



DECIPHER

Holistic decision-making for climate & environment

POLICY BRIEF

Innovating Climate-Economy Modelling: Dealing with Uncertainty, Risk and Complexity

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1. Motivation

Designing effective climate, biodiversity and energy policy requires making decisions today about uncertain futures. Policymakers face complex risks that unfold over decades, shaped by technological innovation, evolving financial conditions, and the macroeconomic impacts of extreme weather. To navigate these challenges, models of the climate–economy system are indispensable for exploring alternative futures and stress-testing policy choices. The value of these models depends on how well they capture uncertainty, incorporate behavioural dynamics, and reflect real-world constraints such as financing costs, systemic shocks, and physical damages. Without these elements, even sophisticated analyses can miss critical vulnerabilities or opportunities.

The DECIPHER (Decision-making framework and processes for holistic evaluation of environmental and climate policies) project, funded under Horizon Europe, aimed to overcome limitations in conventional policy appraisal by creating a new, holistic decision-making framework that better captures the complex nexus of climate change, biodiversity, and the economy. The project included an iterative knowledge co-creation process for more **transparent, inclusive and representative** policy design and evaluation. Moreover, it developed **new generation of state-of-the-art economic models** featuring feedback loops with **physical system models** and embedded **systemic risks** and **uncertainty** and capture behavioural and knowledge dynamics allowing it to improve the representation of the **economy–climate–biodiversity nexus**.

Compared to mainstream economic models that often neglect uncertainty and resilience, DECIPHER integrates advanced economic and biophysical modelling, empirical methods, and stakeholder co-creation to assess the feasibility, resilience, risk, and opportunity dimensions of climate and environmental policy options. The framework is designed to be operational under real-world conditions and is being applied to key EU policy domains such as the “Fit for 55” package, LULUCF regulation, and national recovery plans. Through this approach, DECIPHER equips policymakers with tools that do more than forecast: they reveal trade-offs, highlight robust strategies, and strengthen the legitimacy and adaptability of decisions in an uncertain future.

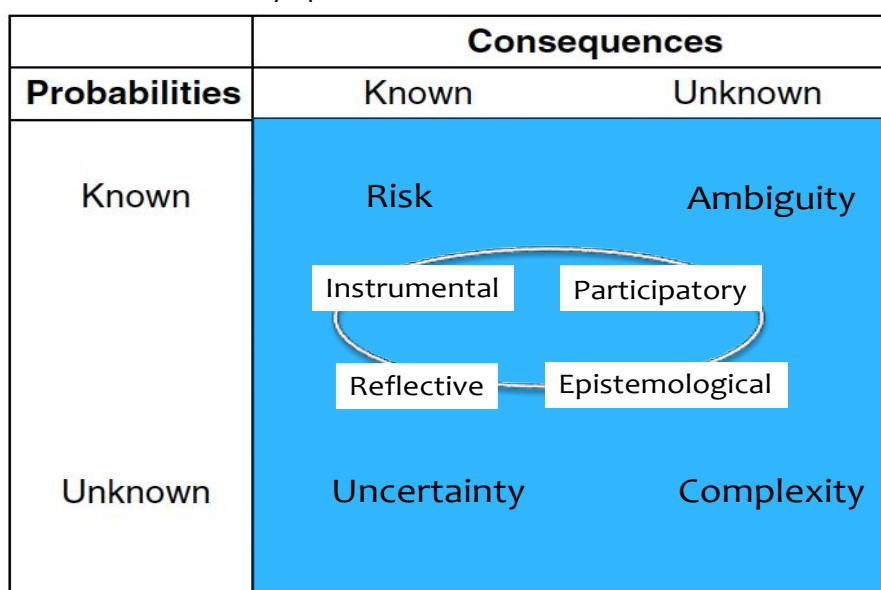
DECIPHER research draws upon the comprehensive framework of IRGC (2006)¹ to identify discourses that science, policy, and application must address in the ‘uncertainty’ space. These discourses are based on different classes of risk and uncertainty, broadly aligned with the Knightian risk and uncertainty definitions of simple and complex, high-uncertainty, and high-ambiguity risk (see **Figure 1**).

- *Instrumental discourse* is suitable for addressing clearly defined risk problems, employing well-tested decision support methods like cost-benefit analysis and focusing on economic incentives and technical solutions.

¹ IRGC-International Risk Governance Council (2006). Risk governance: Towards an integrative approach. White paper no. 1. IRGC, Geneva.

- *Strong participatory discourse* is crucial, particularly (but not exclusively) for addressing issues of ambiguity where values are contested, aiming at conflict resolution and broad-based stakeholder engagement.
- *Reflective discourse* becomes essential when dealing with high levels of uncertainty, emphasizing precautionary principles and the need for careful consideration of 'danger' and 'adaptation limits.'
- *Epistemological discourse* is particularly important for characterizing the available evidence for understanding risk across the entire risk spectrum, especially in the face of complexity and ignorance.

Figure 1: The risk and uncertainty space.



Source: Mechler et al., 2025.² Based on Knight, 1921

This policy brief presents five recent modelling advances that strengthen the evidence base for climate and biodiversity action and economic decision-making amidst uncertainty based on DECIPHER research:

1. **Emulation for Uncertainty Quantification** – enabling thousands of simulations to identify which policies are robust across many futures.
2. **Rational Expectations in Computable General Equilibrium (CGE) Models** – showing how forward-looking investment behavior can lower transition costs and smooth shocks.
3. **Cost of Financing in Technology Diffusion** – reflecting how interest rates and capital costs affect the uptake of clean technologies.
4. **Flood and Coastal Damage Assessment** – linking detailed coastal risk assessment with macroeconomic models to reveal the economic value of adaptation.
5. **Multiple Resilience Dividend** – capturing avoided losses, development co-benefits and inequality reductions from risk-management investments, strengthening the case for sustained adaptation and mitigation.

² Mechler, R., Żebrowski, P., Clercq-Roques, R., Patil, P., Stefan Hochrainer-Stigler (2025). The role of extreme event and systemic risk - assessment and guidance. DECIPHER project, Deliverable 5.3

These innovations share a common goal: to assist decision-makers in moving beyond static forecasts toward more resilient policy development. They identify targeted measures, such as investing in adaptation, improving access to affordable finance for renewable energy, or considering investor expectations, which might help contain costs and deliver long-term economic and social benefits.

Incorporating these approaches into climate and energy planning and impact assessment tools can help policymakers make credible choices across various future scenarios, increasing confidence that policies will safeguard citizens and economies while supporting a well-managed transition.

The following sections present each modelling innovation by setting out **the problem** it addresses and why it matters for policy, **the solution** with key modelling features, **illustrative figures** showing main results, **guidance on application**, including when the method is most suitable and its limits, and **references** to academic work by project partners for readers seeking further detail.

2. Incorporating uncertainty in impact assessment tools

2.1. Emulation for Uncertainty Quantification

Problem

Traditional climate and macroeconomic scenario models often fail to capture uncertainty in policy inputs and assumptions systematically, making it challenging for policymakers to assess policy robustness, defined as the ability to achieve policy goals under uncertainty and shocks, across various possible futures. Robustness differs from resilience, which emphasises ‘returning to a stable equilibrium point after a shock’.

Modelling solution

A machine-learning-based emulator was developed to serve as a computationally inexpensive surrogate for complex simulation models, such as FTT:Power. The emulator allows for:

- thousands of scenario evaluations at minimal cost,
- simultaneous variation in uncertain inputs (for example, techno-economic parameters such as learning rates³, as well as policy ambition).

The emulator systematically explores uncertainty in 15 techno-economic parameters, such as build and connection speed, learning rates, energy demand growth, cost of capital, and technology lifetimes. In addition, the emulator explores the effect of different policy instruments within the country that implements them and cross-boundary.

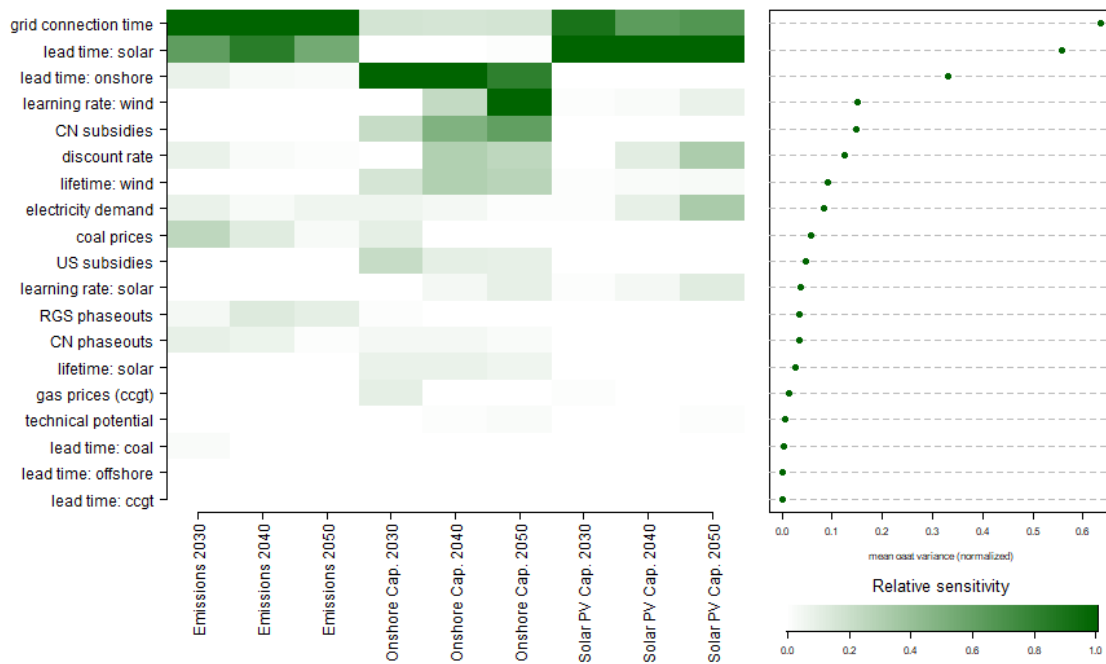
Illustrative example

Key uncertainties in the speed of transition are identified in **Figure 2**. Over the last decade, the pace of building out solar and wind energy has accelerated, and grid expansion has struggled to keep pace with the growth of renewables in some countries. These two

³ A measure of reduction in costs of energy technologies for each doubling of cumulative production or capacity.

uncertainties lead to the highest variation in FTT:Power. Learning rates for onshore wind come next; its mean learning rate is much lower, so that slight variations in the learning rate can have a large effect on cost-competitiveness. Finally, Chinese policy plays a key role in the global cost of certain technologies, as their large market has the strongest ability to induce innovation. US subsidies, and their potential rollback, have a limited direct effect via induced innovation. Solar PV is no longer sensitive to these dynamics of regional policy.

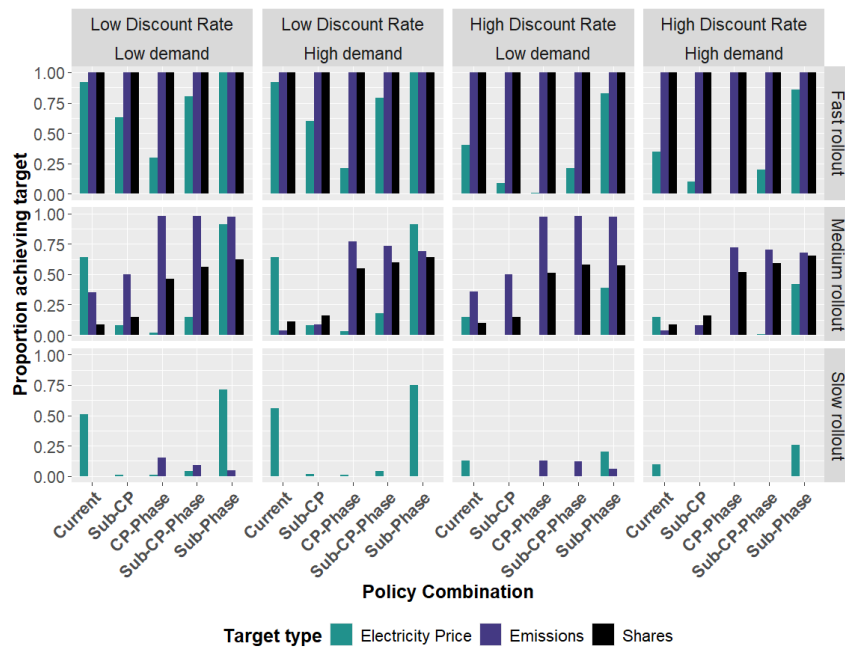
Figure 2: One-at-a-time analysis (oaat), for the top 19 variables in the analysis, (a) in terms of global emissions, capacity of onshore wind and capacity of offshore wind. Panel (b) shows the average sensitivities across all three outputs.



Note, the figure was produced using code adapted from McNeall et al. (2024).

Figure 3 shows the robustness of policy combination against key uncertainties. None of the policies are very robust against grid delays and worsening of relative build times for solar and wind (bottom row). In terms of other uncertainties, such as the cost of finance and high demand growth, the combination of subsidies and phase-outs is the most robust.

Figure 3. Share of emulator runs meeting India's 2030 targets. The bottom row shows the policy combinations tested (current policy, and combinations of upfront subsidies (Sub), carbon pricing (CP), and phase-outs (Phase)).



Application

Use when: a high number of model runs is required to assess the sensitivity or robustness of policy outcomes.

Avoid when: the target model has rapidly shifting dynamics that are too complex to be accurately captured by emulators without a large amount of training data.

2.2. Rational Expectations in Computable General Equilibrium (CGE) Models

Problem

Expectations shape economic decisions as they reflect how agents believe key economic fundamentals will evolve. In economic modelling, the way expectations are formed strongly affects model results and policy implications, determining not only the eventual equilibrium but also the path the economy takes to reach the equilibrium. Typically, in economic models, expectations refer to the trajectory of prices or costs, and there are two mainstream approaches:

- **Myopic expectations**, where agents lack foresight and base their decisions solely on current conditions,
- **Rational expectations**, where agents have perfect foresight, meaning they possess complete information on how, for example, prices will change in the future, and their behaviour is influenced not only by current conditions but also by anticipated future conditions.

Myopic expectations, when coupled with restrictions on capital mobility, may lead to an overestimation of costs related to the clean energy transition. The literature has highlighted how myopic expectations can lead to stronger responses to shocks and how rational expectations can lead to milder responses. However, since these are two extreme cases of expectation formation, researchers have also explored alternative methods, such as incorporating savings into the intertemporal problem.

Modelling solution

A short version of CGE model, the GEM-E3 model, was developed that introduces two enhancements:

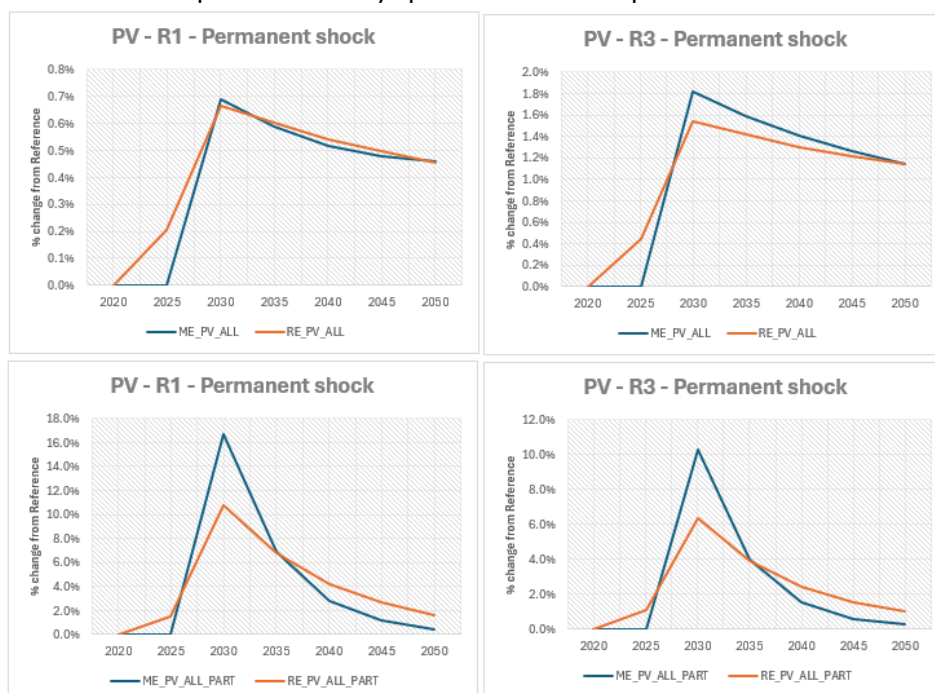
- **Rational expectations**, allowing investors to form forward-looking views about future returns,
- **Capital mobility constraints**, which can be set as partial or full, to capture limits on how easily capital flows between sectors or regions.

These features enable a more realistic treatment of policy impacts and capital reallocation dynamics. Additionally, rational expectations were introduced to the full version of the GEM-E3 model, and the economic implications of the green energy transition were examined for Germany and Italy.

Illustrative example

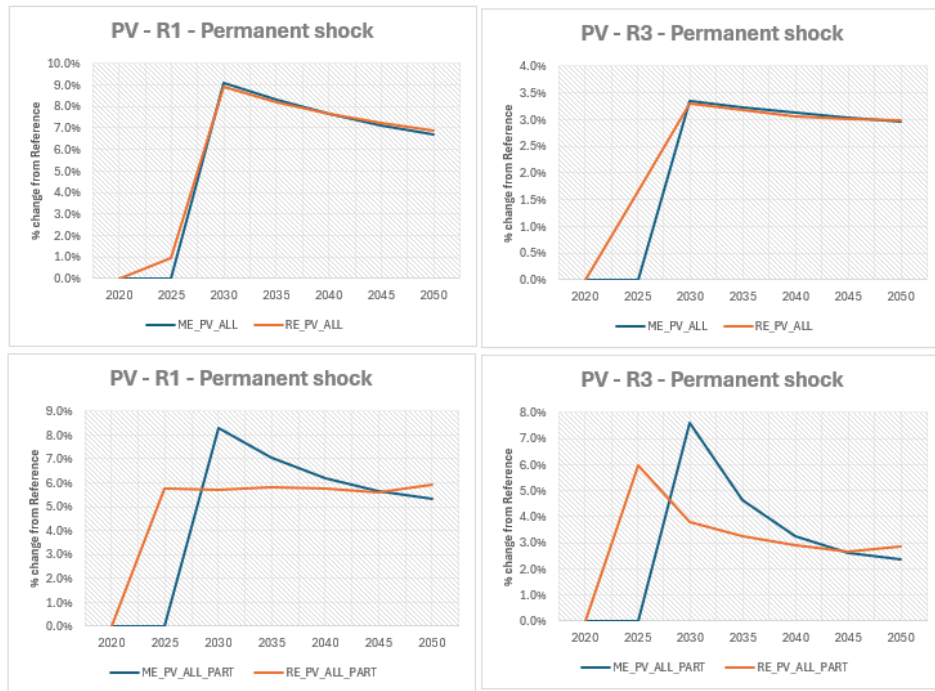
To illustrate the influence of expectation formation and capital mobility, a permanent demand shock for photovoltaic (PV) equipment is simulated in the short version of the GEM-E3 model within the three-region model. Regions R1 and R2 act as net importers of PV equipment, while Region R3 serves as the exporter. The shock originates in R1. Scenarios compare full capital mobility (ALL) with partial mobility (PART).

Figure 4: Unit cost of capital under myopic vs rational expectations.



Myopic expectations lead to no anticipatory adjustment, while rational expectations trigger earlier investment, moderating cost spikes. The assumptions on capital mobility greatly influence the magnitude of the impacts, as capital costs change under partial mobility, peaking at a range of 10% to 18% compared to 0.7% under the assumption of full capital mobility.

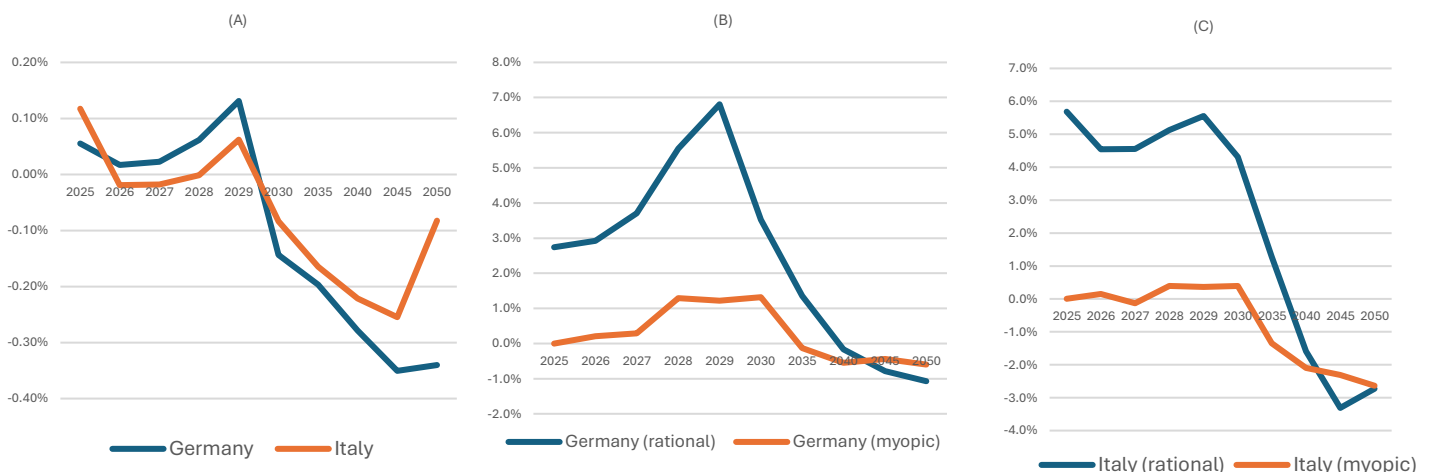
Figure 5: Investment patterns under myopic vs rational expectations.



Under rational expectations, investment begins earlier (2025) in anticipation of 2030 demand. Myopic agents react only at the time of the shock, resulting in higher capital costs and inefficient allocation. These implications are clearer under the assumption of limited capital mobility, as the shock in capital prices is significantly higher, hence the adjustment of investments under perfect foresight begins much earlier.

Then, rational expectations were incorporated into the fully-fledged GEM-E3 model version. To achieve this, a first-order approximation was performed due to the model's large scale and complexity.

Figure 6: Change in the unit cost of capital (A) and investments (B), (C) in % from the reference.



Changing the way expectations are formed may also affect the sectoral structure of investment, shifting it away from traditional manufacturing sectors and towards the production of clean energy and the manufacturing of clean energy equipment. Furthermore, this shift may put pressure on the current account balance due to higher investments in the short to medium term, which leads to an increase in imports of investment goods.

Overall, the rational expectations assumptions lessen the impacts of the transition on the economy and lead to a higher GDP compared to myopic expectations. This, along with other structural changes and shifts in macro drivers during the transition, highlights the need to carefully consider the formation of expectations when assessing the impacts of the clean energy transition.

Application

Use when trying to assess the temporal effects of shocks or policy announcements with long lead times.

Avoid when focusing on very short-term impacts or for situations where reliable data on expectations are lacking.

2.3. Cost of Financing in Technology Diffusion

Problem

The transition requires high levels of investment in low-carbon technologies. These technologies are more capital-intensive than fossil-fuel technologies, making the question of financing more important, both in itself and when comparing the relative attractiveness of the technology options. An understanding of the investment environment and the relative merits of different technology options is vital to inform effective policy. Conversely, failing to account for such specificities risks undermining the reliability of projected technology transitions, especially in scenarios in which wider macroeconomic or policy conditions might change.

Under conventional modelling treatments, a fixed discount rate (for example, 10%) is more common, across all technologies (failing to identify technology-specific features) and regions (failing to ignore more local financing conditions). This simplification thus ignores differentials that might be consequential in determining the pace and global distribution of the transition, or the role of differential changes in such conditions e.g. policy-induced uncertainty and rising interest rates.

Modelling solution

The FTT: Power model was enhanced to incorporate weighted average cost of capital (WACC), which takes into account the cost of debt and cost of equity that vary by:

- Technology type (for example, solar PV, onshore/offshore wind, gas, coal),
- Region.

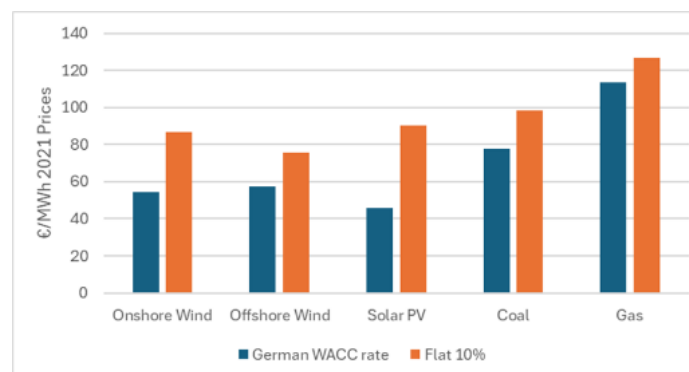
The implementation of the WACC rate is done at a granular level to allow for the modelling of how financing costs could vary under different macroeconomic and policy conditions (for example, interest rate hikes, green financing options). This enriches the FTT-Power's

representation of dynamic investor behaviour, making it more aligned with real-world conditions. This enables the model to capture uncertainty stemming from changing financial environments.

Illustrative example

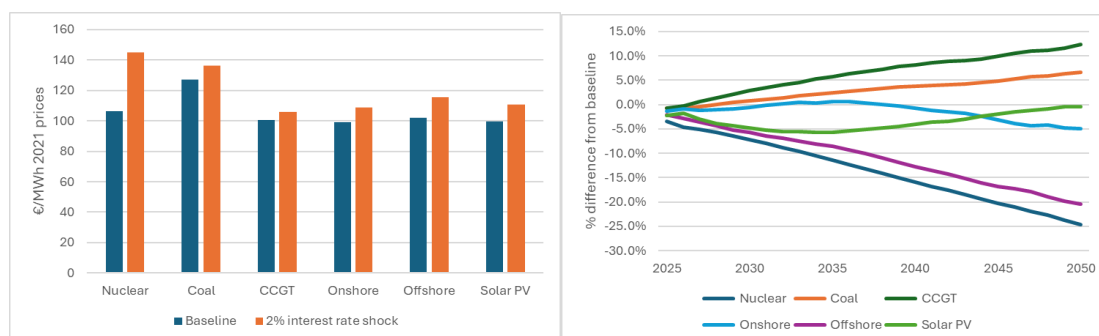
The implication of changing from a 10% discount rate to region and technology-specific weighted cost of capital can make a large difference in the estimated levelised cost of electricity. **Figure 7** shows the impact of the change across key technologies for Germany. The impact of relative cost is much larger for renewables, which are more capital-intensive than fossil fuel technologies. However, in Germany, the policy environment and financing structure also favour solar and wind technology, resulting in favourable WACC rates compared to fossil fuels.

Figure 7: Change in LCOE for power generation technologies in Germany under a 10% discount rate compared with specific WACC rates.



This improves the starting baseline position for modelling technology diffusion in the power sector. We can then examine how changes in financing costs impact technology diffusion. For example, we can explore the implications of a discrete shock in base interest rates for the EU. **Figures 8 and 9** illustrate the impact of a 2% interest rate increase from 2025 onwards. The uniform increase in interest rates leads to a larger percentage increase in costs of generation for low-carbon technologies compared to coal and gas. The impact of this leads to a moderate slowdown in the diffusion of low-carbon technologies, slowing the removal of coal and gas generation from the EU power mix.

Figures 8 and 9: Impact of 2% base interest rate shock on EU average LCOE and share of generation capacity.



This shows that changes in financing conditions can have material impacts on the speed of the transition to low-carbon power generation. Beyond the direct impacts on the speed of transition, this can have broader macro-economic implications as financing costs raise the average system cost, which leads to higher electricity prices, imposing high costs for households and businesses. In addition, due to the path dependency of technology diffusion and the long-term nature of financing agreements, the impact of short-term shocks to the cost of financing can persist well beyond the period of the initial shock.

Application

Use when: evaluating energy policy and renewable deployment under different financial conditions.

Avoid when: interest rate variability is not relevant or not expected to vary based on the scenario condition being evaluated

References

Mercure, J.-F. (2012). FTT:Power: A global model of the power sector with induced technological change and natural resource depletion. *Energy Policy*, 48, 799–811.

2.4. Flood and Coastal Damage Assessment

Problem

Conventional economic models typically do not dynamically integrate physical climate damages – notably those from sea-level rise (SLR) and coastal flooding. This limitation undermines

- the quantification of capital stock losses under alternative warming pathways;
- the differentiation of outcomes under varying adaptation strategies;
- the disaggregation of damages by sector and jurisdiction, which is crucial to trace cascading effects across economies.

Without realistic modelling of flood-related capital destruction, climate impact assessments risk underestimating losses and misleading adaptation policy design.

Modeling solution

We adopt a next-generation coastal risk modelling framework based on the **Dynamic Interactive Vulnerability Framework (DIVA)**, reengineered as an open-source **Julia package**. has been extensively used in assessments of coastal flood impacts and coastal adaptation in various European projects and scientific publications. The reworked *DIVACoast*⁴ library supports greater spatial granularity and facilitates seamless integration into macroeconomic impact environments.

Key features of the approach:

- **High-resolution segmentation:** The original DIVA employed ~12,150 coastal segments; the updated model subdivides into ~143,000 local floodplains. These are defined as hydrologically connected zones lying below local 1-in-100-year water levels (with an additional 2 m SLR allowance). Exposure of population and GDP is calculated by overlaying digital elevation models with gridded socioeconomic data.

⁴ <https://github.com/GlobalClimateForum/DIVACoast.jl>

- **Damage estimation under scenario trajectories:** Expected annual damages (EAD) from coastal flooding are projected under scenarios combining Shared Socioeconomic Pathways (SSPs) and Representative Concentration Pathways (RCPs). Explicit adaptation scenarios (see below) allow the model to evaluate residual damages, avoided losses and adaptation costs.
- **Adaptation intervention evaluation:** DIVACoast supports cost-effectiveness analyses of strategies such as coastal defence (e.g. dikes) and managed or reactive retreat, using scenario and optimisation techniques to identify adaptation trajectories which minimise the total costs from SLR for the 21st century and can help to efficiently allocate adaptation budgets.

To assess the macroeconomic implications of sea-level rise and coastal flooding, two macroeconomic models (E3ME and GEM-E3) were extended to include temperature-driven flood damage functions using outputs from the DIVACoast model:

- Damage functions are quadratic regressions of Expected Annual Damages (EAD) against global temperature rise (GMTI). This captures the non-linear escalation of flood damage as warming intensifies.
- Adaptation scenarios:
 - **Low adaptation:** The protection **level** is kept constant at today's standard. The existing protection height depends on input data and assumptions. In this scenario, dikes are increased in height to keep pace with sea-level rise, but no new dikes are constructed. Additional yearly investments to raise the dikes and maintenance costs are necessary to maintain protection levels. Migration is modelled as the permanent coastal retreat of people and assets as soon as they fall in the 1-in-1-year floodplain. In this scenario, damages grow steeply with temperature over the course of the century.
 - **High (optimal) adaptation:** Coastal planners pursue a more proactive protection strategy in which **optimal protection levels** are assessed today and maintained throughout the century. Dikes also grow with sea-level rise in this scenario to maintain the optimal protection level. Migration is modelled as in the low adaptation scenario. The damage growth from coastal flooding over the century is slower, but the initial investment burden is high due to the construction of new dikes. The reduction in expected annual damages, however, outweighs increased adaptation costs in the long term.

Illustrative example

This example illustrates an application of the DIVACoast model using a scenario pathway (SSP-RCP245, 50th percentile). Specifically, we estimate the large economic potential that effective adaptation strategies could provide in the future. We compare the residual damages measured as EAD at the end of the century of two potential future worlds, one with low adaptation to sea-level rise and in the other implementing high (optimal) adaptation.

Figure 9 shows the expected annual damages estimated by the DIVACoast model for each country by the end of the century if low adaptation as defined above is pursued. The

highest absolute flood damages in this scenario concentrate in Asia (Bangladesh, India, China, Vietnam), Northern Europe (Netherlands, UK and Germany), the US and Nigeria. With ~60 billion USD annual average flood damages, Bangladesh is the most affected country in absolute terms, then the Netherlands with ~40 billion USD. These magnitudes reflect the large low-lying coastal zones and high coastal economic activity in those countries.

Figure 9: Expected annual damages (2100, SSP-RCP245, Q0.5); constant protection levels, with migration

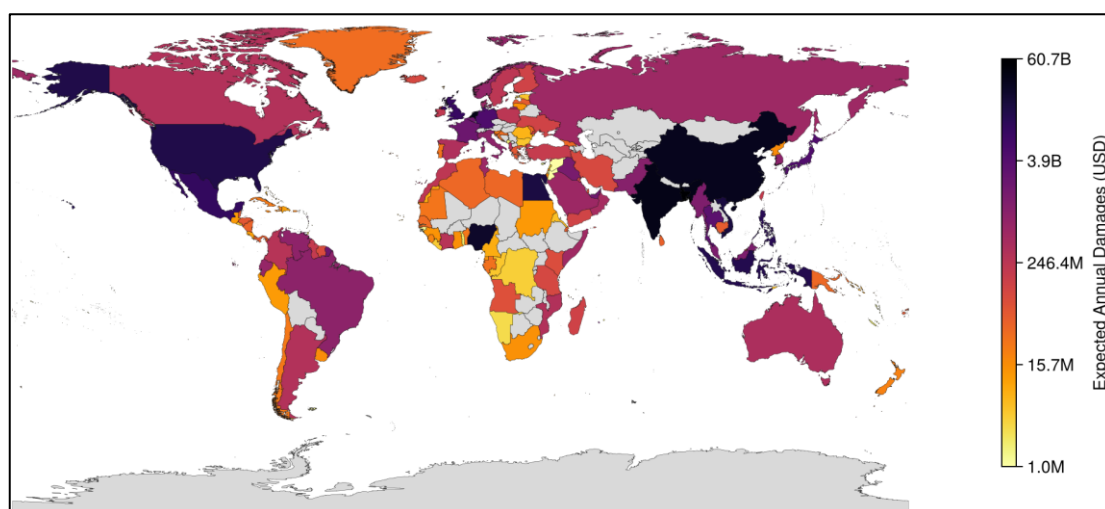
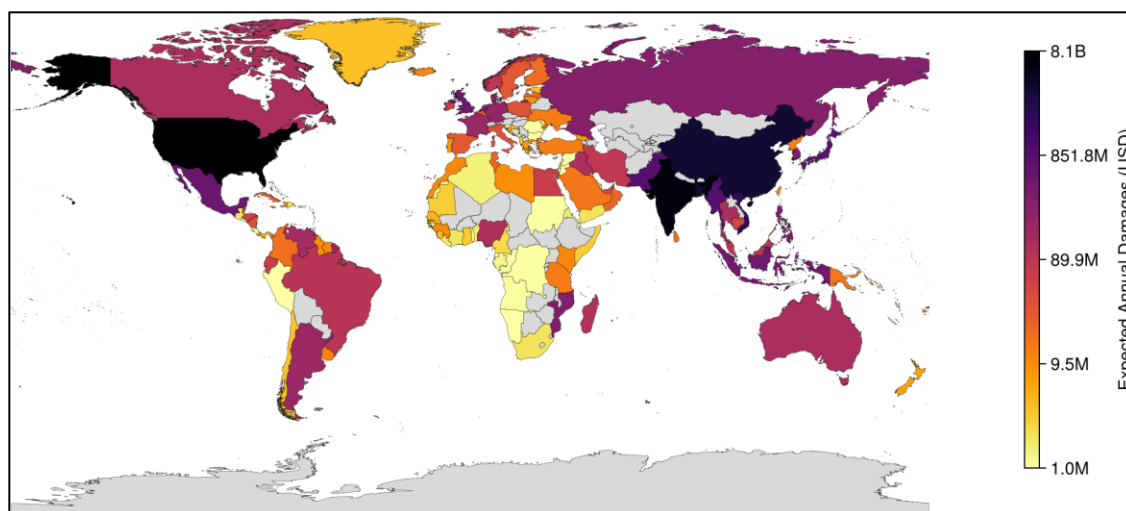


Figure 10 illustrates the potential of well-planned coastal adaptation. In the high adaptation scenario, overall damages fall sharply with large regional variation. The US in this scenario is the most affected country in terms of expected damages in 2100, reducing the EAD by roughly half to 8 billion USD. In Bangladesh, previously the most affected country, EAD are reduced from ~60 billion USD to ~3 billion USD annually. Significant reductions in EAD can also be achieved in the most affected European countries, where effective adaptation could reduce residual damages by up to 2 orders of magnitude to less than 1 billion USD annually.

Figure 10: Expected annual damages (2100, SSP-RCP245, Q0.5); optimal protection, with migration.



Application

Use when: evaluating macroeconomic impacts of climate change, comparing the costs and benefits of different adaptation strategies, or developing climate finance strategies.

Avoid when: focus is on near-term forecasting, or when spatially disaggregated socioeconomic and flood risk data are unavailable.

2.5. Enhancing decision-making on risk and uncertainty through the multiple resilience dividend approach.

Problem

Climate change has often been described in terms of a narrative of risk and risk management only, which has not led to sustained investment for adaptation and risk management. Analysts informing international frameworks, such as the Sendai Framework for Disaster Risk Reduction, the Paris Agreement, and the Sustainable Development Goals, have emphasised the need for orienting risk management investments towards interventions that generate so-called multiple or triple resilience dividends. This means extending the focus in decision making from avoiding and reducing impacts and risks to also considering development (co-)benefits arising irrespective of disaster event occurrence, as well as unlocking development (the “triple resilience dividend” (TDR) concept). Yet, despite the increasing burdens imposed by systemic disasters and climate risks, as well as the widespread recognition of this concept for over a decade, along with solid evidence regarding the benefits of reducing risk, it has remained challenging to motivate sustained investment across scales into disaster and climate risk reduction.

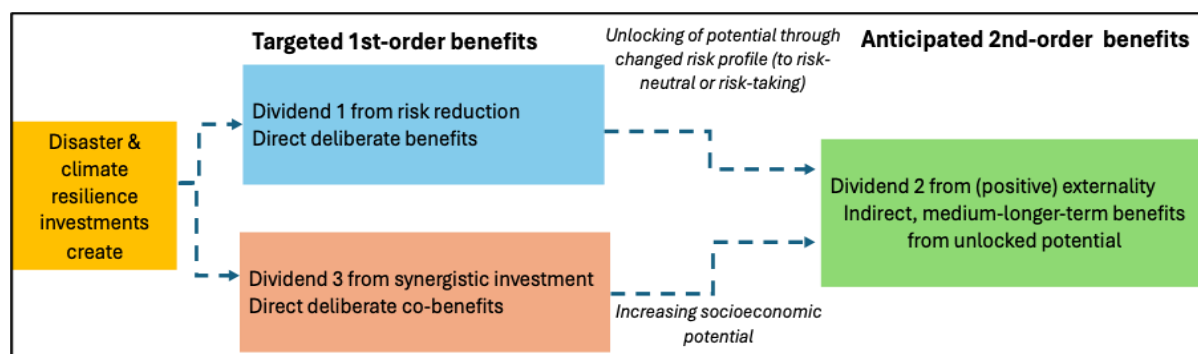
Modelling solution

IIASA staff in a paper on “Polycrises and Positive Externalities” argue that this gap in investment and attention is due in part to conceptual ambiguity around the notion of “unlocking dividends,” lack of consistent reporting, insufficient awareness of positive externalities, and a limited understanding of how dividends evolve across time and space. They argue and show based on evidence across scales from local to global, that the ‘unlocking benefits’ have to be understood as positive externalities ‘unlocked by changed risk perception, when risk management actions are taken, as well as solid co-benefits from disaster and climate risk reduction, enhancing development outcomes. Systemic risk research and practice, coupled with resilience dividend reasoning, may thus help identify those dividends more effectively for improved decision-making on disaster and climate risk reduction. They provide a review that reveals significant (co-)benefits and positive externalities in both implemented and planned risk management and adaptation projects, as well as in model-based simulations used to support policy design across various scales. Advancing research on systemic risk and resilience can help to surface these benefits, improve decision-making, and strengthen governance—crucial for managing escalating disaster and climate risks in a polycrisis context.

Illustrative example

Understanding Macro-Economic Benefits of adaptation and mitigation of Decreased Inequality for Climate Action using IAM

Figure 12: Reconceptualising the resilience dividend framework in the context of externalities and systemic risk.

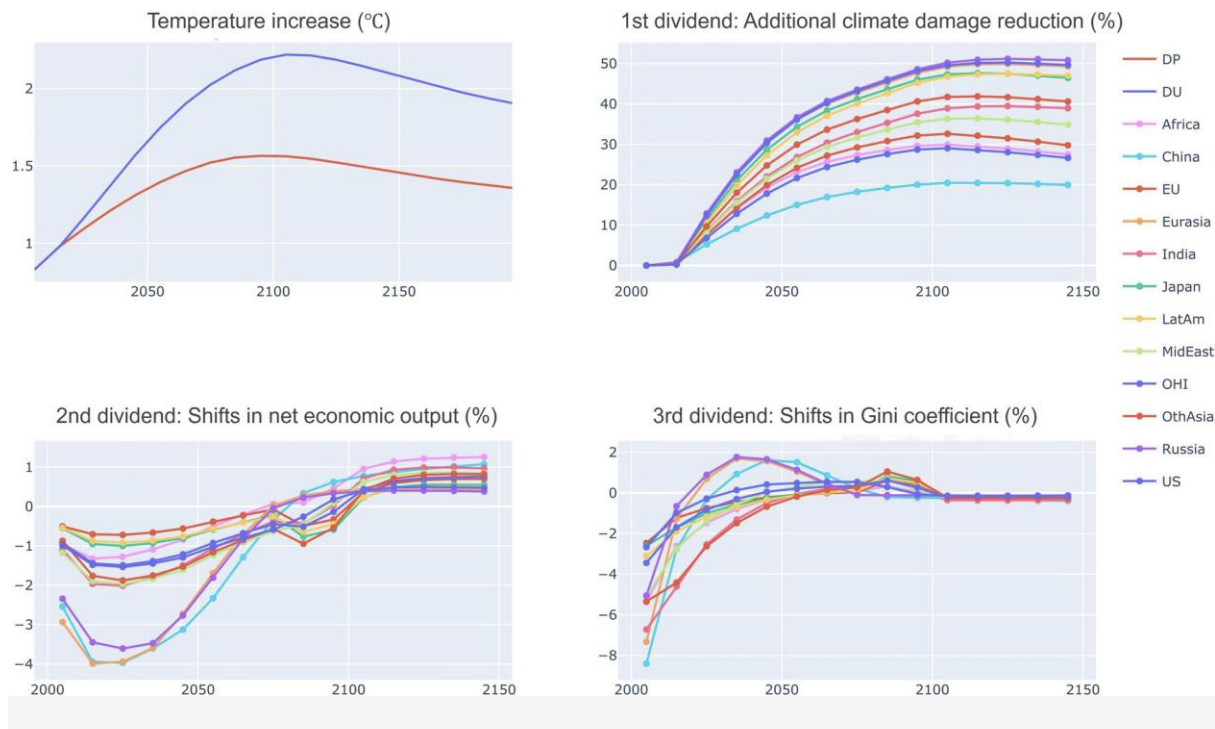


Source Adapted from Surminski and Tanner (2015).

The NICE model (and other IAMs) allows for measuring the resilience dividend 2 of climate action in terms of economic output increases relative to the baseline. The increased economic output enables the accumulation of capital, which enhances the resilience of regions and households to climate-related damage. We compare results for the optimal policy under the discounted prioritarian policy (DP), which acts to maximise both dividends 1 and 3 of climate action, and the optimal discounted utilitarian (DU) policy, which focuses solely on dividend 1. This comparison reveals that the inclusion of fairness co-benefits (dividend 3) as one of the policy objectives enables a higher dividend 2 of resilience globally and regionally.

The optimal DP policy recommends more ambitious climate action compared to DU, limiting the global temperature increase to 1.6°C in the case of DP, compared to 2.2°C for DU (see the top left panel for the absolute global warming resulting from DU and DP policies). Lower global peak temperatures lead to significantly reduced climate damages, which disproportionately affect the poor. The DP results in 20–50% lower damages in 2100 compared to DU, and thus in dividend 1 gains. The DP policy also delivers a higher dividend 3, that is, a reduction in economic inequalities, measured by changes in Gini coefficients. Initial high reductions in inequality within regions (up to 8%) are due to redistribution of carbon tax revenues. These initial improvements are slightly reversed around 2050 as the revenue from the carbon tax decreases; however, by 2100, inequalities again decrease (slightly) due to the avoided climate damages. More ambitious climate action under DP comes at a price of an initial slowdown in economic output compared to DU, but output (and utility) steadily improves, unlocking additional growth potential beyond 2050. Thus, a fairness-sensitive DP policy that promotes both dividend 1 and 3 gains in the long run also realises returns to dividend 2.

Figure 13: Dividend 1, 2, and 3 gains for optimal discounted prioritarian (DP) policy versus the standard discounted utilitarian (DU) approach (left upper panel shows absolute warming for DP and DU policies)



Application

Use when: evaluating development-oriented disaster risk reduction and adaptation policies across scales.

Avoid when: doing technically-minded disaster risk reduction and adaptation policies across scales.

Reference

Mechler, R., Żebrowski, P., Clercq-Roques, R., Patil, P. & Hochrainer-Stigler, S. (2025). *Positive Externalities in the Polycrisis: Effectively Addressing Disaster and Climate Risks for Generating Multiple Resilience Dividends*. *International Journal of Disaster Risk Science* 10.1007/s13753-025-00661-2.

3. Conclusion

The DECIPHER project shows that advances in climate-economy modelling can provide more policy-relevant insights when they explicitly address uncertainty, behavioural dynamics, and real-world constraints. Across the methods presented, ranging from machine-learning emulators to high-resolution damage assessments and financial risk models, the common theme is a stronger foundation for assessing policy impact against a wide range of potential futures.

These innovations do not replace traditional modelling; instead, they improve it by identifying where policy outcomes are most sensitive to external shocks, where targeted interventions can reduce costs, and how adaptation and mitigation measures can produce co-benefits beyond emissions reduction. Incorporating these approaches into national and

regional planning can assist governments in devising strategies that stay credible and effective even as economic and climatic conditions evolve.

Key Policy Takeaways

- **Integrate uncertainty analysis into policy formulation.** Employ emulation and other methods to assess whether policies meet their objectives across a range of probable scenarios, not just a central forecast. This is particularly relevant for the 2025–2026 NECP revisions.
- **Consider expectations and financing conditions.** Forward-looking behaviour and the cost of capital greatly influence investment patterns and the speed of technology diffusion. Policies should take these dynamics into account to prevent underestimating transition costs. Policies should account for these dynamics to avoid underestimating transition costs that is a key consideration for the Green Deal Industrial Plan and monitoring investment flows under NextGenerationEU.
- **Integrate flooding and coastal damage risk into macroeconomic planning.** High-resolution flood and coastal damage assessments, as well as financial risk models that link climate impacts to asset values, provide vital evidence for adaptation and financial stability strategies. These insights can inform the EU Strategy on Adaptation to Climate Change and the design of resilience components in Cohesion Policy funds.
- **Recognise potential broader benefits of climate action.** Policies that lower risk can also promote economic growth, social fairness, and development advantages. Valuing these “multiple resilience dividends” reinforces the economic argument for early and sustained investment, in line with the European Green Deal’s Just Transition Mechanism, which combines emissions reduction with social fairness.
- **Encourage collaboration between modellers and policymakers.** Ongoing dialogue helps guarantee that modelling innovations meet policy needs and that results are interpreted and used appropriately.

By applying these lessons, policymakers can design climate and energy strategies that are more resilient, economically sound, and capable of protecting citizens and economies in an uncertain future.