	28.70%	29.00%
Fixed O&M	$/kW/yr	25.31	25.04	24.77	24.51	24.24	23.97	23.70	23.43	23.16	22.89	22.62	20.56	20.48	20.41	20.35	20.28	20.21	20.15	20.08	20.02	19.95	19.72	19.48	19.24	19.01	18.77
Variable O&M	$/MWh	3.80	3.67	3.54	3.41	3.28	3.15	3.02	2.89	2.76	2.63	2.50	3.33	3.26	3.13	3.13	3.07	3.02	2.96	2.91	2.91	2.91	2.91	2.90	2.90	2.90	2.90
Fuel Cost	$/MWh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Debt Term	years	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Abin Fixed Costs	$/MWh	307.92	246.78	194.38	163.33	140.57	138.74	136.54	139.91	136.60	137.61	128.13	124.18	128.65	140.53	135.42	120.39	117.79	115.64	115.38	114.85	114.51	113.49	112.63	111.29	110.22	107.02
LCOE	$/MWh	176.64	140.16	108.77	90.07	76.41	73.66	70.85	70.99	67.80	66.85	60.94	57.86	58.74	62.91	59.46	52.25	50.74	49.26	48.60	47.85	47.36	46.44	45.59	44.58	43.84	42.13

Resources:

- Costs Data: EIA, OECD, NREL, Wood Mac (US), Related National Department of Energy
- Macro Data: LIBOR/SOFR (US, 2018); (BGP)LIBOR/SONIA (UK, 2021); BPLR/MCLR(India, 2016); LPR (China), SELIC (Brazil), NIBOR (Norway)

LCOE Analysis

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Model Comparison

This capstone project benchmarks LCOE analyses from market sources such as IEA, Lazard, NREL, and DNV. It finds that LCOE values can vary for a specific country in the same year.

LCOE Variations Across Sources: US, 2020

Findings:

- Solar PV LCOE is most consistent across sources, ranging narrowly from $37–65/MWh, suggesting broad agreement on solar costs regardless of methodology
- Offshore Wind shows the widest disagreement across sources, ranging from $86/MWh (Lazard) to $156/MWh* (SIPA), reflecting different assumptions on capacity factors, financing costs and project maturity

These findings reflect a specific period only and do not capture long-run trends.

Avoided CO2 per Dollar Invested (ACDI)

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Concept

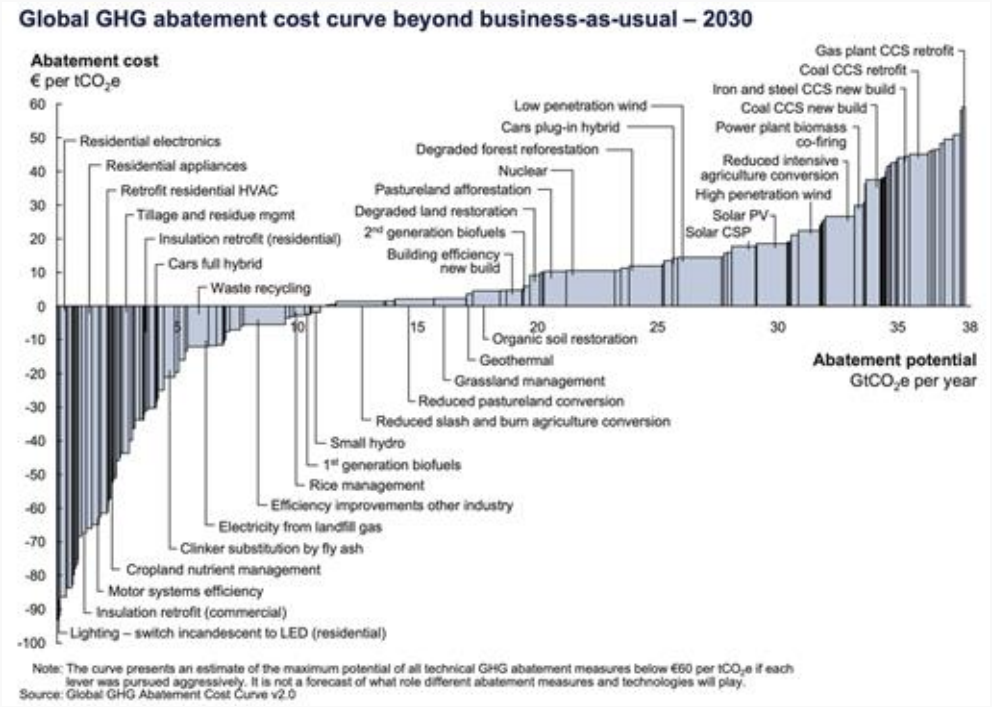
ACDI expresses the tonnes of CO_2 avoided per dollar of capital committed over the full life of an asset. Rather than treating sustainability as a qualitative overlay on investment decisions, ACDI converts it into a comparable, quantifiable output, allowing us to rank and screen investment opportunities on both financial and climate dimensions simultaneously.

This is particularly valuable in a retrenchment environment, where capital is scarce and every deployment decision carries greater strategic weight. Tracking ACDI ensures that a contraction in the investment portfolio does not translate into a disproportionate contraction in sustainability impact.

Methodology

1. Counterfactual Baseline Establishment Define the marginal fossil generation technology displaced by the candidate asset in each of the six countries
2. Production Cost Modelling Model dispatch behaviour, output, and grid interaction over the asset life for each of the six renewable energy types across all six countries
3. Avoided CO_2 Quantification Calculate lifetime avoided emissions per country-technology combination relative to the counterfactual. Adjust for capacity factor, market saturation, and output covariance.
4. Cost Normalisation Divide avoided CO_2 by all-in fixed capital cost for each combination to produce a comparable ACDI figure ($tCO_2/\$$), incorporating country-level cost differentials.
5. Comparative Screening Rank all country-technology combinations by ACDI. Apply a minimum ACDI threshold to filter out low-impact combinations.
6. Optimal Selection Identify the highest ACDI combination as the recommendation.

Marginal Abatement Cost Curve (MACC)



Source: McKinsey&Company, 2009

The abatement cost is the cost of an intervention that reduces greenhouse gas emissions by one tonne.

Comparing LCOE ($/MWh) for solar, wind, and CCGT with MACC ($/tCO2e) is useful because both metrics express cost relative to an output, although they measure different things. LCOE measures the cost per unit of electricity generated, while MACC measures the cost per unit of emissions avoided.

We will compare the MACCs of the different options to identify the most cost-effective way to deliver clean energy or avoid one tonne of emissions.

Formula:

MACC ($/$tCO_2e$) = (LCOE_tech – LCOE_fossil_baseline) / Emissions_Intensity_displaced

Final Synthesis Framework

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1. The final synthesis is divided into three scenarios: the Base Case, Scenario #1 – Society-Led Case, and Scenario #2 – AI Boom Case.
2. For each scenario, rank all countries based on the Investable Momentum result from Layer 1 or Layer 2 (A). The lower the rank, the more attractive the country.
3. Rank all countries based on the Risk Assessment Analysis (B). The lower the rank, the more attractive the country.
4. Rank all countries based on LCOE and avoided carbon per dollar invested (C). The lower the LCOE, the lower the value.
5. For technologies, the ranking (D) differs depending on marginal emissions intensity and technology saturation in each country.
6. To determine the final location for each scenario (E), calculate A + B + C. The lower the total, the more attractive the country as an investment destination.
7. To determine the final technology (D), select the lowest value among the technologies available in each country. This may vary depending on carbon reduction impact.
8. For the final combination of location and technology (F), sum E + D and rank in ascending order. The lower the score, the more attractive the combination.
9. Ultimately, the analysis will result in three sets of location and technology combinations.
10. Furthermore, this capstone will compare these results with Equinor's current business to identify which combinations align with the company's strategic interests.

Final Synthesis Results

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Base Case

Layer 1 - Investable Momentum Base Case (A)	Layer 2a - Risk Assess. (B)	Layer 2b - LCOE & ACDI Analysis		Layer 3 - Final Result Location (E) = (A+B+C) Lowest Total = Best	Layer 3 - Final Order (Country + Tech) (F) = (E)+(D) Lowest Total = Best
		Countries (C)	Tech. (Emission Reduction Impact, Policy Support & Market Saturation) (D)		
China (1)	Norway (1)	China (1)	China: Solar (1); Wind (2); CCS (3)	China (8)	China + Solar (9); China + Offshore Wind (10); China + CCS (11)
UK (2)	UK (2)	India (2)	India: Solar (1); Wind (2); CCS (3)	UK (8)	UK + Offshore Wind (9); UK + CCS (10); UK + Solar (11)
Brazil (3)	US (3)	Brazil (3)	Brazil: Solar (1); Wind (2); CCS (3)	Brazil (10)	Brazil + Solar PV (11); Brazil + Offshore Wind (12); Brazil + CCS (13)
US (4)	Brazil (4)	UK (4)	UK: CCS (1); Solar (2); Wind (3)	US (12)	US + Solar PV (13); US + Offshore Wind (14); US + CCS (15)
India (5)	India (5)	US (5)	US: Solar (1); Wind (2); CCS (3)	India (12)	India + Solar PV (13); India + Offshore Wind (14); India + CCS (15)
Norway (6)	China (6)	Norway (6)	Norway: CCS (1); Wind (2); Solar (3)	Norway (13)	Norway + CCS (14); Norway + Offshore Wind (15); Norway + Solar (16)

Final Synthesis Results

Scenario #1 - Society Led

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Layer 1 - Investable Momentum Scenario #1 - Society-Led (A)	Layer 2a - Risk Assess. (B)	Layer 2b - LCOE & ACDI Analysis		Layer 3 - Final Result Location (E) = (A+B+C) Lowest Total = Best	Layer 3 - Final Order (Country + Tech) (F) = (E)+(D) Lowest Total = Best
		Countries (C)	Tech. (Emission Reduction Impact, Policy Support & Market Saturation) (D)		
China (1)	Norway (1)	China (1)	China: Solar (1); Wind (2); CCS (3)	China (8)	China + Solar (9); China + Offshore Wind (10); China + CCS (11)
UK (2)	UK (2)	India (2)	India: Solar (1); Wind (2); CCS (3)	UK (8)	UK + Offshore Wind (9); UK + CCS (10); UK + Solar (11)
Brazil (3)	US (3)	Brazil (3)	Brazil: Solar (1); Wind (2); CCS (3)	Brazil (10)	Brazil + Solar PV (11); Brazil + Offshore Wind (12); Brazil + CCS (13)
US (4)	Brazil (4)	UK (4)	UK: CCS (1); Solar (2); Wind (3)	US (12)	US + Solar PV (13); US + Offshore Wind (14); US + CCS (15)
India (5)	India (5)	US (5)	US: Solar (1); Wind (2); CCS (3)	India (12)	India + Solar PV (13); India + Offshore Wind (14); India + CCS (15)
Norway (6)	China (6)	Norway (6)	Norway: CCS (1); Wind (2); Solar (3)	Norway (13)	Norway + CCS (14); Norway + Offshore Wind (15); Norway + Solar (16)

Final Synthesis Results

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Scenario #2 - AI Boom

Layer 1 - Investable Momentum Scenario #2 - AI Boom (A)	Layer 2a - Risk Assess. (B)	Layer 2b - LCOE & ACDI Analysis		Layer 3 - Final Result Location (E) = (A+B+C) Lowest Total = Best	Layer 3 - Final Order (Country + Tech) (F) = (E)+(D) Lowest Total = Best
		Countries (C)	Tech. (Emission Reduction Impact, Policy Support & Market Saturation) (D)		
China (1)	Norway (1)	China (1)	China: Solar (1); Wind (2); CCS (3)	China (8)	China + Solar (9); China + Offshore Wind (10); China + CCS (11)
US (2)	UK (2)	India (2)	India: Solar (1); Wind (2); CCS (3)	US (10)	US + Solar PV (11); US + Offshore Wind (12); US + CCS (13)
Brazil (3)	US (3)	Brazil (3)	Brazil: Solar (1); Wind (2); CCS (3)	Brazil (10)	Brazil + Solar PV (11); Brazil + Offshore Wind (12); Brazil + CCS (13)
India (4)	Brazil (4)	UK (4)	UK: CCS (1); Solar (2); Wind (3)	India (11)	India + Solar PV (12); India + Offshore Wind (13); India + CCS (14)
UK (5)	India (5)	US (5)	US: Solar (1); Wind (2); CCS (3)	UK (11)	UK + Offshore Wind (12); UK + CCS (13); UK + Solar (14)
Norway (6)	China (6)	Norway (6)	Norway: CCS (1); Wind (2); Solar (3)	Norway (13)	Norway + CCS (14); Norway + Offshore Wind (15); Norway + Solar (16)

Synthesis Results

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Final Order (Country + Tech) Base Case Lowest Total = Best	**Final Order (Country + Tech) Scenario #1 – Society-Led** Lowest Total = Best	**Final Order (Country + Tech) Scenario #2 – AI Boom** Lowest Total = Best
China + Solar PV (9)	China + Solar PV (9)	China + Solar PV (9)
UK + Offshore Wind (9)	UK + Offshore Wind (9)	China + Offshore Wind (10)
China + Offshore Wind (10)	China + Offshore Wind (10)	US + Solar PV (11)
UK + CCS (10)	UK + CCS (10)	Brazil + Solar PV (11)
Brazil + Solar PV (11)	Brazil + Solar PV (11)	US + Offshore Wind (12)
Brazil + Offshore Wind (12)	Brazil + Offshore Wind (12)	Brazil + Offshore Wind (12)
US + Solar PV (13)	US + Solar PV (13)	India + Solar PV (12)
India + Solar PV (13)	India + Solar PV (13)	UK + Offshore Wind (12)
Norway + CCS (14)	Norway + CCS (14)	UK + CCS (13)

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