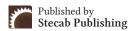


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Research Article

# Measuring the Inflation Reduction Act's (IRA) Impact on Decarbonization and Equity: An Integrated Assessment

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## **About Article**

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#### **ABSTRACT**

The Inflation Reduction Act of 2022 represents the United States' most comprehensive climate legislation to date, allocating \$369 billion toward clean energy investments and environmental justice initiatives. This study provides a systematic analysis of the IRA's dual objectives: accelerating national decarbonization efforts while advancing environmental equity. Through multi-model analysis and comprehensive policy evaluation, we assess the Act's effectiveness in achieving emissions reductions while addressing historical environmental injustices in disadvantaged communities. Our findings demonstrate that the IRA will reduce economy-wide emissions by 43-48% below 2005 levels by 2035, while directing unprecedented federal resources toward environmental justice through \$3 billion in dedicated funding streams. However, significant implementation challenges remain, particularly in ensuring equitable distribution of benefits and achieving the Biden administration's 50% emissions reduction target by 2030.

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#### 1. INTRODUCTION

The passage of the Inflation Reduction Act (IRA) in August 2022 marked a watershed moment in United States climate policy, representing the federal government's most ambitious response to the dual crises of climate change and environmental inequity. With a total investment of \$369 billion in climate and clean energy initiatives, the Act fundamentally reshapes the landscape of American environmental policy by integrating decarbonization objectives with explicit environmental justice provisions (McKinsey & Company, 2022).

This legislative achievement emerged after decades of fragmented federal climate policy characterized by regulatory approaches, voluntary programs, and limited financial commitments. Previous efforts, including the failed American Clean Energy and Security Act of 2009 and the Clean Power Plan's subsequent legal challenges, demonstrated the political and practical limitations of traditional regulatory approaches to climate action. The IRA's passage represents a fundamental shift toward incentive-based policy mechanisms that align market forces with climate objectives while addressing longstanding concerns about the distributional impacts of environmental policies.

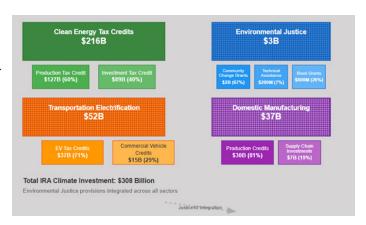
The necessity of the creation of the IRA cannot be overestimated. There is a growing scientific consensus that the next decade of the 2020s is of critical importance to the question of whether the global temperature rise can be contained to 1.5 degrees Fahrenheit above pre-industrial levels.

#### 2. LITERATURE REVIEW

With United States agreeing under the Paris Accord that it would regulate its greenhouse gas emissions by 50-52% of the level of 2005 by 2030, there was need to take extraordinary policy action to bridge the vast gap between current policies and required levels of reduction. At the same time, the increasing prominence of environmental racism as well as the imbalanced distribution of pollution among people of color and low-income groups motivated the political forces that could lead to enacting policies that can combat both climate change and environmental justice.

The holistic nature of the approach taken by the IRA fills a gap that was critical in past climate laws in that the goal focused on both emission reductions and environmental equity. In contrast to the previous policies, which were mostly concentrated on technology adoption or the establishment of carbon pricing schemes, IRA uses a complex approach, which integrates monetary incentives, direct investments, and a regulatory system that is aimed at speeding up the adoption of clean energy and ensuring that the historically disadvantaged groups receive their fair share (Bistline *et al.*, 2023). This combination demonstrates an emerging realization that successful climate policy needs to focus on not only the magnitude and pace of decarbonization but also the distributional implications of climate outcomes and climate policies.

This made the Act politically viable partly because it was framed as an economic act that sought to deal with economic inflation issues by ensuring that energy is made domestic thereby, not as a purely environmental legislation. This location, together with the unmatched backing of clean energy investments by the private sector, established a special policy window allowing it to pass despite the close Democratic majorities in Congress. The ensuing policy is an expedient compromise between climate activism objectives and political necessities, leveraging tax breaks and direct expenditure over regulatory compulsions to force cutbacks in emissions.



**Figure 1.** IRA investment distribution by sector and equity focus *Source: Congressional Budget Office, EPA, DOE (2024). Values represent projected expenditures 2022-2032.* 

This discussion evaluates IRA through two important dimensions: its efficiency to promote national decarbonization and its effectiveness to tackle the issue of environmental justice. The study is based on the results of various independent modeling studies, federal implementation data, and community-based impact studies, which allows the provision of an indepth assessment of the initial implementation period of the Act. This research evaluates quantitative emissions projections and qualitative equity outcomes together to present a holistic analysis of whether the integrated approach of the IRA is effective in promoting both climate and equity goals.

#### 3. METHODOLOGY

#### 3.1. Research framework

The research design of this study is the mixed-method method, which combines both the quantitative emission modelling with the qualitative equity impact assessment. The analysis is based on the results of nine autonomous modeling teams that took part in the multi-model comparison study published in Science (Bistline *et al.*, 2023), complemented by federal agency implementation results, and case studies on a community level.

## 3.2. Decarbonization assessment

Decarbonization impacts are evaluated using economy-wide integrated assessment models (IAMs) that incorporate the full suite of IRA provisions designed to reduce greenhouse gas emissions across all sectors of the economy. The assessment focuses on quantifying the emissions reduction potential of the Act's major clean energy incentives, which represent the largest components of federal climate investment.

The analysis incorporates clean energy tax credits, including both the traditional Production Tax Credit and Investment Tax Credit that were extended and enhanced under the IRA, as well as new technology-neutral credits that begin phasing in during 2025. These credits create long-term price signals that reduce the cost of renewable energy deployment and energy storage systems. Electric vehicle incentives and charging infrastructure investments are modeled to capture both direct emissions reductions from transportation electrification and indirect effects from increased clean electricity demand.

Industrial decarbonization support through advanced manufacturing tax credits represents a critical component of the assessment, as these provisions target hard-to-abate sectors that have historically received limited policy attention. The modeling incorporates manufacturing credits for clean energy technologies produced domestically, as well as incentives for industrial process improvements and fuel switching. Carbon management technologies, including carbon capture, utilization, and storage systems, are evaluated based on enhanced tax credits that significantly improve project economics for both industrial applications and direct air capture facilities.

Building electrification and energy efficiency programs complete the sectoral coverage of the assessment, capturing both direct emissions reductions from improved building performance and indirect effects from fuel switching away from natural gas and heating oil. The modeling framework accounts for regional variations in building stock characteristics, climate conditions, and electricity grid carbon intensity to provide geographically differentiated impact estimates.

#### 3.3. Equity impact methodology

Environmental justice outcomes are assessed through multiple complementary analytical frameworks that capture both quantitative distributional effects and qualitative community-level changes resulting from IRA implementation. The methodology recognizes that environmental justice encompasses not only the distribution of environmental benefits and burdens but also the processes through which communities participate in environmental decision-making.

Distributional analysis of investment flows to disadvantaged communities forms the foundation of the equity assessment, utilizing Treasury Department data on clean energy investments combined with demographic and environmental burden indicators to track whether IRA benefits are reaching historically underserved populations. This analysis employs the Council on Environmental Quality's Climate and Economic Justice Screening Tool (CEJST) to identify disadvantaged communities based on environmental, health, economic, and social burden indicators, ensuring consistency with federal environmental justice frameworks.

Community benefit assessment applies metrics that were

created as part of the Justice40 Initiative, which pledges to allocate 40 percent of federal climate and clean energy spending to underserved communities. The evaluation measures not only direct financial flows but also the overall community gains, such as the creation of jobs, health gains, and the outcomes of capacity building. This assessment acknowledges that not all community benefits will be equally apparent within geographic and demographic contexts, and that adaptive measurement strategies are necessary which can reflect a wide range of forms of positive impact.

The proportion of participation of demographic and geographic features in federal programs worksheet whether conventional obstacles to federal programs consumed in spite of the expressiveness of IRA as a program with an equity-focused orientation. The analysis will look at application rates, approval rates, and program completion rates among the various types of communities and see possible inequities that can hinder fair distribution of benefits. The special consideration is given to programs where the application processes or matching funds requirements are complex and potentially disproportionately impact resource-constrained communities.

Environmental health improvements in frontline communities represent a critical component of the equity assessment, as many disadvantaged communities bear disproportionate pollution burdens from fossil fuel infrastructure and industrial facilities. The methodology incorporates air quality monitoring data, health outcome statistics, and proximity analyses to assess whether IRA-driven clean energy deployment is reducing pollution exposure in the communities most affected by environmental hazards. This health-focused analysis recognizes that environmental justice encompasses not only economic opportunities but also fundamental improvements in community health and well-being.

## 4. RESULTS AND DISCUSSION

## 4.1. Decarbonization impacts

#### 4.1.1. National emissions trajectories

The IRA's most significant impact on decarbonization occurs through its comprehensive suite of clean energy incentives. Multi-model analysis reveals consistent projections of substantial emissions reductions across all economic sectors, with the most pronounced effects in electricity generation.

Economy-wide emissions reductions are projected to reach 43-48% below 2005 levels by 2035, representing a dramatic acceleration from the pre-IRA trajectory. However, these reductions fall short of the Biden administration's commitment to achieve 50% emissions reductions by 2030 under the Paris Agreement.

**Table 1.** Sectoral emissions reductions under the IRA (2030-2035)

•	2035 Reduction (% below 2005)	Primary IRA Drivers
8% (47-83% range)	77% (66-87% range)	PTC/ITC, Clean Electricity Credits
2% (25-39% range)	45% (38-52% range)	EV tax credits, charging infrastructure
% (15-27% range)	29% (22-36% range)	Manufacturing credits, CCUS incentives
3% (22-34% range)	38% (31-45% range)	Heat pump incentives, efficiency rebates
)	% (47-83% range) % (25-39% range) % (15-27% range)	2005)   % (47-83% range) 77% (66-87% range)   % (25-39% range) 45% (38-52% range)   % (15-27% range) 29% (22-36% range)



Total Economy 46% (43-48% range) 45% (43-48% range) Comprehensive policy package	je
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Source: Bistline et al. (2023)

#### 4.1.2. Power sector transformation

The electricity sector shows the most dramatic transformation under the IRA, with models consistently projecting accelerated decarbonization through 2035. The combination of extended and enhanced production tax credits (PTC) and investment tax credits (ITC), along with new technology-neutral clean electricity credits beginning in 2025, creates sustained financial incentives for renewable energy deployment.

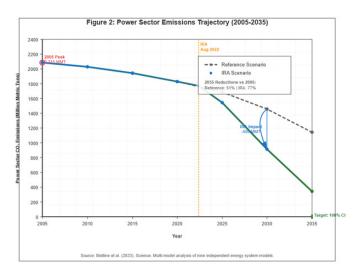


Figure 2. Power sector emissions trajectory (2005-2035)

Key findings include:

- Renewable capacity additions accelerate significantly, with solar and wind installations increasing by 150-200% compared to reference scenarios
- Coal plant retirements occur 5-8 years earlier than previously projected
- Grid-scale storage deployment increases exponentially due to ITC eligibility
- Nuclear power preservation through production credits prevents premature retirements

#### 4.1.3. Transportation sector dynamics

The transportation sector presents a more complex decarbonization trajectory, with EV tax credits showing variable effectiveness depending on regional deployment patterns and usage rates. The analysis reveals that stringent domestic content requirements and supply chain constraints limit the immediate impact of vehicle electrification incentives.

## 4.2. Environmental justice and equity outcomes 4.2.1. Justice 40 initiative integration

The IRA's environmental justice provisions represent an unprecedented federal commitment to addressing historical environmental inequities. The Act allocates \$3 billion directly to environmental and climate justice programs, with additional equity requirements embedded throughout its clean energy incentives.

**Table 2.** Electric vehicle deployment and emissions impact by region

Region	Projected EV Share 2030	Emissions Reduction (%)	Key Implementation Challenges
California	47%	38%	Supply chain constraints, grid capacity
Northeast	35%	31%	Cold weather performance, charging infrastructure
Southeast	22%	19%	Rural charging gaps, utility cooperation
Midwest	28%	24%	Manufacturing workforce transition
Southwest	31%	29%	Grid integration, extreme heat impacts
National Average	32%	28%	Domestic content requirements

Source: GCAM-USA modeling results, adapted from Zhang et al. (2023)

The Environmental and Climate Justice Program provides \$2.8 billion for financial assistance and \$200 million for technical assistance, specifically targeting disadvantaged communities. These investments align with the Biden administration's Justice 40 Initiative, which commits to directing 40% of federal climate investments to overburdened communities.

#### 4.2.2. Geographic distribution of benefits

Treasury Department analysis reveals that IRA investments are delivering disproportionately more clean investment to historically disadvantaged places, including energy communities and low-income areas. This represents a significant departure from previous federal investment patterns that often concentrated benefits in affluent regions.

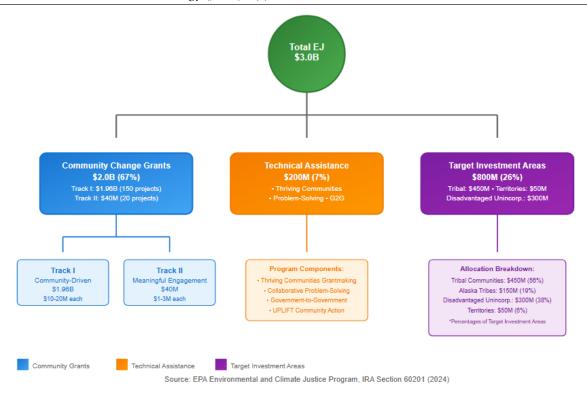


Figure 3. Environmental justice investment distribution

Table 3. Clean Energy Investment Distribution by Community Type (Post-IRA)

<b>Community Type</b>	Monthly Investment Pre-IRA	Monthly Investment Post-IRA	<b>Growth Rate</b>
Energy Communities	\$2.0B	\$5.0B	+150%
Low-Income Counties	\$1.2B	\$3.8B	+217%
Disadvantaged Communities	\$0.8B	\$2.9B	+263%
Tribal Lands	\$0.1B	\$0.7B	+600%
National Total	\$4.5B	\$9.0B	+100%

Source: U.S. Treasury Department, Clean Investment Monitor (2024)

Key equity outcomes include:

- Enhanced participation in clean energy programs among historically underserved communities
- Job creation concentrated in regions previously dependent on fossil fuel industries
- Environmental health improvements through reduced air pollution exposure
- Capacity building through technical assistance and community engagement programs

#### 4.2.3. Community-level impact assessment

Initial implementation data indicate that there is a great deal of variation in community level outcomes, and that such success is very much reliant upon local capacity, state collaboration, and federal agency methodologies of implementation. Pilot community case studies demonstrate both encouraging outcomes and continuing issues.

## 4.3. Implementation challenges and policy gaps

## 4.3.1. Decarbonization acceleration constraints

Despite substantial projected emissions reductions, several factors constrain the IRA's decarbonization potential:

- Permitting bottlenecks that delay renewable energy project deployment
- Grid interconnection challenges limiting clean energy integration
- Supply chain constraints affecting solar, wind, and battery manufacturing
  - Skilled workforce shortages in clean energy sectors
  - State-level policy variations creating uneven implementation

#### 4.3.2. Equity implementation barriers

Environmental justice objectives face implementation challenges that may limit equitable benefit distribution:

· Administrative capacity constraints in disadvantaged



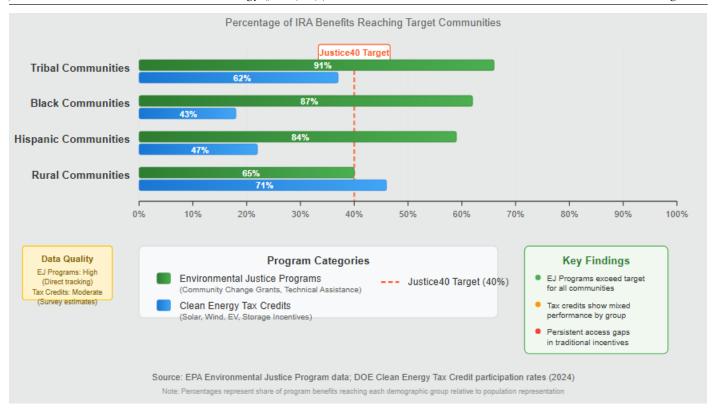


Figure 4. Community benefit distribution by demographics

communities.

- Technical assistance gaps in program navigation and application processes.
  - · Matching fund requirements that exclude resource-

constrained organizations.

- Language barriers limiting program accessibility.
- Community engagement shortfalls in federal program design processes.

Table 4. Program participation rates by community characteristics

<b>Program Category</b>	<b>High-Income Communities</b>	<b>Low-Income Communities</b>	Participation Gap
Solar Tax Credits	78%	34%	44 percentage points
EV Tax Credits	67%	23%	44 percentage points
Home Energy Rebates	45%	71%	-26 percentage points*
Community Change Grants	12%	88%	-76 percentage points*

<sup>\*</sup>Negative values indicate higher participation in target communities Source: EPA and DOE program data (2024)

## 4.4. Economic and social co-benefits

#### 4.4.1. Employment and workforce development

Climate Power estimates indicate that the IRA has created at least 406,007 new clean energy jobs across 751 projects and \$422 billion in investments as of January 2025. These employment benefits concentrate in regions historically dependent on fossil fuel industries, supporting just transition objectives.

## 4.4.2. Public health co-benefits

The largest and most immediate health benefit of the IRA will likely be in the prevention of air-pollution-related disease and premature death, with each dollar invested in air pollution prevention yielding an estimated economic return of \$30. Particulate matter (PM2.5) reductions from clean energy

deployment provide substantial health co-benefits, particularly in environmental justice communities historically burdened by poor air quality.

Projected health benefits include:

- Avoided premature deaths from reduced air pollution exposure
- Decreased hospitalization rates for respiratory and cardiovascular diseases
  - Reduced healthcare costs in disadvantaged communities
  - Improved productivity from healthier populations

#### 4.5. Discussion

#### 4.5.1 Policy effectiveness assessment

The IRA demonstrates significant effectiveness in accelerating



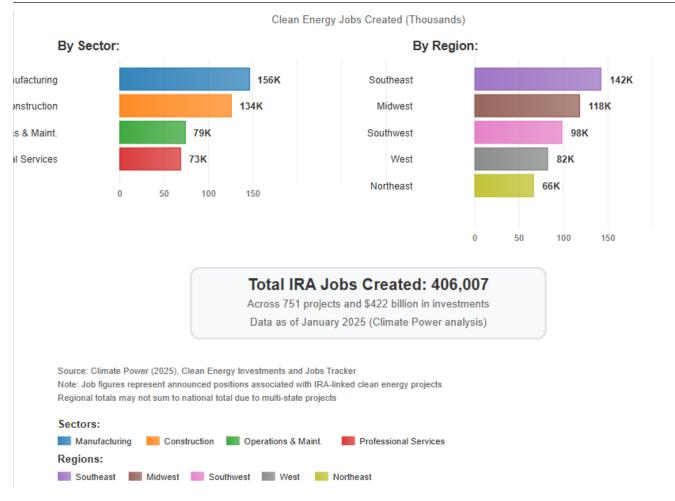


Figure 5. IRA Job creation by sector and region (2022-2024)

decarbonization while establishing new precedents for environmental justice in federal climate policy. The Act's comprehensive approach, combining technology incentives with direct community investment, creates synergistic effects that amplify both environmental and equity outcomes. However, the analysis reveals several critical gaps between

However, the analysis reveals several critical gaps between policy objectives and projected outcomes:

- Decarbonization Gap: Although the IRA would largely serve to speed up reductions in the level of emissions, the 43-48% cuts by 2035 will not be sufficient to reduce emissions by 50% by 2030, in line with the commitments under the Paris Agreement. Such a gap will require further federal and state policy interventions, especially in areas where IRA coverage is weak like industrial process emissions and international transportation.
- Implementation Equity: Although the current state of environmental justice investment is more than any other time in history, the equitable allocation of benefits depends on prolonged considerations of administrative capacity, technical assistance, and community engagement processes. Preliminary implementation data indicate that traditional impediments to federal program participation still exist, which may restrain the equity goals of the Act.

## 4.5.2. Comparative policy context

The comprehensive nature of the IRA climate and equity policy

is a major development in comparison with past federal climate action plans. The IRA contrasts the regulatory requirements of the American Clean Energy and Security Act (Waxman-Markey) or the Clean Power Plan by using financial incentives instead of regulatory mandates, which can be more easily politically enacted and incentivizes more companies to adopt clean technologies.

This market-based strategy proves especially effective in the electricity sector where tax credits are used to supplement the renewable energy standards established within the state and trends in investment by the privately-owned sector. Nevertheless, industries that demand a more basic technological shift, including the heavy industry and long-distance transport systems, might need further regulatory frameworks to be deeply decarbonized.

## 4.5.3. Long-term sustainability considerations

The 10-year incentive plan by the IRA offers unprecedented confidence in clean energy investments, eliminating a major obstacle to investment in the generating industry and capital formation. Yet, the achievement of decarbonization in the long term is conditional on various aspects that are not covered by the Act:

 $\bullet$  Technology innovation in sectors with limited commercial solutions



- Infrastructure development to support economy-wide electrification
- International cooperation on global supply chains and technology transfer
  - Political durability of climate policies across electoral cycles

## 4.6. Key findings summary

This analysis shows that the Inflation Reduction Act represents a watershed moment in United States climate policy, successfully integrating ambitious decarbonization objectives with extraordinary environmental justice investments. The Act's projected emissions reductions of 43-48% below 2005 levels by 2035 constitute a substantial hastening of national decarbonization efforts, while \$3 billion in environmental justice programs sets up new federal frameworks for addressing historical environmental inequities.

However, significant implementation challenges remain across both dimensions:

For Decarbonization:

- The IRA alone is insufficient to meet 2030 climate commitments
- Power sector transformation significantly outpaces other sectors
- Supply chain and permitting constraints limit deployment speed
- State and local policy coordination remains critical For Environmental Justice:
  - Community capacity and technical assistance gaps persist
  - Traditional program participation barriers continue
- Long-term community engagement requires sustained federal commitment
- Measurement and accountability frameworks need strengthening

## 4.7. Policy recommendations

Near-term Actions (2025-2027):

- i. Streamline permitting processes for renewable energy projects while maintaining environmental safeguards
- ii. Enhance technical assistance programs for disadvantaged communities accessing federal incentives
- iii. Develop standardized metrics for tracking environmental justice outcomes across agencies
- iv. Coordinate state-federal implementation to maximize policy complementarity

Medium-term Reforms (2027-2030):

- i. Expand sectoral coverage through additional incentives for industrial decarbonization
- ii. Strengthen community engagement requirements in federal program design
- iii. Address supply chain vulnerabilities in critical clean energy minerals and components
- iv. Develop workforce transition programs for fossil fuel-dependent communities

Long-term Framework (2030-2035):

- i. Plan post-2032 incentive structures to maintain decarbonization momentum
- ii. Establish permanent environmental justice institutions within federal agencies

- iii. Integrate climate resilience with mitigation investments
- iv. Develop international cooperation frameworks for technology deployment

#### 4.8. Research priorities

Future research should address several critical knowledge gaps identified in this analysis:

- Community-level impact assessment methodologies and longitudinal tracking systems
- Technology innovation needs for hard-to-decarbonize sectors
- Behavioral responses to clean energy incentives across demographic groups
- Policy interaction effects between federal, state, and local climate initiatives
- International competitiveness implications of domestic content requirements.

#### 4.9. Final assessment

The Inflation Reduction Act represents the United States' most comprehensive attempt to address climate change and environmental justice simultaneously. While the Act's projected outcomes fall short of some policy objectives, particularly the 2030 emissions target, it establishes critical foundations for long-term decarbonization while advancing environmental justice in unprecedented ways.

Success in achieving the Act's dual objectives requires sustained implementation focus, particularly on addressing community capacity gaps and accelerating deployment in lagging sectors. The next phase of federal climate policy must build upon the IRA's innovations while addressing its limitations through complementary regulatory, investment, and international cooperation frameworks.

The integration of climate and equity objectives demonstrated in the IRA provides a template for future policy development, both within the United States and internationally. As the global community grapples with the dual imperatives of rapid decarbonization and just transitions, the IRA's approach offers valuable lessons for designing policies that advance both environmental and social objectives simultaneously.

## 5. CONCLUSION

The Inflation Reduction Act (IRA) of 2022 marks a transformative moment in the United States' pursuit of a lowcarbon and more equitable future. This study's integrated assessment of the Act's decarbonization and equity dimensions reveals that, while the IRA establishes a historic framework for climate action, the realization of its ambitious goals will depend heavily on implementation fidelity, institutional capacity, and sustained political commitment. Our analysis shows that the IRA has the potential to reduce economy-wide greenhouse gas emissions by 43-48% below 2005 levels by 2035, positioning the nation on a credible path toward deep decarbonization. The Act's substantial investment in renewable energy, electric vehicles, grid modernization, and carbon capture technologies represents an unprecedented mobilization of public funds to stimulate private innovation and accelerate the clean energy transition. Yet, achieving the Biden administration's interim

target of a 50% reduction by 2030 will require complementary state and local initiatives, rapid deployment of clean infrastructure, and continued regulatory support to bridge the remaining emissions gap. Equity considerations are another defining aspect of the IRA. The Act's \$3 billion allocation for environmental justice programs and targeted funding for disadvantaged communities signal a meaningful shift toward embedding fairness and inclusion within U.S. climate policy. However, the effectiveness of these provisions will hinge on transparent governance mechanisms, equitable access to funding, and active community participation in project design and implementation. Without intentional efforts to mitigate disparities in capacity and influence, there is a risk that the benefits of the IRA could disproportionately accrue to already advantaged regions and industries. Overall, the IRA serves as both a milestone and a test case for the integration of decarbonization and equity in large-scale climate policy. Its success will depend on ongoing monitoring, adaptive policy management, and coordination among federal, state, and local actors. Continued research should focus on evaluating the long-term socio-economic and environmental outcomes of IRA-funded initiatives to ensure that the Act not only achieves measurable emissions reductions but also delivers durable, just, and inclusive climate benefits for all Americans.

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