PCRAM in Practice

Outputs from the Physical Climate Risk Assessment Methodology (PCRAM) 1.0 Case Studies

Background and acknowledgements

The Physical Climate Risk Methodology (PCRAM) is a process methodology that was conceptualised and developed by the Asset Design & Structuring working group of the Coalition for Climate Resilient Investment (CCRI), with special thanks to Mott MacDonald for their instrumental support in this work.

35 different institutions, ranging from banks, investors, engineering firms, climate risk data providers, lenders, credit rating agencies and academic institutions, collaborated to produce PCRAM. It represents a cross-industry effort to advance a dynamic impact assessment of physical climate risks that can be incorporated into investment decision-making.

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Introduction

The potential economic impacts of climate change can grow with each investment decision that does not adequately consider physical climate risks. Investors and lenders increasingly recognise these growing risks to the return profiles of their assets and portfolios, as well as the communities they invest in. Additionally, they see the potential to generate long-term value creation through investment in the climate resilience of their assets. Decision-makers across private and public finance are refining their practices and metrics to integrate climate-related risks and opportunities into their processes.

Despite this ambition, physical climate risk analyses are not standardised across private and public finance. A sole focus on "Value at Risk" outputs from often opaque and proprietary models can define potential increased costs or losses, however, it often only incentivises risk transfer and asset reallocation to ameliorate the financial exposure within discrete portfolios. These measures don't always solve the problem in the real economy, increasing systemic risk. Calculations also often do not fully reflect the benefits of investment in resilience which can include more predictable cash flows, improved credit quality, or/and a more efficient allocation of costs across an asset life cycle, as highlighted in the below case studies.

PCRAM is a process methodology that was developed and has been tested in its first iteration (PCRAM 1.0) as a dynamic process that would enable market actors to evaluate the operational, commercial, and financial materiality of physical climate risks in infrastructure assets, so that resilience can be incorporated in decision-making over the life cycle of an asset. A unique feature of the methodology is that it is asset specific, considering each asset's distinctive key performance indicators (KPIs) in relation to identified risks, allowing for the design of optimised resilience options. The full methodology is described in Guidelines for Integrating Physical Climate Risks in Infrastructure Investment Appraisal.

PCRAM is designed as guidance for a common robust process of assessing physical climate risks. It alone is not a risk measurement tool or calculation methodology, with these specific actions and analyses to be performed by professionals using their discretion and in line with their individual risk management policies and processes.

This report presents the results of the pilot phase of PCRAM 1.0, reflecting on the effectiveness of the methodology and its unique value-add for investors. It then explores the potential benefits of industry wide adoption of PCRAM and outlines next steps for PCRAM 2.0, to be taken forward by IIGCC as part of the CCRI Legacy Programme.

Introduction continued

The PCRAM Process

	1	2	3	4
Steps	**Scoping and data gathering**	**Materiality assessment**	**Resilience building**	**Economic and financial analysis**
Objectives	Determine data sufficiency	Assessing asset resilience	Identifying resilience options	De-risk asset exposure to PCRs
Sub-tasks	Project initiation Project definition Data gathering and sufficiency	Hazard scenarios Impact identification Impact severity Risk quantification	Resilience options: Hard (Structural/Capex) Soft (Operational/Systems)	Cost/benefit analysis IRR comparison
Outputs	Initial climate study Critical components KPI selection (the "Base Case")	Detailed climate study List of impacts and severity by component The "Climate Case"	Repeat materiality assessment Revised climate study for new elements The "Resilience Case"	Recommendations Value implications
Decision gates	Gate A Is data good and sufficient?	Gate B Are PCRs material to this asset?	Gate C What resilience options are available for this asset?	

Results of PCRAM 1.0 case studies

The pilot phase of PCRAM 1.0 proved the credibility of the approach, providing a practical demonstration of the assessment process and illustrating three key value propositions for investors:

1 The credible integration of physical climate risks into investment appraisal processes may improve the long-term risk and return profiles of financial portfolios, and may have positive implications for cost of capital and asset valuations.

2 A standardised method to accurately value the climate resilience of assets and optimise life cycle costs presents a significant engagement opportunity between investors and their clients, government actors, and/or wider stakeholders. This can support the value proposition for investors whilst generating opportunities to allocate capital to resilience to benefit communities that rely on critical infrastructure.

3 PCRAM offers a clear, dynamic, and meaningful process, which can address the needs of many disclosure frameworks that address physical climate risk, such as the Sustainability Disclosure Standards of the International Sustainability Standards Board (ISSB).

The pilot for PCRAM 1.0 comprised three detailed case studies conducted by multi-disciplinary teams, integrating climate science, engineering, and infrastructure finance to translate climate risk analytics into metrics typically used in the investment appraisal process. The range of the case studies demonstrated PCRAM's potential broad applicability to a variety of infrastructure assets in different locations, across financing and ownership models, each faced with different climate risks.

As a series of discrete assessments, the results of each case study provide examples of how using PCRAM to model cashflows, by integrating the impact of physical climate risks to understand "valuation at risk", provides a clearer picture of the materiality of asset-specific physical climate risks. They also highlight new opportunities to mitigate them beyond many of those available under current practices. This is different from the climate "value at risk" assessments used in the insurance industry. Taken together, they showcase a number of potential applications for the analysis, exhibiting the value of robust and standardised physical climate risk assessments to all stakeholders.

Case study highlights

Case study

~50 MW Nearshore windfarm

Location: Non-OECD

KPIs: 20 years operation; annual generation of 159GWh p.a.; IRR

Material risk: Sea level rise impacting energy transmission

Resilience option: Relocate electricity substation

Result: Impact on project IRR of incremental capex is counterbalanced by higher power generation when considering climate risks

Case study

~40 MW Run-of-river hydropower facility

Location: Non-OECD

KPIs: 40 years operation; annual generation of ~200GWh p.a.; IRR

Material risk: Changes in precipitation/ drought impacting energy yield

Resilience option: New access road, flexible intake design, variable flow turbines, slope design/monitoring

Result: Marginally higher IRR in most scenarios

Case study

High speed railway

Location: OECD

KPIs: Trains timetabled; trains delayed

Material risk: Heat, sea level rise impacting services

Resilience option: Temperature monitoring and mitigation measures, track raising, drainage and pumping

Result: Allocation of resilience investments between stakeholders; opportunity for cheaper insurance, lower lifecycle costs and greater bankability; avoided emissions from alternative transport; workforce and public safety

Case study

Water reservoir

Location: OECD

KPIs: 150Ml/day public water supply, irrigation water storage, additional flood storage, biodiversity net gain, community benefits

Material risk: Flooding interrupting water output

Resilience option: Additional flood control storage

Result: Increased output in climate scenario estimated to increase revenue; limiting or offsetting of local flood risk

***Internal Rate of Return (IRR).**

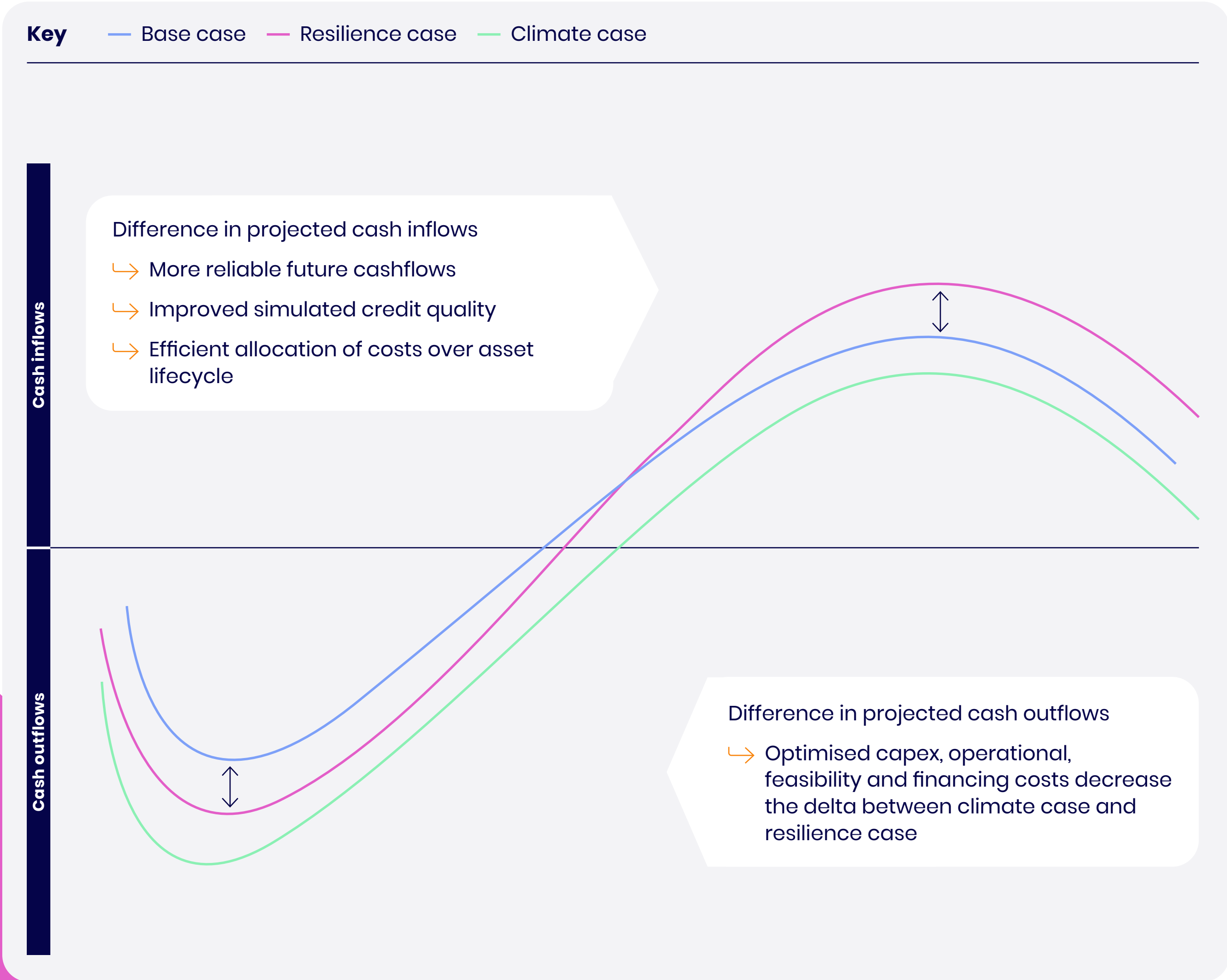
Deeper insight into some of these case studies is provided in the appendix

Potential practical implications and benefits of PCRAM

1 By capturing and quantifying the value of resilience measures throughout an asset life cycle, PCRAM could enable value creation through more reliable cashflows and cost optimisation

PCRAM allows investors to evaluate whether adjusted cashflow projections which integrate resilience measures justify incremental increases in upfront expenditure (to the extent that they form part of the relevant resilience options for an asset). Examples include reducing downtime of the asset, reduction in penalties linked to breaches of a concession agreement, potential improvements in the quality of revenue streams and reductions in operation and maintenance costs over time, or improved ability to meet loan covenants. It is only by quantifying the potential impacts of physical climate risks on cashflows *with* and *without* resilience measures, that investment in resilience was demonstrated to be value-supporting. PCRAM's ability to quantitatively reflect the full range of financial and other benefits of resilience can also enable the optimisation of costs throughout an asset life cycle.

PCRAM and cashflow projections



Potential practical implications and benefits of PCRAM continued

2 PCRAM can support approaches to monetising resilience benefits and allocating costs of incremental investments in resilience between stakeholders

The railway case study revealed that, for some asset ownership and financing models, demonstrating the strength of the case for investment in resilience is just a first step. In this example, it led to an important follow-up question: *Who is responsible for the incremental upfront costs of resilience for assets under a concession, and how might they be funded?*

The PCRAM process could provide a basis for engagement between regulators and concessionaires to identify ways to ensure the optimisation of life cycle costs by smoothing the costs of resilience measures over the length of a concession. Ultimately, this would create value for investors as well as the public sector and communities dependent on the functioning of critical infrastructure, including at the time when these assets revert to the public sector.

3 KPIs and materiality thresholds allow the design of optimised resilience options

During Step 1 of a PCRAM assessment, KPIs used to measure the impacts of physical climate risk are selected. These can include financial metrics such as internal rate of return (IRR), debt service coverage ratio (DSCR) used in debt covenants, return on investment (ROI), legal or regulatory costs such as expected commercial penalties or liquidated damages, as well as other performance and impact metrics such as energy yield, CO_2 emissions, energy/water output, etc. These KPIs help determine the materiality of physical climate risks to the physical asset owners, operators, lenders, investors and public stakeholders as a key step to exploring resilience solutions.

4 PCRAM could have positive implications for credit quality and the cost of capital of resilient assets

PCRAM assessments can enable the development of more resilient infrastructure assets. The methodology facilitates a quantification of improvements in resilience to climate risk impacts which can then be reflected in an asset's risk profile. In theory then, investment in resilience following a PCRAM assessment could lead to improved credit quality simulations and potentially reduce the cost of capital for an asset. PCRAM could also have benefits in data-scarce environments, where improvements in data quality resulting from a PCRAM assessment could have positive implications for credit quality, even before integrating resilience measures. Improvements to credit quality could lead to lower target equity returns for investors and margins or coupons required by lenders and debt investors (everything else being equal, including asset leverage).

Spotlight: Physical Climate Risk and Credit Quality

Simulated credit quality assessments on PCRAM case studies

S&P Global, comprising colleagues from S&P Global Ratings and S&P Global Market Intelligence (SPGMI), applied as an illustrative exercise SPGMI's credit assessment Scorecard (which broadly aligns to S&P Global Ratings' criteria), to assess the credit quality of projects selected by CCRI and opine on differences in creditworthiness of the projects with and without climate resilience options. The emphasis of the analysis was on infrastructure projects' exposure to physical climate risks. The work suggests that credit quality may be positively affected when taking adaptation measures in infrastructure investments into account. There were variations in credit quality for the different climate scenarios that were tested.

Original document: Guidelines for Integrating Physical Climate Risks in Infrastructure Investment Appraisal

PCRAM 2.0

Looking forward, the pilot PCRAM case studies provide a path toward a second phase of development "PCRAM 2.0". The essential leadership of engineering firms and climate scientists, in partnership with investors, has produced a rigorous process to translate physical climate risks into quantifiable impacts to infrastructure asset performance. It is also clear that the next steps must engage investors to take this forward and facilitate potential market adoption of PCRAM.

If led by public and private finance actors, systematic adoption of PCRAM as a basis for a sound physical climate risk assessment, that includes options for building real world resilience in assets, could spur a shift to resilient investment. This could in turn deliver assets with more predictable future cash flows and/or optimised life cycle costs, helping build systemic resilience from the "bottom up" in asset portfolios and in the communities in which they operate.

Delivered by a cross-industry workstream, and guided by IIGCC, priorities for PCRAM 2.0 include:

Spotlight: COP28 Call for Collaboration

IIGCC and partners issued a Call for Collaboration at COP28 to policy makers to support efforts to scale existing actions, innovations and leadership on adaptation and resilience finance by supporting efforts to further enabling conditions for the nascent adaptation and resilience market. This called for policy frameworks that support efforts, such as PCRAM, to quantify resilience benefits and integrate resilience metrics assessments into financial decision-making processes. The Call received support from five governments: Austria, Chile, Colombia, Guatemala and Switzerland and was driven by organisations representing insurers, banks, and institutional investors.

1 Raising awareness and adoption of PCRAM

IIGCC will continue to engage with investors, credit rating agencies, and government actors on integrating physical climate risk assessment across financial decision-making processes.

IIGCC will seek to raise PCRAM's profile by engaging:

- **Regulators of infrastructure assets** (such as railways and water utilities) to consider PCRAM as a method to help achieve the optimum allocation of resilience costs and benefits between stakeholders in the public and private sectors. For example, PCRAM could be used to help smooth the incremental costs of resilience measures over the length of a concession and ensure that physical climate risks have been adequately assessed and properly mitigated when an asset is transferred back to the public sector.
- **Financial regulators**, to consider PCRAM e.g., for incorporation into the TCFD/ISSB framework, and transition plan guidance, such as that issued by the UK Transition Plan Taskforce, to add further detail and direction for organisations seeking to manage financial risks from physical climate impacts.
- **Government and NGO standard setters**, to consider PCRAM taxonomy and guidance providers, e.g., ISO, Green Book, ICSI and the European Commission.
- **Government foreign aid and development organisations**, including Multilateral Development Banks and Development Finance Institutions who themselves already have similar complementary processes to address physical climate risks. Ideally all lending and investments made by DFIs should be done after a resilience assessment such as PCRAM has been undertaken.

PCRAM 2.0 continued

2 Advancing the integration of PCRAM into lending and investment processes

- Comprehensive evaluations as demonstrated in the case studies will not be feasible for all existing and potential new assets in portfolios. Feedback from the finance community has highlighted a need to develop a less resource-intensive iteration of the methodology, and a view of how it can be integrated into current risk management and due diligence processes.
- The IIGCC Adaptation and Resilience working group along with wider stakeholders will look to develop the PCRAM process for financial institutions in-house practices. The intention is for this to assist both portfolio risk management and pre lend/investment due diligence. These may then help identify cases in which a full, in-depth PCRAM assessment should be conducted and inform engagement with clients and investees on resilience.

3 Refining and expanding the methodology.

PCRAM 2.0 will also seek to refine and expand the current 4-step process.

Steps 1 to 3:

1. Explore expanding the modelling and materiality assessments to reflect assets' impacts and dependencies in a broader network of assets and measure the impact of multiple hazards occurring simultaneously.
2. Better include non-financial metrics to broaden the use and applicability of PCRAM assessments to other stakeholders.
3. Include guidance on exploring and evaluating nature-based solutions as a standardised part of an assessment.
4. Will be further developed to potentially include:
    - Advances in the approach to determining the quantum and the timing of changes to revenues and costs associated with resilience options (especially considering nature-based solutions).
    - Consideration of adjustment to discount rates in relation to physical climate risk.
    - Deeper consideration of the extent to which risk transfer (insurance and other related mechanisms) can be complementary alongside investment in resilience measures in a changing risk landscape, including consideration of expected changes in the price of risk transfer on climate resilient assets.

Recognising that the benefits of resilience are often shared and extend across multiple actors and users of critical infrastructure assets, a new "Step 5" will also be explored.

This entails the development of a process to assess the full value and benefits of climate-resilient assets to a range of stakeholders beyond asset owners and investors. Depending on the asset and ownership and financing model, beneficiaries could include businesses, local governments, national governments, households and communities. Step 5 will aim to devise an approach to identifying beneficiaries and monetise resilience benefits such as through levies or tax credits.

Coastal windfarm assessment

Read more about this case study here

Overview

Equity investment for construction of a ~50 MW nearshore wind farm in a non-OECD country

Objectives/ KPIs: 20 years useful life at ~160 GWh/year

Impact

~70,000	+500	~130,000
tCO_2e/year emissions avoided	construction jobs	people reached

CCRI Case Study Team

Investment, Engineering & Data firms

Step 1: Scoping and Data Gathering

- Focus on damage to the windfarm and primary supporting infrastructure and energy yield
- Selection of climate scenario/s
- Hazards identified impacting energy generation and causing damage: sea level rise, flooding, decrease in wind speeds

Step 2: Materiality Assessment

The potential impacts of sea level rise and storms on the windfarm, its primary supporting infrastructure, and energy generation were assessed and found to be potentially material

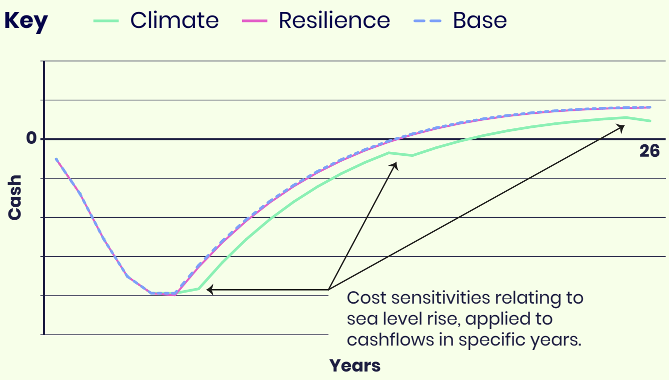
- Floodplain projected to rise by 2050
- The assessment found that the projected 1-in- 100-year storm event would not cause flooding above a critical elevation by 2050
- It was projected that the 1-in-100-year storm flood inundation level would not be likely to breach a critical elevation until later in the century, beyond the useful life of the asset

The potential negative impact of projected changes in wind speeds on energy generation was assessed and found to be negligible

- Nine global circulation models (GCMs) were assessed, revealing a predominant trend of a slight increase in projected daily mean wind speed, with significant disagreement and uncertainty between the models
- Range of projected changes to wind speed around -1.5% to +8%
- Assessment of the potential influence of a decrease in average wind speeds on energy generation found a negligible drop in annual yield, showing non-material impact

Asset manager: Confidential
Investors: Confidential
Location: Non-OECD
Sector: Power generation (renewable)
Climate variables analysed: Changes in wind speeds/ sea level rise
Finance type: Development finance, blended finance facility

Illustrative cashflow model



Step 3: Resilience Building

It was determined that the primary substation, a critical single point of failure for the asset, would be resilient to flood impacts if placed far inland and raised above the natural ground elevation

Step 4: Economic and Financial Analysis

Project IRR was calculated for the "Climate Case" and "Resilience Case", integrating projected flood risk to the primary substation without and with resilience measures

- The potential "Climate Case" project IRR is an estimated 60-200 basis points lower than the "Base Case", depending on the timing of a flood event in the asset life
- The "Resilience Case" project IRR is an estimated 10 basis points lower than the "Base Case"

In the Climate Case, the primary substation was not located inland/raised above the floodplain

- A major flood event would damage the substation, incurring replacement costs and causing a six-month shutdown with no energy production during the wet season

In the Resilience Case, the primary substation was raised to higher ground

- Increasing CAPEX by <1% of total development cost
- Avoiding flood damages and losses in the Climate Case

Hydropower project assessment

Read more about this case study here

Overview

Development financing for construction of a ~40 MW run-of-river hydropower project in a non-OECD country

Objectives/ KPIs: 40 years useful life at 200 GWh/year

Impact

25,000 tCO_2e/year emissions avoided

+300 construction jobs

600,000 people reached

Asset manager: Confidential
Investors: Confidential
Location: Non-OECD
Sector: Power generation (renewable)
Climate variables analysed: Changes in precipitation
Finance type: Development finance, blended finance facility

CCRI Case Study Team

Investment, Engineering & Data firms

Step 1: Scoping and Data Gathering

- Focus on damage and energy yield
- Selection of climate scenario/s
- Hazards identified impacting energy generation: changes in precipitation, drought

Step 2: Materiality Assessment

The hydrological model was adjusted, based on projected changes in annual precipitation, and fed into an energy model to calculate the expected change in energy generation.

- Projected seasonality changes in precipitation were found likely to result in drier and longer wet season, with an increase in extreme precipitation; under a high scenario, river flow is likely to decrease annually by approximately 8%, mostly during the wet season with a projected decline of between 25% to 35%, while increasing slightly in the dry season.
- Drought risk was found likely to double by the end of the assets' useful life: three-month prolonged droughts are likely during 2021-2040, and for even longer periods after 2040.
- Overall, the future climate projections revealed minimal reduction in average annual river discharge through to 2040 and a 15-20% reduction in discharge from 2040 to 2060.
- The asset is not materially impacted in the near term (up to 2040) because of the projected dry season flow increase. However, beyond 2040, it is expected to be materially impacted, with a significant loss of energy production anticipated year on year.

Step 3: Resilience Building

A suite of structural and functional resilience measures and their impact on CAPEX and OPEX were identified to enhance management, efficiency, and a quicker recovery from decreased rainfall and drought events. Complimentary distributed renewable resources were also proposed to help smooth out energy production.

Step 4: Economic and Financial Analysis

Internal Rate of Returns (IRRs) were derived for the new Climate Base Cases and Drought Sensitivities and compared against the in-built resilience measures.

The analysis was done over 20 years to align with initial concession term.

One month drought in the dry season and three months drought in the wet season were selected based on findings in the climate data.

Their effect on expected energy production was applied as a sensitivity in specific years throughout the cashflow projections.

IRR	1 month drought in dry season (% change from baseline)	3 month drought in wet season (% change from baseline)
P90	+1.36	+0.27
P75	-0.32	-1.24
P50	+0.08	-0.77

Key financial results:

- Climate Base Cases have net lower IRRs except the P90 case due to projected increases in precipitation during dry seasons.
- Marginal negative impact of 1 month drought.
- Significant impact of 3-month drought in wet season.

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