

*HELLENIC OPEN UNIVERSITY*

*DPS: MIXIOTIS ATHANASIOS*

*SUPERVISOR: DOUKAKIS LEONIDAS*

*STUDENT: MAGNISALIS KONSTANTINOS*

*STUDENT ID: 158163*

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An illustration depicting various renewable energy sources in a landscape. In the background, three wind turbines stand on rolling green hills. In the foreground, four solar panels are arranged in two rows. To the right, a dam with water flowing over it is visible. In the bottom right corner, two large grey batteries with black lightning bolt symbols are shown. The entire scene is set against a backdrop of dark, stylized mountains.

# The Influence of Climate Change on the Renewable Energy Investments Sector in Greece.

# Renewable Energy: A Global & National Shift

## Global Trends:

- Renewables are now a cornerstone of global energy strategies.
- Over 200% growth in global renewable capacity (2010–2025).
- Solar and wind dominate due to falling costs and tech advancements.
- Global push for net-zero by 2050 (Paris Agreement).

## Greece Progress:

- Massive expansion in solar and wind over the past decade.
- Solar PV installations grew 10 times, wind capacity tripled (2010–2025).
- Supported by EU Green Deal, feed-in tariffs, and investment incentives.
- Renewables now make up over 40% of Greece's energy mix.

Fun Fact!

- The first wind park in Europe was established on the Greek island of Kythnos in 1982. This pioneering project consisted of five wind turbines, each with a capacity of 20 kW, marking the beginning of wind energy development in Europe.



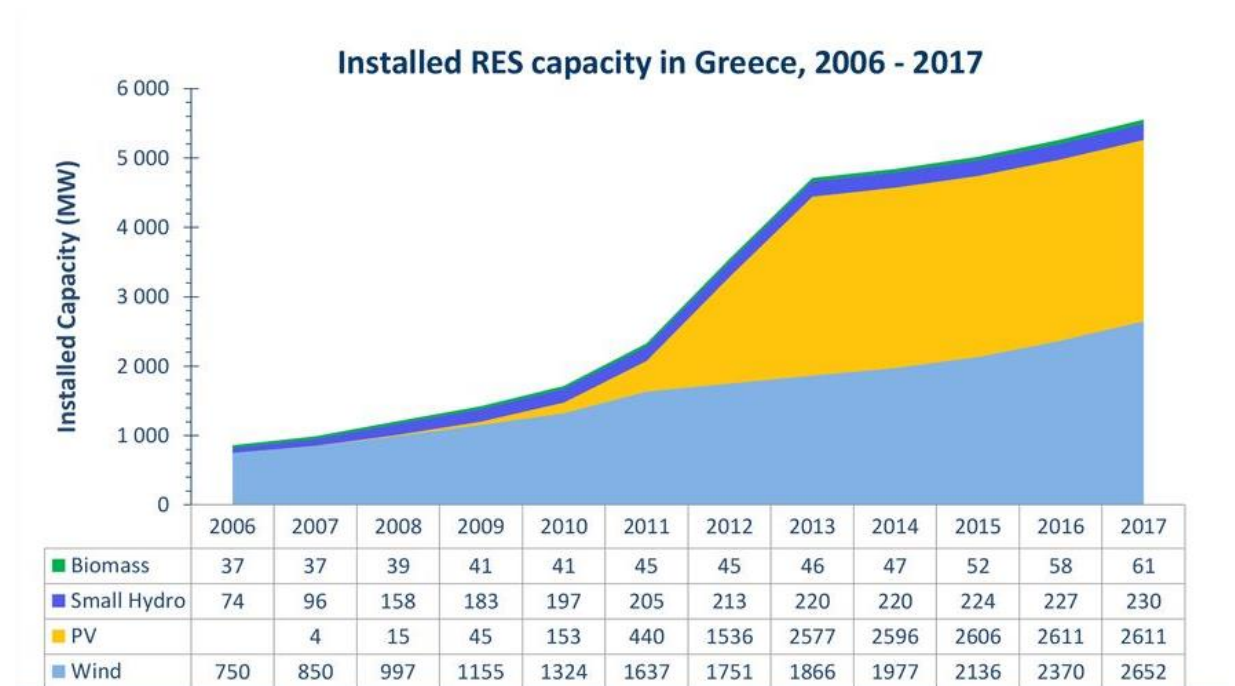
## Solar Power Capacity in Greece

- **2010:** Approximately **1.2 GW** (1.200 MW) of installed solar photovoltaic (PV) capacity.
- **2025:** Approximately **11.5 GW** of installed solar PV capacity.



## Wind Power Capacity in Greece

- **2010:** Approximately **1.2 GW** (1.200 MW) of installed wind power capacity.
- **2025:** Approximately **6.5 GW** of installed wind power capacity.



# Climate Change Impacts & Investment Implications in Greece

## Solar Power Variability

*Heatwaves reduce panel efficiency, while storms and cloud-cover cause unpredictable solar output.*  
Even in sunny Greece, extreme temperatures and weather events can lower solar energy reliability.

## Shifting Wind Patterns

*Climate change alters wind speeds and directions, especially during high-demand summer months.*  
This impacts turbine efficiency and challenges grid stability with inconsistent energy supply.

## Hydropower Pressure

*Droughts reduce water flow; heavy rainfall can damage infrastructure.*  
Hydropower faces growing risks from changing precipitation patterns and extreme weather events.

## Increased Investment Risk

*Uncertain weather patterns make energy yields less predictable.*  
This drives up risk premiums, reduces investor confidence, and raises financing costs.

## Rising Infrastructure Costs

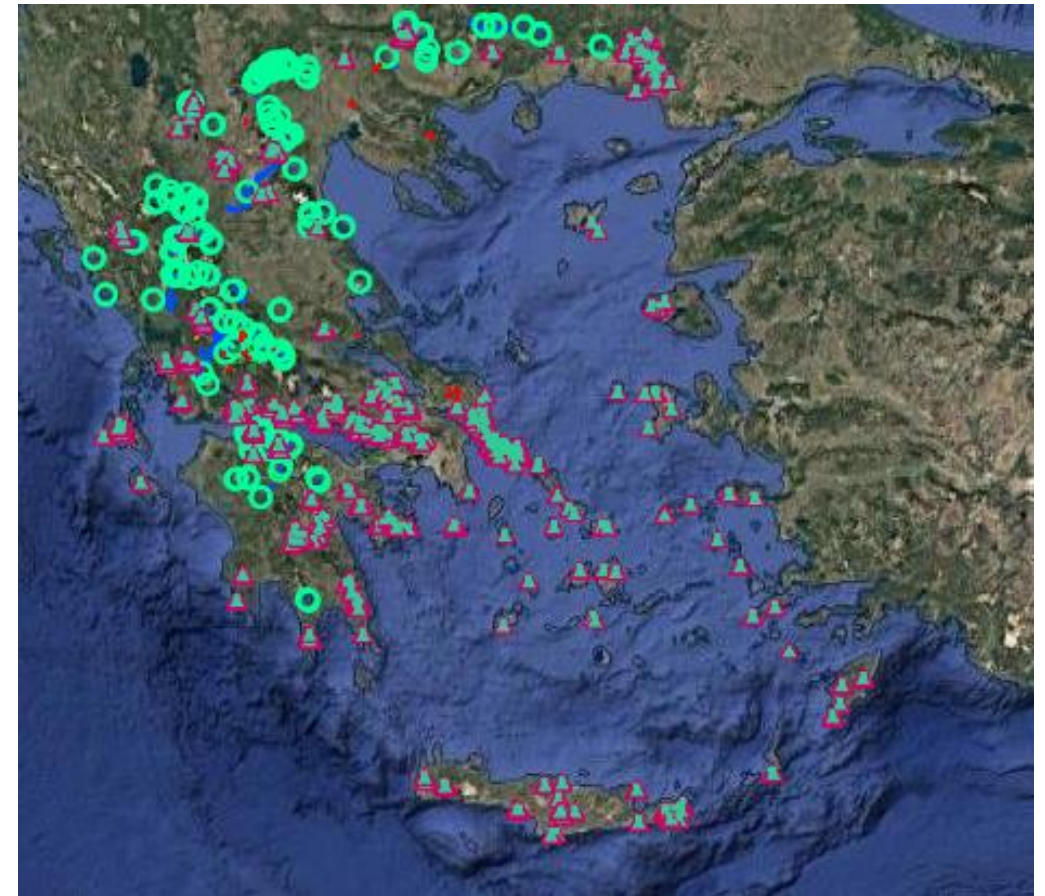
*Greater need for energy storage and modern grids to manage intermittency.*  
Projects now require costly upgrades like batteries or smart grids to maintain stable output.

## Policy & Regulatory Uncertainty

*Adapting regulations to climate impacts adds complexity for investors.*  
Frequent policy shifts on subsidies, pricing, or grid access create hesitation in long-term planning.

## Opportunities in Green Investment

*Climate-resilient technologies and EU funding offer new potential.*  
Despite risks, targeted investments in resilient systems could attract capital and support sector growth.



"Renewable Energy Production Stations in Greece"

Source: <https://geo.rae.gr>



# The Role of Renewables in Climate Change Mitigation

## Global Adaptation Strategies

- **Geographic Diversification**  
Spreading renewable assets across regions reduces local climate impact risk.
- **Technology Innovation**  
New materials and designs improve performance under extreme conditions.
- **Energy Storage Integration**  
Batteries and other storage systems are vital to balance intermittent renewable supply.
- **Global Research Focus**  
Growing interdisciplinary studies highlight both risks and the pivotal role of renewables in climate mitigation.  
Regions vary: Europe and North America explore future wind/solar trends; tropics focus on water shortages; Asia invests in system resilience.



# The Renewable Energy Landscape in Greece

## National Targets & Policy Support

Greece aims for **70% renewable electricity by 2030**, driven by the National Energy and Climate Plan (NECP).

Incentives include subsidies, tax breaks, and tenders to attract clean energy investment.

## Boom in Solar & Wind Projects

High solar radiation and favorable wind geography boost investor interest.

Strong presence of domestic and international developers in PV and wind farms.

## Emerging Technologies

Growth in **energy storage** and **green hydrogen** supports decarbonization and grid flexibility.

Hybrid systems and battery installations are on the rise.

## Climate Challenges

Heatwaves and wind variability impact energy output and increase maintenance needs.

Extreme weather events (wildfires, storms) create operational risks.

## Adaptation Opportunities

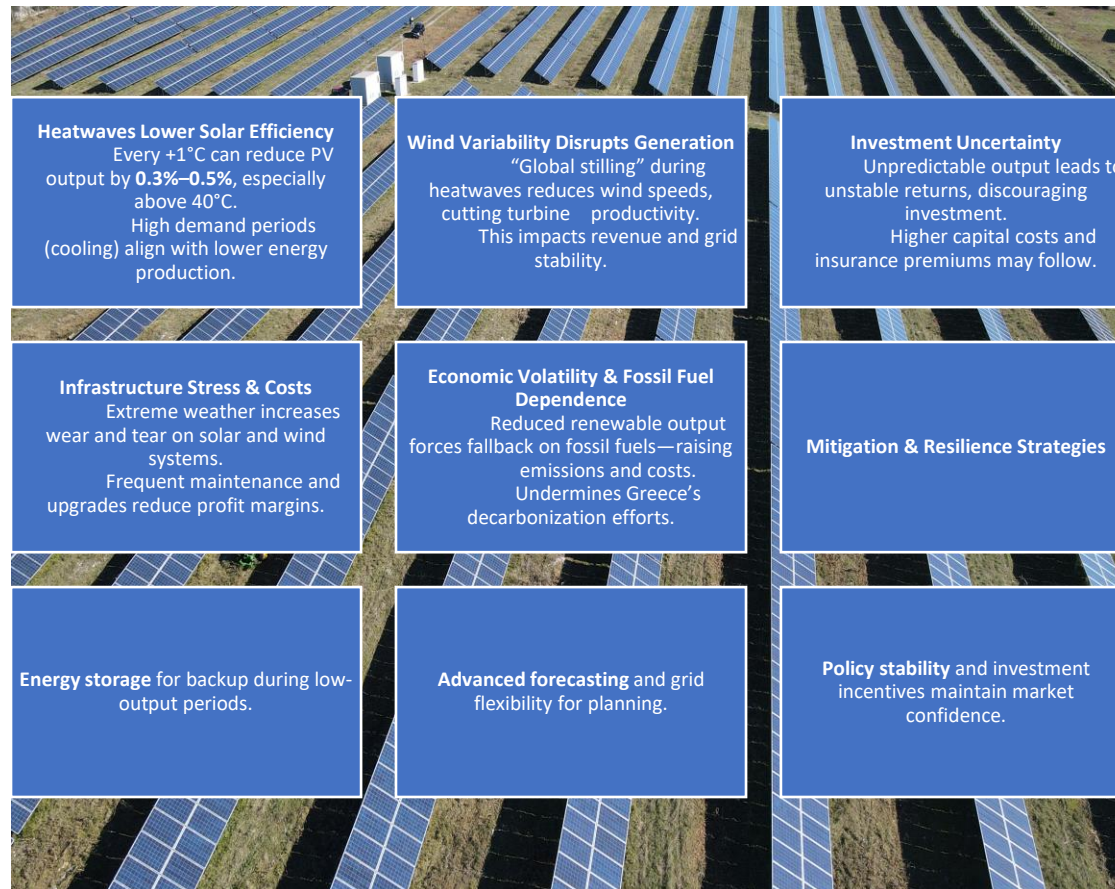
Diversifying the energy mix, promoting hybrid projects, and investing in resilient infrastructure are key.

Greece could become a **regional renewable energy hub** with the right strategy.



# Climate Risks & Investment Perspectives

Investments in the renewable energy (RES) sector have not slowed down overall due to climate change—in fact, in many regions, they’ve accelerated. However, climate change introduces new risks that are beginning to influence investor behavior and financing conditions.



## Where Climate Change Has Introduced Investment Challenges:

- Increased Variability in Output
  1. Heatwaves reduce solar efficiency.
  2. Unpredictable wind patterns disrupt turbine productivity.  
-This makes **cash flows less predictable**, increasing financial risk.
- Rising Insurance & Maintenance Costs
  1. Extreme weather (fires, floods, storms) damages infrastructure.
  2. Higher O&M costs reduce profitability and **lengthen payback periods**.
- Investor Caution in Vulnerable Regions
  1. In countries with weak grids or limited storage (like Greece), variability in energy supply may **discourage new large-scale investments**.

## But Overall Global Trends Show Continued Growth:

- Record-high global RES investments in 2022 and 2023, driven by:
  1. EU Green Deal & RE-PowerEU
  2. U.S. Inflation Reduction Act
  3. China’s expansion of wind/solar capacity
- Investors are shifting focus to:
  1. Hybrid projects (solar + battery storage) or (Wind + hydro)
  2. Climate-resilient technologies
  3. Regions with strong policy stability and grid capacity

# Problems of Producing More Renewable Energy Than Demand

## Overproduction vs. Demand Mismatch

When renewable generation (especially from solar or wind) exceeds real-time consumption, it creates energy surpluses that the grid may struggle to manage.

## What Happens to Excess Power?

### Curtailment

Grid operators may shut down or limit renewable output to protect grid stability. Wasted clean energy and reduced revenues for producers.

### Energy Storage (If Available)

Excess power can be stored in batteries, pumped hydro, or thermal systems. Still costly and limited in scale.

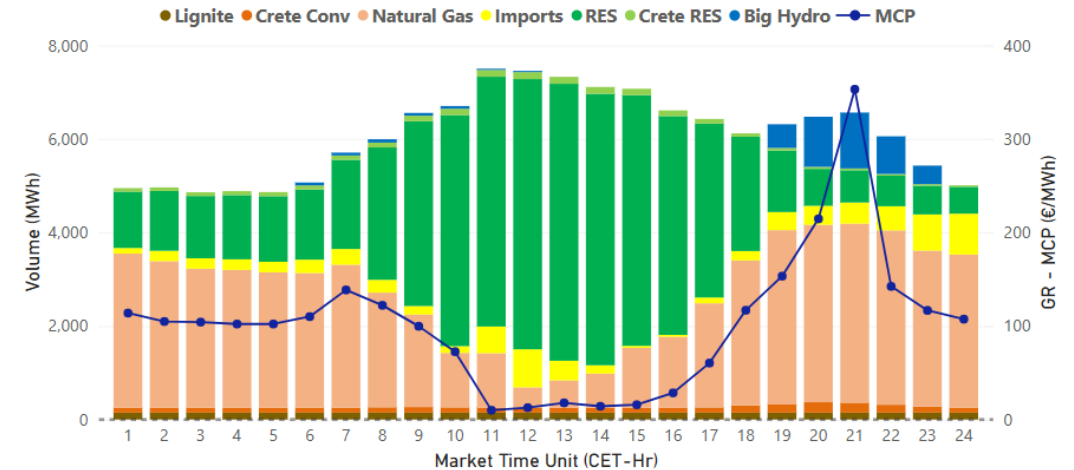
### Export to Neighboring Grids

In interconnected markets, surplus power can be exported—if infrastructure allows. Helps balance supply-demand but not always feasible.

### Smart Grid Management

Advanced systems may shift demand (e.g., incentivizing EV charging, industrial usage during peak production). Still under development in many regions.

- In April 2024, parts of Portugal and Spain experienced a blackout due to an oversupply of renewable energy combined with limited grid flexibility. Excess solar and wind power overwhelmed the grid during a low-demand period, leading to system instability. Without sufficient energy storage or export capacity, grid operators had to curtail production abruptly, triggering a regional power disruption.



## Greek Electricity Markets (for 15/05/2025)

Source: <https://www.enxgroup.gr/web/guest/home>

## Consequences of Unmanaged Surplus

- Grid Instability (voltage/frequency issues)
- Revenue Loss for renewable producers due to curtailment
- Increased reliance on fossil backup if flexibility is low
- Lower investment appeal if returns are unpredictable

## Solution Focus:

- Expand energy storage capacity
- Improve grid flexibility & forecasting
- Promote demand-side management and cross-border energy flows



# Climate Sensitivity and Renewable Energy Production in Greece

## Solar Energy & Temperature Effects

**Efficiency Drop:** For every +1°C, PV efficiency declines by **0.3–0.5%**.

**Greek Context:** Summer heatwaves >40°C cause notable output and financial losses.

**Mitigation:** High-temp resistant panels, better cooling, and airflow-based installations.

## Wind Energy & Climate Variability

**Changing Patterns:** "Global stilling" and erratic gusts disrupt generation.

**Impact:** Uncertain output affects **grid stability** and **investor confidence**.

**Adaptation:** Advanced forecasting, hybrid systems, and resilient turbines.

## Seasonal & Extreme Weather Impacts

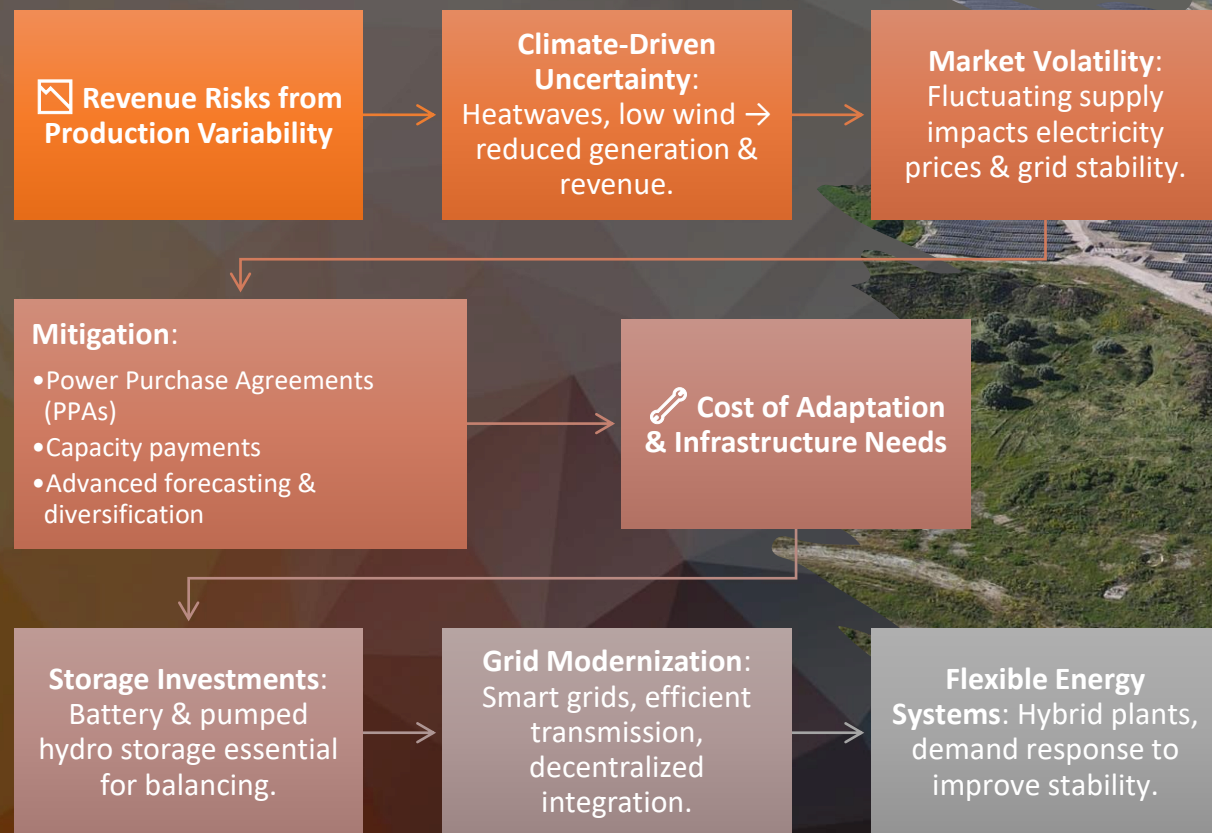
**Solar:** Winter = less sun; Summer = overheating.

**Wind:** Seasonal variability; unpredictable cycles due to climate shifts.

**Events:** Storms, wildfires, snow → infrastructure damage and cost spikes.

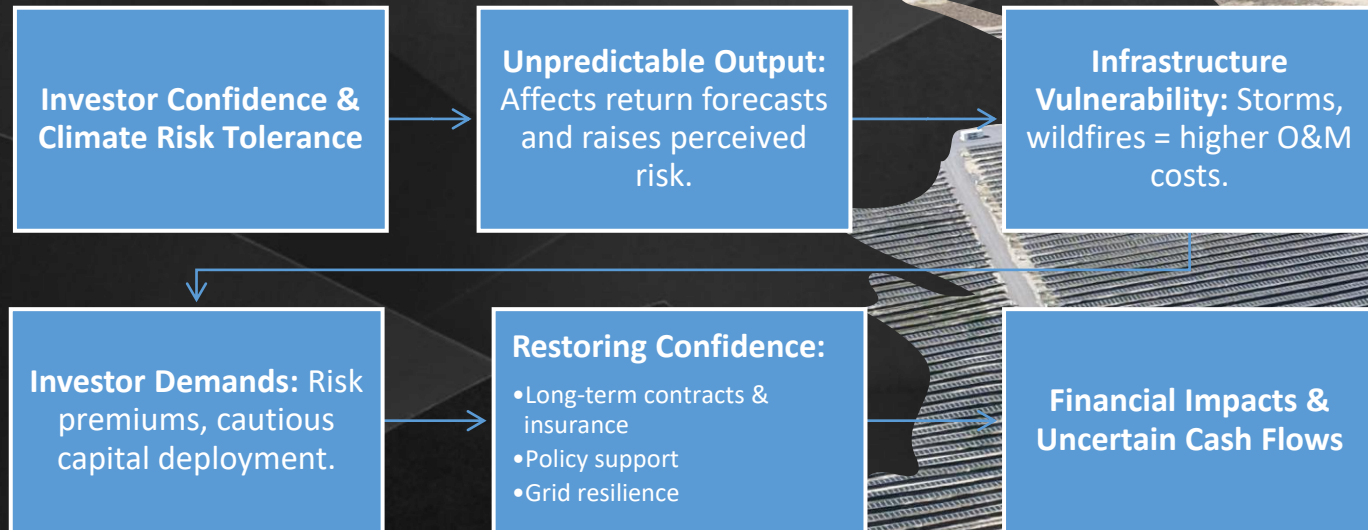


# Investment Risks and Climate-Driven Financial Impacts





# Investment Risks and Climate-Driven Financial Impacts



Uncertain cash flows from new renewable energy projects—caused by fluctuating production levels due to climate variability and grid limitations—pose a serious risk to financial planning and investment strategies. These inconsistencies reduce the predictability of returns, making it difficult for developers to secure financing or reinvest in future projects. When cash flows are irregular or lower than expected, they undermine investor confidence, strain loan repayment schedules, and limit reinvestment capacity, ultimately slowing the growth of the renewable energy sector.





# Research Design & Data Collection

## Data Collection Method

**Primary Tool:** Structured questionnaire with closed-ended questions

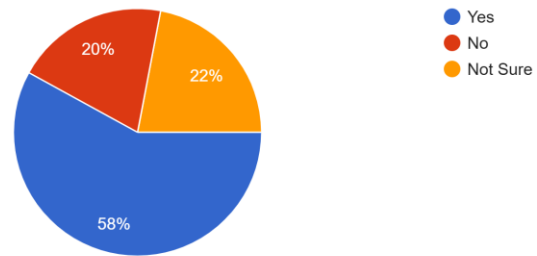
**Target Group:** 51 respondents from energy sector and retail businesses

Focus on capturing industry perspectives on climate change & renewables

# Research Design & Data Collection

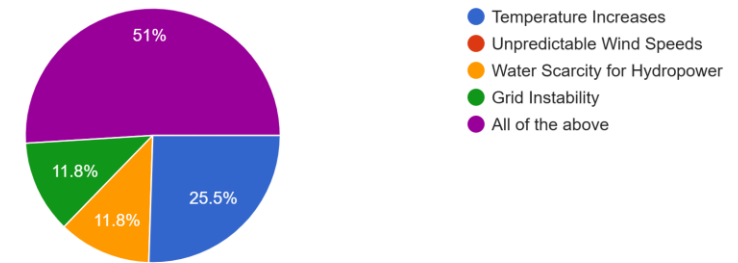
Do you think Greece's geography (e.g., island regions, mainland differences) makes climate impacts on renewables more severe?

50 responses



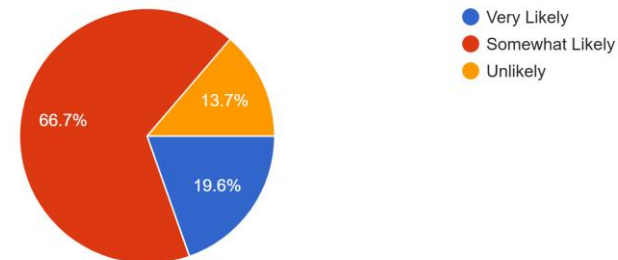
What do you believe is the biggest climate-related challenge for renewable energy?

51 responses



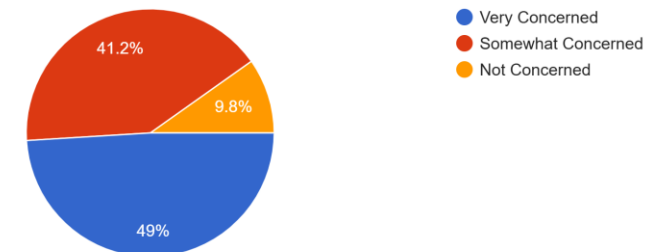
How likely do you think changing wind patterns will reduce wind farm efficiency in Greece?

51 responses



How concerned are you about extreme weather events (e.g., heatwaves, wind fluctuations) affecting renewable energy output?

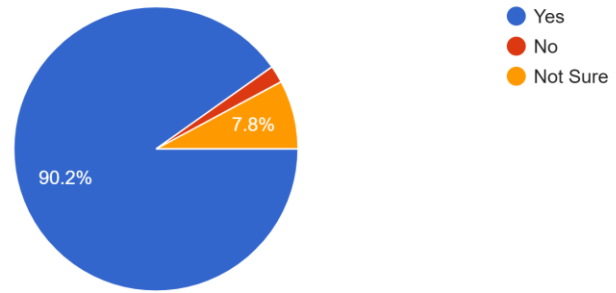
51 responses



# Research Design & Data Collection

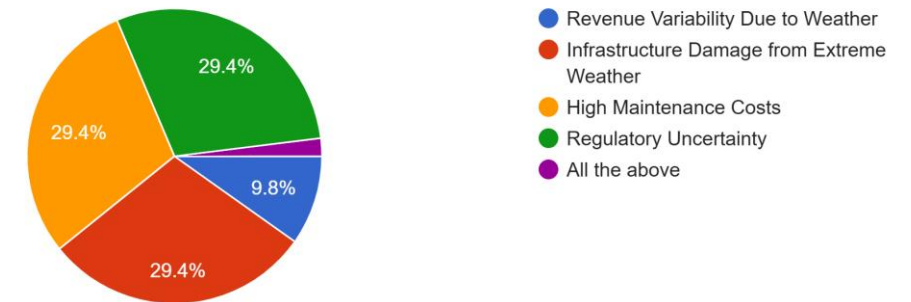
Would you support technological upgrades to mitigate climate risks for renewables?

51 responses



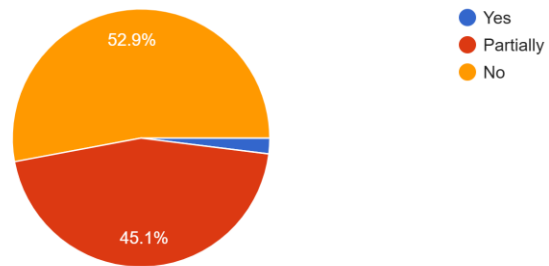
Which climate-related risk discourages renewable energy investment the most?

51 responses



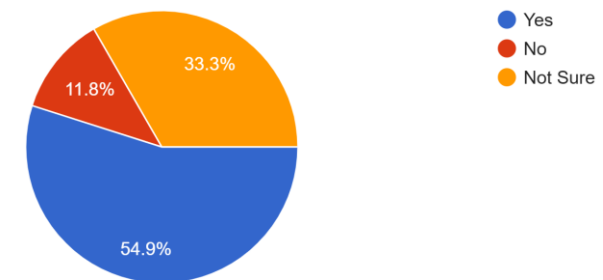
Do you believe Greece is prepared to handle climate risks in renewable energy?

51 responses



Would you invest in Greece's renewable energy sector despite climate risks?

51 responses

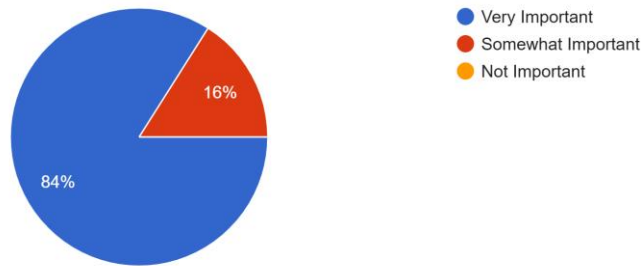




# Research Design & Data Collection

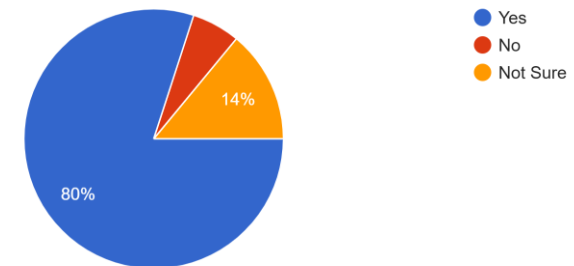
How important is energy storage investment to mitigating climate-related risks?

50 responses



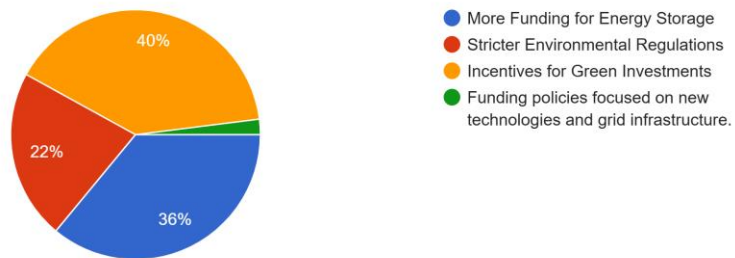
Should financial institutions offer climate insurance for renewable energy investors?

50 responses



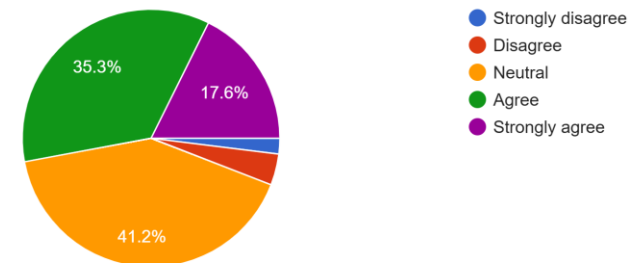
Which policy is most important for climate resilience in renewables?

50 responses



Should Greece strengthen cross-border energy connections to reduce reliance on domestic climate-impacted energy?

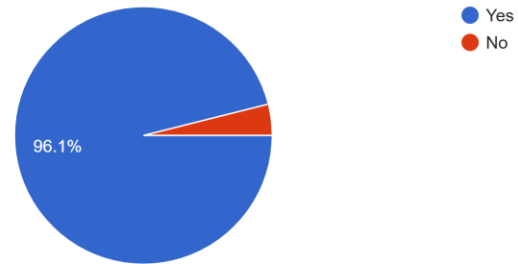
51 responses



# Research Design & Data Collection

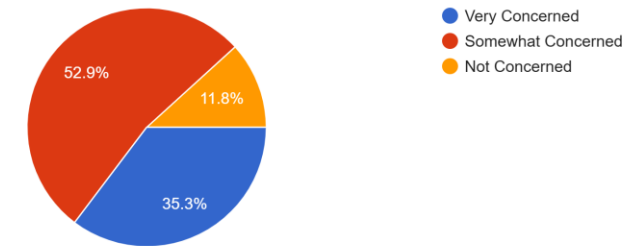
Should Greece collaborate more with EU countries on climate-resilient renewable strategies?

51 responses



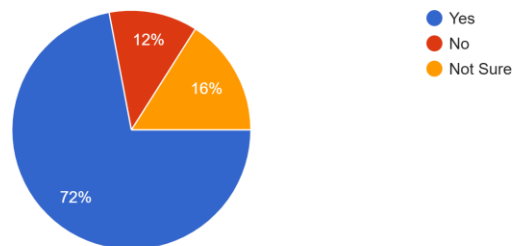
How concerned are you about the long-term impact of climate change on Greece's renewable energy sector?

51 responses



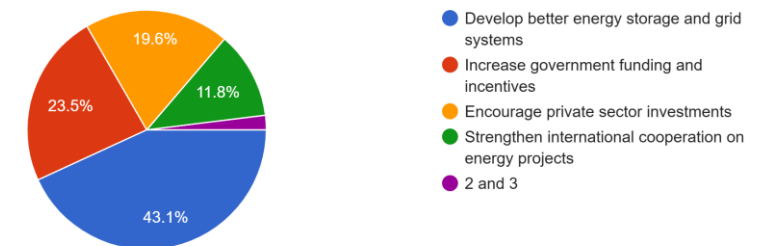
Should the Greek government introduce stricter laws to ensure renewable energy companies adapt to climate risks?

50 responses



What is the most important step Greece should take to ensure a successful renewable energy transition?

51 responses





An aerial photograph of a vast solar farm. The solar panels are arranged in long, parallel rows that stretch across a field. The panels are tilted at an angle, and the rows are separated by narrow paths or grass. The overall scene is a large-scale agricultural-like layout of renewable energy technology.

The End