# CLIMATE SMART AGRICULTURE, FOOD SECURITY AND SUSTAINABLE DEVELOPMENT

*GLOBAL ISSUES & LOCAL PERSPECTIVES* volume One

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# Preface

This book adopts an exegetical approach as well as a pedagogic model, making it attractive agriculture and environmental economics teachers, professional practitioners and scholars. It is eschews pedantry and lays bars the issues in such clarity that conduces to learning. The book elaborates on contemporaneous **Climate Smart Agriculture, Food Security and Sustainable Development** issues of global significance and at the same time, is mindful of local or national perspectives making it appealing both to international and national interests. The book explores the ways in which climate smart agriculture (CSA) food security, Sustainable Development issues are and should be presented to increase the public's stock of knowledge, increase awareness about burning issues and empower the scholars and public to engage in the participatory dialogue climate smart agriculture, food security, and sustainable development necessary in policy making process that will stimulate increase in food production and environmental sustainability.

**Climate Smart Agriculture, Food Security and Sustainable Development:** *Global Issues & Local Perspectives* is organized in three parts. Part One deals with The Concept of **Climate Smart Agriculture**, Part Two is concerned with The Concept of **Food Security And** and Part Three deals with the Concept of **Sustainable Development**

**Eteyen Nyong; October 2025**

# Chapter Fourteen
# The Political Economy of Renewable Energy Transitions: Implications for Fisheries

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OUTLINE



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## 1.0 Introduction

The current universal shift toward renewable energy is a defining feature of the twenty-first-century policy landscape, reflecting mounting apprehension over climate change, energy insecurity, and the long-term sustainability of traditional energy systems (Sovacool, Del Rio & Griffiths, 2020). Various renewable energy sources (Figure 1) can be used to produce energy that can replace fossil fuels and as a tool for climate change mitigation strategies. The most common energy sources are solar, wind, geothermal, hydropower, and biomass. Hydrothermal is the leading energy source, with the capacity to generate 1,150 gigawatts of electricity. This transformation frequently called the renewable energy transition, involves a profound reconfiguration of energy production, circulation, and consumption, with significant ramifications for a range of sectors from industry and transportation to agriculture, forestry, and fisheries (Jenkins & Hall, 2021; Acheampong, Opoku & Dogah, 2023).

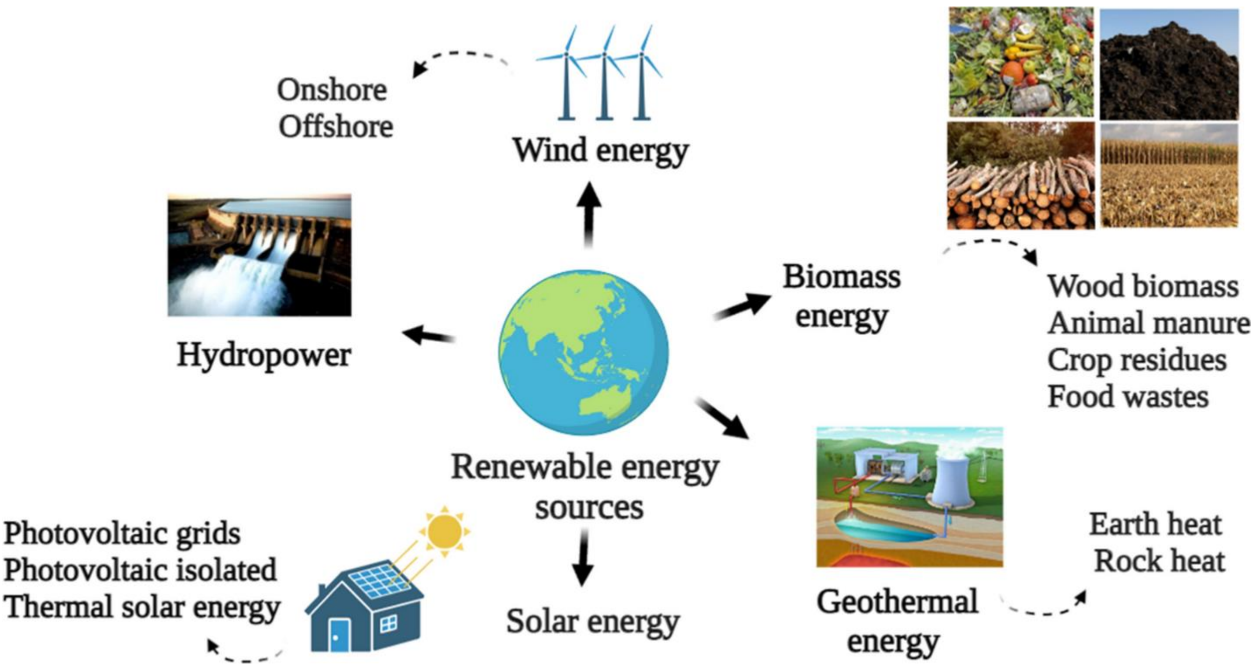


Figure 1: Renewable energy types.
Source: Osman, Chen, Yang, Mingyu, Msigwa, Farghali, Fawzy, Rooney & Yap (2023)

Fisheries, in particular, are situated at a delicate intersection of climate, policy, economics, and community livelihoods. Traditionally a sector vulnerable to climate impacts, overfishing, and ecosystem degradation, fisheries now face a new set of pressures stemming from policy choices and financial mechanisms designed to accelerate the expansion of renewable energy (Andrews, Bennett, Le Billon, Green, Cisneros-Montemayor, Amongin, Gray & Sumaila, 2021). The installation of offshore wind farms, the conversion of coastal spaces for solar energy production, and the growing competition for financial resources and policy incentives collectively reshape the political and economic context within which fisheries operate (Hoegh-Guldberg, Caldeira, Chopin, Gaines, Haugan, Hemer, Howard, Konar, Krause-Jensen, Lovelock, Lindstad, Michelin, Nielsen, Northrop, Parker, Roy, Smith, Some & Tyedmers, 2019).

This complex intersection highlights the political economy dimensions of the renewable energy transition that is, the way power, institutions, incentives, stakeholders, and financial flows collectively influence policy outcomes and determine winners and losers (Sovacool *et al*., 2020). Importantly, policy decisions made today will profoundly affect the future livelihoods of fishing communities, the health of marine habitats, and the distribution of costs and benefits across different social groups (Pashakolaie, Cotton & Jansen, 2024). Without careful consideration of these political and economic dimensions, the energy transition runs the risk of exacerbating inequalities, fueling conflict over resources, and undermining the resiliency of both human and ecological systems (Gilmour, 2024).

This chapter aims to illuminate these political economy mechanisms and their implications for fisheries, focusing on policy regimes, financial incentives, stakeholders' power relations, and mechanisms for participatory decision-making. Drawing upon empirical case studies, policy analyses, and theoretical perspectives from political ecology, institutional economics, and environmental policy, we identify key policy instruments and strategies for navigating these challenges in a way that is socially just, environmentally sustainable, and economically viable (Jenkins & Hall, 2021; Acheampong *et al*., 2023). Our discussion emphasizes the necessity for policy coherence, stakeholder engagement, and mechanisms to enable vulnerable communities to influence decisions that directly affect their livelihoods and well-being (Andrews *et al.,* 2021). Ultimately, understanding the political economy of renewable energy transitions is not a peripheral concern; it is central to designing policy regimes that enable a just transformation toward low-carbon energy while honoring the rights, knowledge, and traditions of those most vulnerable to its impacts, especially small-scale fishers and coastal communities (Pashakolaie *et al*., 2023). This chapter therefore contributes to ongoing policy and academic conversations by framing fisheries within the larger context of energy policy transformation, arguing for policy mechanisms and institutions that account for both equity and sustainability.

### 1.1 Problem Statements

- Spatial and Livelihood Displacement

Evidence from the UK, Norway, and the U.S. shows that offshore wind development often displaces fishers from traditional grounds, reducing catch and income, and causing spatial and operational conflicts (NOAA Fisheries, 2024; Szostek, Watson, Trifonova, Beaumont & Scott, (2025). The lack of co-management or early stakeholder involvement exacerbates mistrust and undermines cooperative planning (Szostek *et al.*, 2025).

- Regulatory and Policy Gaps

Even when spatial planning tools exist, they are often inadequately integrated into policy frameworks or lack enforcement regarding fisheries' access and equity (Kyvelou & Ierapetritis, 2020). Trade-offs between renewable infrastructure and marine protected areas often fail to address social dimensions leading to adverse outcomes for small-scale fishers (de Gutierrez & Calado, 2024).

- Fragmented Compensation Mechanisms

Existing schemes for compensating fishing communities for lost livelihoods remain inconsistent and inadequate. The absence of standardized, transparent compensation protocols frequently leaves fishers undercompensated or excluded from decision-making processes (NOAA Fisheries, 2024; Szostek *et al.*, 2025).

1.2 Objectives

This chapter seeks to critically examine the political economy of renewable energy transitions as they intersect with fisheries, guided by these objectives:

i. Analyze Policy Interactions
Explore how renewable energy policy, fisheries governance, and spatial planning interact, often reinforcing unequal power structures.

ii. Assess Impacts on Livelihoods
Evaluate socio-economic and ecological impacts of renewable energy expansion such as displacement, income loss, and habitat disruption on fishing communities.

iii. Evaluate Decision-Making Frameworks
Investigate models and structures for participatory governance, compensation strategies, and integrated spatial planning that facilitate equitable coexistence.

iv. Recommend Policy Instruments
Propose policy strategies rooted in institutional economics, political ecology, and environmental justice. Emphasis will be placed on tools such as co-management frameworks, transparent compensation systems, and multi-stakeholder spatial zoning for fisheries and renewables.

v. Advocate for Inclusive Transition
Promote transformation within energy policy that sustains equitable participation of traditionally marginalized communities, especially small-scale fishers, safeguarding both ecosystems and livelihoods.

2.0 Political Economy of Renewable Energy Transitions

2.1 Definition and Framework

Political economy emphasizes how power, institutions, and financial flows shape policy outcomes (Söylemez & Söylemez, 2024). In the renewable context, market design (e.g., auctions, feed-in tariffs) and regulatory interventions dictate how rapid offshore wind deployment interacts with maritime stakeholders (Söylemez & Söylemez, 2024). Auction structures particularly those guaranteeing revenue stability have enabled massive deployment, but often insufficiently integrate fishing interests until later stages (Söylemez & Söylemez, 2024).

Marine spatial planning (MSP) frameworks seek to mediate this interface by identifying overlapping zones and allocating space for competing uses. The U.S. Bureau of Ocean Energy Management (BOEM) has published fisheries mitigation guidance promoting transparency, early engagement, and compensation frameworks as central to equitable MSP (BOEM, 2025).

The political economy of renewable energy transitions refers to the study of how political interests, economic forces, and institutional arrangements collectively influence the shift from fossil-based to renewable energy systems (Figure 2). This perspective emphasizes that energy transitions are not purely technical or market-driven; instead, they are profoundly political and subject to competing agendas, policy regimes, financial incentives, and power relations that determine their trajectory and outcomes (Acheampong *et al.*, 2023; Söylemez & Söylemez, 2024)


Figure 2: Diversity of blue economy
Source: Failler & Seisay (2021)

2.1.1 Key components include:

a) Policy-making and regulation: The framework within which energy transitions take place is defined by legislation, policy directives, and regulations. This includes mechanisms for allocating incentives, setting renewable energy targets, and mandating environmental safeguards (Tsai, Tseng, Huang, & Yu, 2022; BOEM, 2025). The policy process is inherently political, reflecting negotiations among stakeholders with differing preferences and degrees of influence.

b) Investment flows and market incentives: The financial mechanisms that enable or prohibit transformation subsidies, feed-in tariffs, power purchase agreements, and incentives for innovation directly determine which technologies are funded and which are neglected (Söylemez & Söylemez, 2024). This, in turn, guides the trajectory of the energy mix and the financial viability of various energy producers.

c) Ownership and control of resources: The political economy perspective also assesses who owns and controls the resources from the physical sites where offshore wind installations are constructed, to the intellectual property related to renewable technologies. This control, or lack thereof, profoundly influences the distribution of profits, rents, and financial power within and across communities (Acheampong *et al.,* 2023; Pashakolaie *et al.*, 2024).

d) Labor, land, and ecological implications: The transformation toward renewable energy is not without social and environmental impacts. Labor practices, employment patterns, and the distribution of benefits and burdens are influenced by policy decisions and financial incentives (Kazimierczuk, Henderson, Duffy, Hanif, Bhattacharya, Biswas, Jacroux, Preziuso, Wu, Bhatnagar & Tarekegne, 2023; Warlick, Liu, Layton, Harvey, Samhouri, Hazen & Andrews, 2025). Furthermore, the appropriation of land and coastal space for offshore installations can undermine traditional livelihoods, displace community members, and undermine ecosystem health fueling resistance or policy conflict (Lian, Liu, & Yang, 2022).

Together, these components illuminate the complex and often uneven process by which societies move toward renewable energy. The political economy framework emphasizes the necessity for policy design that is participatory, socially just, environmentally responsible, and context-specific ensuring that the benefits of the energy transition are broadly shared while mitigating its potential drawbacks for vulnerable stakeholders (Tsai *et al.*, 2022; Söylemez & Söylemez, 2024).

### 2.2 Drivers and Barriers

The transformation toward renewable energy is influenced by a range of drivers and barriers that collectively determine its trajectory, speed, and eventual outcomes (Acheampong *et al.*, 2023; Söylemez & Söylemez, 2024).

#### 2.2.1 Drivers:

According to Tsai *et al.*, (2022), one of the most momentous drivers for the renewable energy modification is climate policy. National regulations, policy motivations, and emission decline targets create a strong background for firms and stakeholders to chase low-carbon energy options. Additionally, technological advancement in solar, wind, storage, and grids innovations continually bring down costs and enhances performance, making renewable energy more viable compared to traditional sources (Warlick *et al*., 2025). International agreements, particularly the Paris Agreement, consolidate this momentum by fostering a collective understanding and commitment to reduce greenhouse gas emissions across borders (Söylemez & Söylemez, 2024). This multilateral policy context helps align incentives, standardize regulations, and enable financial mechanisms to aid in the delivery of renewable energy projects. Additionally, growing public pressure and civic activism reflecting growing awareness of climate change impacts further pushes policy makers and companies toward adopting clean energy solutions (Gilmour, 2024). Rising voter concern about climate impacts, alongside campaigns by environmental organizations, strengthens the political will to prioritize and accelerate the energy transition.

2.2.2 Barriers:

At the same time, there are significant barriers that can slow or undermine the process. Incumbent fossil fuel interests, for instance, retain substantial financial resources, political influence, and policy mechanisms to protect their market share, often opposing legislation or incentives for renewable energy (Acheampong *et al*., 2023; Söylemez & Söylemez, 2024). Regulatory inertia stemming from complex and outdated policy regimes further impedes adaptation to new technologies and market structures (Tsai *et al*., 2022). Furthermore, many renewable energy projects face financial constraints related to high upfront investment, limited access to financing, and policy uncertainty, which collectively raise the cost of entry (Warlick *et al*., 2025). Social resistance to land or sea use for renewable energy installations adds another layer of complexity. Local stakeholders may be concerned about the effects on their livelihoods, traditional practices, viewscapes, or the health of nearby ecosystems (Kazimierczuk *et al*., 2023). This resistance underscores the necessity for participatory decision-making and for policy mechanisms to account for community preferences and vulnerabilities.

Together, these drivers and barriers highlight the delicate balance policy makers and stakeholders must strike in navigating the political, financial, and social landscape of the renewable energy transition (Acheampong *et al*., 2023; Söylemez & Söylemez, 2024).

3.0 Intersection of Renewable Energy with Fisheries

The expansion of renewable energy infrastructures directly intersects with fisheries, influencing both the livelihoods of coastal and inland fishing communities and the health and functionality of aquatic ecosystems (Kazimierczuk *et al*., 2023; Liu, 2025). This intersection brings forward policy and management questions about how to balance competing uses of space, resources, and financial incentives while honoring traditional practices and conserving marine habitats (Söylemez & Söylemez, 2024). Empirical evidence points to measurable revenue losses and operational disruptions for many fisheries as a result of renewable energy expansion (Chaji and Werner, 2023; Söylemez & Söylemez, 2024; Warlick *et al*., 2025). Fishermen frequently face reduced earnings due to overcrowding and navigational constraints within offshore wind farm (OWF) zones. This happens when access to traditional fishing grounds is limited by safety buffers, structural installations, or policy restrictions, forcing crews to travel further, incur greater operational costs, and reduce their profits (Tsai *et al.*, 2022).

For instance, bottom trawling in UK waters fell by nearly 77% following the installation of offshore wind facilities (Chaji and Werner, 2023), reflecting a dramatic contraction in opportunity for a major segment of the industry. While this decline can sometimes be viewed as a form of de facto protection for seafloor habitats yielding eventual ecosystem benefits, it also directly undermines the financial stability and employment prospects for many small-scale and medium-sized enterprises that rely upon these fisheries (Liu, 2025).

Furthermore, conflicts over space and resources are growing in many European waters, with overlapping operations for fisheries and offshore energy production adding pressure to a limited marine space (Söylemez & Söylemez, 2024). Analysis across the North Sea, Baltic Sea, and Mediterranean shows a significant rise in conflict potential, particularly for demersal trawl fisheries that target species such as flatfish, crustaceans, and demersal finfish (Tsai *et al.*, 2022). This growing competition underscores the necessity for policy mechanisms that account for both the financial impacts on traditional livelihoods and the need for responsible and sustainable expansion of renewable energy.

Ultimately, navigating these complex interactions requires a careful balance between conserving marine habitats, honoring the rights of traditional fishers, and fostering a clean energy future (Söylemez & Söylemez, 2024). Collaborative policy design, stakeholder participation, and adaptive management strategies are crucial to mitigating financial harm while retaining incentives for energy transformation

### 3.1 Spatial Conflicts and Marine Zoning

Renewable energy infrastructure, especially offshore wind and tidal energy, frequently competes with traditional fishing grounds and other maritime uses (Tsai *et al.*, 2022). The growing number of offshore wind installations, for instance, can displace small-scale and commercial fishers from their historical fishing areas, fueling conflict and resistance (Liu, 2025). Marine spatial planning (MSP) emerges as a crucial policy tool for navigating these competing demands (Söylemez & Söylemez, 2024). Collaborative processes that bring together stakeholders' regulators, energy companies, conservation organizations, and fishing communities enable the identification of shared spaces and compromise solutions. Successful MSP typically involves mapping out human and ecological uses, assessing their compatibility, and developing strategies to enable coexistence and minimize conflict (Tsai *et al.*, 2022).

### 3.2 Impacts of Hydropower on Inland Fisheries

Hydropower dams profoundly influence freshwater habitats by changing flow regimes, sediment transport, and migration routes for numerous freshwater species (Lian *et al.*, 2022; Kazimierczuk *et al.*, 2023). This can undermine the health of freshwater fisheries, which many rural communities rely upon for food, income, and cultural practices (Söylemez & Söylemez, 2024).

In regions such as Sub-Saharan Africa and Southeast Asia, these impacts have disrupted traditional livelihoods and forced many families to abandon their ancestral settlements (Liu, 2025). Hydroelectric projects frequently sever migratory pathways for species like salmon, catfish, and freshwater prawns, while altering sediment delivery a process crucial for maintaining healthy spawning grounds. Furthermore, reduced water flow can exacerbate problems related to water temperature, oxygen levels, and the susceptibility to disease in freshwater species (Tsai *et al*., 2022).

### 3.3 Bioenergy and Land Use Changes

The large-scale production of bioenergy feedstocks, such as oil palm, sugarcane, or fast-growing trees, can exacerbate land use pressures and undermine the health of freshwater and wetland habitats (Söylemez & Söylemez, 2024). This occurs when agricultural expansion displaces traditional landholders, degrades soil, and contributes to sedimentation and erosion, thereby affecting nearby lakes, rivers, and floodplains (Warlick *et al*., 2025). The result is reduced water quality, disrupted food chains, and a dramatic decline in the productivity of freshwater fisheries upon which many vulnerable communities depend (Tsai *et al.,* 2022)

### 3.4 Offshore Wind and Marine Ecosystems

While offshore wind farms can create artificial reef structures that provide refuge and additional habitat for some species of fish (Lian *et al*., 2022), their overall effects remain complex and context-specific Kazimierczuk *et al*., 2023). The construction and operation of offshore wind installations can:

a) Interfere with traditional fishing routes, requiring fishers to travel farther or avoid previously productive grounds (Söylemez & Söylemez, 2024).
b) Introduce underwater noise pollution during pile-driving and maintenance, which may affect the behavior, communication, and health of marine species (Warlick *et al*., 2025).
c) Displace small-scale fishers who may lack the financial resources, training, or policy support needed to adapt their operations in the face of reduced access and growing competition (Tsai *et al*., 2022).

This highlights the necessity for policy mechanisms, stakeholders' participation, and careful policy design to enable a socially just energy transition that maintains both ecosystem health and community livelihoods (Acheampong *et al* 2023; Söylemez & Söylemez, 2024).

## 4.0 Ecological and Habitat Dynamics

The deployment of offshore wind farm (OWF) infrastructure introduces both opportunities and challenges for marine ecosystems. One of the most commonly observed ecological phenomena associated with OWFs is the creation of "artificial reef" effects, whereby turbine foundations, scour protection materials (e.g., rock armor), and subsea cabling infrastructure provide hard substrates that support the colonization of benthic organisms such as mussels, barnacles, sea anemones, and lobsters (Lian *et al*., 2022; Kazimierczuk *et al*., 2023). These structures often enhance local biodiversity by attracting a variety of invertebrates and demersal fish species, increasing localized biomass and altering trophic interactions. In some cases, these habitats may even benefit certain commercially valuable species, potentially offering spillover effects to nearby fisheries (Tsai *et al*., 2022).

However, the ecological benefits of artificial reef formation must be weighed against broader ecosystem-level concerns. One such concern is the alteration of primary productivity patterns due to OWF-induced changes in water column stratification and turbulence. Wind turbine foundations can interfere with vertical mixing processes, which may affect nutrient cycling and the distribution of phytoplankton at the base of marine food webs (Lian *et al*., 2022). This has implications for ecosystem productivity, particularly in nutrient-sensitive environments or regions prone to seasonal stratification.

Moreover, the hydrodynamic changes induced by OWFs can result in localized modifications to sediment transport, seabed erosion, and deposition patterns, all of which may influence benthic community structure and habitat suitability for spawning and juvenile development Söylemez & Söylemez, 2024). Such changes could be beneficial or detrimental, depending on site-specific conditions and species sensitivities.

Another important ecological concern is the emission of low-frequency underwater noise during both the construction and operation phases of OWFs. Pile driving commonly used during turbine foundation installation generates acute noise pulses that can disrupt marine mammal behavior, cause temporary hearing loss, or displace species from critical habitats (Kazimierczuk *et al*., 2023). Even during operational phases, aerodynamic and mechanical vibrations can contribute to chronic noise pollution that may interfere with the communication, migration, and foraging behavior of acoustically sensitive species, such as cetaceans and some fish (Lian *et al.,* 2022).

Additionally, the cumulative impacts of multiple OWF installations across a region may lead to habitat fragmentation or broader-scale ecological regime shifts. As renewable energy development expands, long-term ecosystem monitoring and adaptive management strategies become essential to mitigate adverse effects while maximizing biodiversity benefits.

In summary, while OWFs can contribute positively to marine habitats by mimicking natural reef functions, their construction and operation also pose complex risks to ecological stability, species interactions, and ecosystem productivity. The trade-offs inherent in these changes highlight the need for precautionary ecological planning, interdisciplinary assessment, and inclusive marine governance frameworks (Tsai *et al*., 2022; Kazimierczuk *et al*., 2023).

## 5.0 Case Studies of Renewable Energy Transitions

Case studies from various global regions underscore the complex and often contested relationship between renewable energy development and fisheries. These examples (Table 1) offer valuable insights into the policy, ecological, and social trade-offs involved in achieving sustainable energy transitions while maintaining coastal and inland fishery livelihoods.

Table 1: Case Studies of Renewable Energy Transitions and Their Implications for Fisheries

| S/ N | Location / Country | Renewable Energy Development | Fisheries / Ecological Impact | Governance & Social Dynamics |
|---|---|---|---|---|
| 1 | Mekong River (China → Laos, Cambodia, Vietnam) | Large-scale hydropower (Lancang dams) | Altered flow / sediment; ~20% of fish species at risk; disrupted inland fisheries and rice cultivation | Weak transboundary governance; Mekong River Commission limited enforcement; fragmented compensation |
| 2 | Scotland (Seagreen Offshore Wind Farm, Little Loch Broom) | Offshore wind farms (e.g. Seagreen) and undersea cables | Spawning habitat concerns; proactive mitigation through environmental reviews | Adaptive, inclusive planning; stakeholder consultations |
| 3 | Norway (North Sea & Coastal Zones) | Offshore wind & marine renewables | Spatial conflicts with fishing grounds; potential displacement | Compensation mechanisms under negotiation; emphasis on co-management, but concerns about equity remain |
| 4 | USA (Northeast Atlantic | Offshore wind development (e.g., East Coast) | Disruption to commercial fishing (e.g., scallop, lobster, groundfish) and uncertainty about long-term ecological impacts. | NOAA - led socioeconomic reviews; fisher engagement improving, but tensions remain over compensation |
| 5 | Germany & Netherlands (North Sea) | Offshore wind clusters integrated into EU energy transition | Habitat loss, altered migration routes for fish; reduced access to fishing grounds. | EU-driven marine spatial planning; fishers often marginalized in decision-making. |
| 6 | Denmark | Offshore wind farms (e.g., Horns Rev 1) and energy islands | Artificial reef effects, increased biodiversity and fish habitat | Integrated research partnerships supporting ecological co-benefits |
| 7 | Ghana | Floating solar PV (5 MW on Bui reservoir); wave energy pilot in Ada Foah | Unknown impact on fisheries and ecosystems; concerns over displacement and ecosystem disruption | Blue economy potential recognized, but need for community engagement and ecosystem safeguards |
| 8 | Philippines | Floating solar (Laguna de Bay) and wind farms (Bangui, Burgos) | Risks to fishing routes, aquaculture; livelihood concerns for ~10k fishers | Fisher groups (e.g., Pamalakaya) demand participatory planning and protections |

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| 9 | Kenya (Lake Turkana Wind Power Project) | Large-scale wind power near Lake Turkana | Indirect impacts on fishing due to altered land/water use patterns and displacement of communities. | Criticized for limited community consultation; calls for better integration of fisheries in land-energy planning. |

Across contexts, renewable energy expansion often creates trade-offs: ecological disruptions, spatial conflicts, and livelihood losses. The difference lies in governance. Where participatory planning and compensation frameworks exist (e.g., Scotland, partly Norway), impacts are better managed. Where governance is fragmented (e.g., Mekong, Kenya, Ghana and Philippines), costs disproportionately fall on fishers and vulnerable communities

Ecological outcomes vary by location: Denmark showcases how offshore wind can enhance fish habitats via artificial reefs; in contrast, the Mekong and Philippines show projects with potentially negative effects on fisheries. Community voices make the difference: Fisher resistance in the Philippines and advocacy in Ghana highlight the importance of equitable consultation and benefit - sharing in energy transitions.

## 6.0 Governance, Equity, and Stakeholder Inclusion

The politics of renewable energy transitions must confront not only the technical and environmental dimensions of infrastructure development but also the complex socio-political dynamics that determine who benefit, who is burdened, and who participates in decision-making. Effective governance of energy transitions requires a deliberate focus on inclusivity, transparency, and justice, especially in contexts where fisheries-dependent communities coexist with expanding renewable energy frontiers (Table 2).

Table 2: Equity and Inclusion in Renewable Energy Transitions and Fisheries

| S/N | Theme | Key Issues | Required Actions / Strategies | Equity Implications for Fisheries |
|---|---|---|---|---|
| 1 | Equity in Decision-Making | ▪ Small-scale and artisanal fishers often excluded from policy dialogues.<br>▪ Lack of institutional representation and political capital.<br>▪ Top-down decisions ignore fishers' knowledge and needs. | ▪ Establish participatory governance frameworks.<br>▪ Create fisheries-specific impact assessments.<br>▪ Develop community liaison and co-decision programs. | ▪ Ensures fisher knowledge informs policies.<br>▪ Builds trust and legitimacy of decisions.<br>▪ Reduces conflict over resource allocation. |

| | | | | |
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| 2 | Compensation and Adaptive Livelihoods | ▪ Displacement of fishing grounds by offshore wind/solar projects<br>.▪ Ecosystem disturbance reduces catches and access.<br>▪ Compensation often reactive and insufficient. | ▪ Design fair and timely compensation schemes.<br>▪ Develop retraining/reskilling programs for alternative livelihoods.<br>▪ Co-design adaptive strategies with local actors. | ▪ Prevents loss of income and cultural identity.<br>▪ Supports long-term resilience of fishing households.<br>▪ Promotes diversification beyond fisheries. |
| 3 | Gender and Social Class Dimensions | ▪ Women play critical roles in post-harvest and markets but are excluded from schemes.<br>▪ Marginalized groups (low-income households) lack networks and resources.<br>▪ Energy transition risks deepening existing inequalities. | ▪ Embed gender-sensitive and intersectional policies.<br>▪ Ensure equal access to training, credit, and information.<br>▪ Highlight women leaders and role models in fisheries and energy. | ▪ Reduces gendered and class-based inequalities.<br>▪ Strengthens social cohesion in fishing communities.<br>▪ Enhances inclusivity and justice in transitions. |
| 4 | Institutional Coherence and Cross-Sectoral Integration | ▪ Fragmented mandates between energy, environment, and fisheries agencies.<br>▪ Conflicting regulations create policy gaps.<br>▪ Lack of coordinated ocean-use planning. | ▪ Develop integrated governance models.<br>▪ Strengthen marine spatial planning with energy – fisheries participation.<br>▪ Foster cross-sectoral collaboration and data sharing. | ▪ Reduces conflicts over ocean space.<br>▪ Aligns ecological and economic priorities.<br>▪ Protects fisheries within broader energy transitions. |

Equity in renewable energy transitions requires inclusive governance, livelihood security, gender sensitivity, and institutional coherence. Without these, fisheries communities, particularly the most vulnerable will bear disproportionate burdens of the transition

## 7.0 Towards a Just and Inclusive Transition

The global shift toward renewable energy must not only be low-carbon but also equitable, inclusive, and sensitive to the social-ecological systems it transforms. For fishing communities especially those already facing environmental pressures, economic marginalization, and regulatory exclusion the renewable energy transition presents both risks and opportunities. A truly just transition in this context demands rethinking governance structures, redistributing power and resources, and repairing historical injustices while enabling ecological regeneration and socio-economic resilience.

A just and inclusive transition (Table 3) is guided by a set of interlinked justice principles that move beyond tokenistic inclusion and toward transformative change.

Table 3: A Just and Inclusive Transition in Renewable Energy and Fisheries

| Domain | Dimension | Key Issues | Required Actions / Strategies | Implications for Fisheries & Communities |
|---|---|---|---|---|
| Principles of Just Transition | Procedural Justice | Fishers, women, and Indigenous groups often excluded from decisions. | Transparent, participatory governance. | Greater trust in energy projects. |
| | | Top-down governance undermines trust. | Culturally appropriate consultations. | Legitimacy of decisions improved. |
| | | Local knowledge undervalued. | Mechanisms for marginalized voices to shape outcomes. | Integration of traditional ecological knowledge in planning. |
| | Distributive Justice | Offshore wind/solar projects displace fishing grounds. | Fair compensation schemes. | More equitable sharing of transition benefits. |

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| | Economic losses borne by fishers with few benefits. | Reinvestment in affected communities. | Reduced economic marginalization of fishing households. |
| | Unequal access to energy, jobs, or revenues. | Revenue-sharing and benefit redistribution models. | Long-term resilience of fishing-dependent economies. |
| Restorative Justice | Historical marginalization of small-scale fishers. | Habitat restoration and ecosystem repair programs. | Strengthened ecosystems and fisheries productivity. |
| | Environmental degradation from industrial fleets, pollution, and past policies. | Protection of customary fishing rights. | Cultural rights and livelihoods protected. |
| | Exclusion from development benefits. | Social redress policies targeting vulnerable groups. | Repair of historical inequalities. |

7.1 Policy Recommendations for a Just and Inclusive Transition

A just and ecologically sound energy transition demands proactive, coordinated policy interventions that recognize the complex interplay between fisheries, renewable energy development, and marine ecosystems. The following recommen:dations aim to enhance governance, reduce conflict, and promote co-benefits between offshore wind farms (OWFs) and fishing communities. To ensure that the renewable energy transition aligns with these principles of justice, the following policy recommendations are critical:

a) Integrate Fisheries into National Renewable Energy Planning

Fisheries must be recognized as a critical stakeholder group within national and regional renewable energy strategies. This entails mapping fishing grounds alongside energy zoning processes, incorporating seasonal migratory patterns of commercially important species, and formally involving fisheries institutions in governance structures for offshore energy development. Such integration reduces the risk of spatial conflicts and safeguards food security while supporting energy transition goals (Andrews *et al.*, 2021).

b) Strengthen Marine Spatial Planning and Stakeholder Dialogue

Marine Spatial Planning (MSP) should adopt a participatory, transparent, and inclusive framework. Effective MSP requires cross-sectoral platforms that bring together fishers, energy developers, regulators, scientists, and local governments to co-design ocean-use strategies. Participatory MSP not only mediates conflicts but also ensures equitable representation of marginalized fisheries communities, enhancing both governance legitimacy and ecological outcomes (House, Kleiber, Steenbergen & Stacey, 2022).

c) Invest in Adaptive Livelihoods for Fishing Communities

The displacement of fishing grounds and ecological shifts caused by renewable energy projects necessitate investment in adaptive livelihood strategies. Governments and development partners should prioritize diversified and resilient income streams through skills training, aquaculture promotion, microfinance schemes, and fisheries value-chain strengthening. Co-designing these programs with fishing communities ensures contextual relevance and cultural acceptance while promoting long-term resilience (Engle & van Senten, 2022).

d) Use Environmental Impact Assessments (EIAs) that Include Social and Economic Metrics

Environmental Impact Assessments must move beyond traditional biophysical indicators to integrate socio-economic and cultural dimensions. Incorporating Social Impact Assessments (SIAs) into project evaluations enables the analysis of impacts on income security, cultural heritage, food access, and community cohesion. Inclusive EIAs, when developed with local participation, strengthen transparency and provide a more holistic understanding of renewable energy impacts (Aziza, Uzougbo & Ugwu, 2023).

d) Promote Co-management Frameworks that Include Fishers in Governance
Decentralized co-management frameworks provide an equitable governance model by empowering fishers to jointly manage marine resources with government agencies and energy developers. Such frameworks enhance compliance, improve local stewardship, and establish conflict resolution mechanisms, particularly in coastal zones where energy and fisheries interests intersect. Co-management also fosters mutual learning and knowledge exchange, ensuring that ecological and social priorities remain central to renewable energy transitions (O'Donnell, Collier, Pineda-Pinto, Cooper, Nulty & Castañeda, 2025).

Table 4 shows some of the enormous benefits and goals of recommended policies to the of Fisheries sector.

Table 4: Fisheries Policy and their Benefits

| S/N | Recommendation | Goal | Benefit to Fisheries |
|---|---|---|---|
| 1 | Embed Fisheries in Auctions & MSP | Inclusive spatial planning | Reduced displacement, early conflict mitigation |
| 2 | Guarantee Compensation | Economic justice | Revenue stability, fairness |

| S/N | Recommendation | Goal | Benefit to Fisheries |
|---|---|---|---|
| 3 | Standardize Mitigation | Predictable developer obligations | Transparency, reduced litigation |
| 4 | Post-Construction Monitoring | Adaptive governance | Ecosystem insights, fisher trust |
| 5 | Co-location Models | Multi-use compatibility | Access retention, new income streams |
| 6 | Institutionalized Co-Governance | Democratic decision-making | Shared power, increased legitimacy |

## 8.0 Political Economy Drivers & Constraints

The political economy of renewable energy transitions is characterized by a tension between rapid infrastructure development and inclusive, equitable governance. While national and regional governments have set ambitious renewable energy targets to meet climate commitments and spur economic growth, these ambitions often outpace the inclusion of affected stakeholders particularly small-scale fishers and coastal communities. This disconnect can lead to social conflicts, spatial competition, and uneven distribution of costs and benefits. Table 5 shows the political economy's drivers, constraints and challenges as it relates to renewable energy transition and fisheries.

Table 5: Political Economy of Renewable Energy Transitions and Fisheries

| S/N | Dimension | Drivers (Enablers of Transition) | Barriers (Structural Constraints) | Challenges (Practical Issues in Fisheries Contexts) |
|---|---|---|---|---|
| 1 | Policy & Governance | ▪ National climate targets & SDG commitments.<br>▪ Marine Spatial Planning (MSP) frameworks.<br>▪ Participatory governance models. | ▪ Weak institutional coordination.<br>▪ Fragmented mandates across sectors.<br>▪ Policy incoherence (energy vs. fisheries). | ▪ MSP often excludes small-scale fisheries (symbolic inclusion).<br>▪ Local mistrust of top-down decisions.<br>▪ Conflicts over zoning of fishing grounds vs. wind farms. |
| 2 | Economic & Financial | ▪ Competitive auctions ensuring investor certainty.<br>▪ Climate finance (e.g., Green Climate Fund). | ▪ Unequal access to finance for Global South fisheries. | ▪ Fishers marginalized in compensation schemes.<br>▪ Reactive (not preventive) conflict resolution. |

| | | | | |
|---|---|---|---|---|
| | | ▪ Renewable subsidies & incentives. | ▪ Competition for funding between energy & fisheries sectors.<br>▪ Investor-first frameworks. | ▪ Unequal sharing of economic benefits from projects. |
| 3 | Technology & Infrastructure | ▪ Offshore wind, floating solar, wave energy innovations.<br>▪ AI/IoT for marine monitoring.<br>▪ Potential artificial reef effects from turbines. | ▪ High capital costs.<br>▪ Limited access to advanced technologies in developing regions.<br>▪ Ecological uncertainties (e.g., turbine impacts on spawning). | ▪ Ecological disruptions to fish migration & spawning.<br>▪ Displacement of artisanal fishing grounds.<br>▪ Dependence on foreign technology providers. |
| 4 | Social & Community Dynamics | ▪ Strong fisher cooperatives & advocacy.<br>▪ Civil society pressure for equity.<br>▪ Gender equity initiatives in agri-tech/fisheries. | ▪ Power asymmetries between developers & local communities.<br>▪ Gender & class inequalities.<br>▪ Lack of long-term engagement frameworks. | ▪ Fisher protests in Philippines & U.S. offshore wind corridors.<br>▪ Limited access for women/youth to decision-making.<br>▪ Distrust from inadequate consultation histories. |
| 5 | Environmental & Climate Factors | ▪ Potential to cut GHG emissions.<br>▪ Co-benefits (habitat creation via artificial reefs).<br>▪ Integration into ecosystem-based management. | ▪ Overlapping stressors: overfishing, pollution, climate variability.<br>▪ Weak cumulative impact assessment tools.<br>▪ Path dependency in energy-first planning. | ▪ Water quality & sediment changes affecting stocks (e.g., Mekong dams).<br>▪ Compressed timelines preventing adequate environmental review.<br>▪ Reduced resilience of fisheries to climate shocks. |

Political economy dynamics determine who wins, who loses, and who decides in renewable energy transitions. Fisheries, often marginalized in energy planning require policy coherence, equitable financing, inclusive governance, and ecological safeguards to avoid being unintended casualties of the clean energy shift.

## 9.0 Synthesis: Winners, Losers, and Trade-Offs

The expansion of offshore wind farms (OWFs) illustrates the complex social-ecological trade-offs inherent in the renewable energy transition. While these projects contribute to decarbonization goals and can stimulate green economic growth, they also transform marine spaces, displacing traditional ocean users and altering ecosystem dynamics. The outcomes of

OWF development are not uniformly distributed, there are clear winners, losers, and a wide range of context-specific trade-offs.

a) Winners: Habitat Enhancement and Economic Opportunities

In some contexts, OWFs have produced positive ecological and economic effects for fisheries. The physical structures of turbines and associated exclusion zones can function as artificial reefs, foster biodiversity and enhancing fish biomass (Moustaka *et al*., 2024; Degraer *et al*., 2020). This habitat creation may benefit certain demersal and reef-associated species, potentially improving catches for adjacent fisheries over time. In regions with effective spatial planning and stakeholder engagement, OWFs have also generated alternative livelihoods through vessel charters, monitoring contracts, and collaborative research with local fishers (Uffman-Kirsch *et al*., 2020).

b) Losers: Displacement and Cultural Erosion

Conversely, mobile gear fisheries particularly those using trawlers or longlines often face displacement due to OWF construction and safety exclusion zones. This can result in increased travel distances, higher fuel costs, spatial crowding in adjacent fishing grounds, and reduced catches (Liu, 2025). For small-scale and artisanal fishers, the disruption is not merely economic but also cultural, as traditional fishing patterns, local knowledge systems, and community identity are closely tied to marine access. These groups frequently lack the institutional leverage to negotiate favorable outcomes, making them more vulnerable to uncompensated losses.

c) Trade-offs: Mediated by Governance and Inclusion

The distribution of these impacts is largely mediated by governance quality, particularly in terms of early stakeholder engagement, adaptive spatial planning, and institutional responsiveness (Figure 3). Case studies from Belgium, the Netherlands, and the United Kingdom show that when fishers are engaged from the outset through co-design workshops, participatory mapping, and compensation schemes conflict is reduced and co-benefits are more attainable (Rezaei *et al*., 2024; Liu, 2025).

In contrast, rigid governance systems with top-down decision-making, inflexible spatial allocations, and delayed or insufficient compensation tend to exacerbate tensions. This is evident in some U.S. offshore wind projects where compressed timelines and limited fisher agency have led to legal disputes and eroded trust (Liu, 2025).

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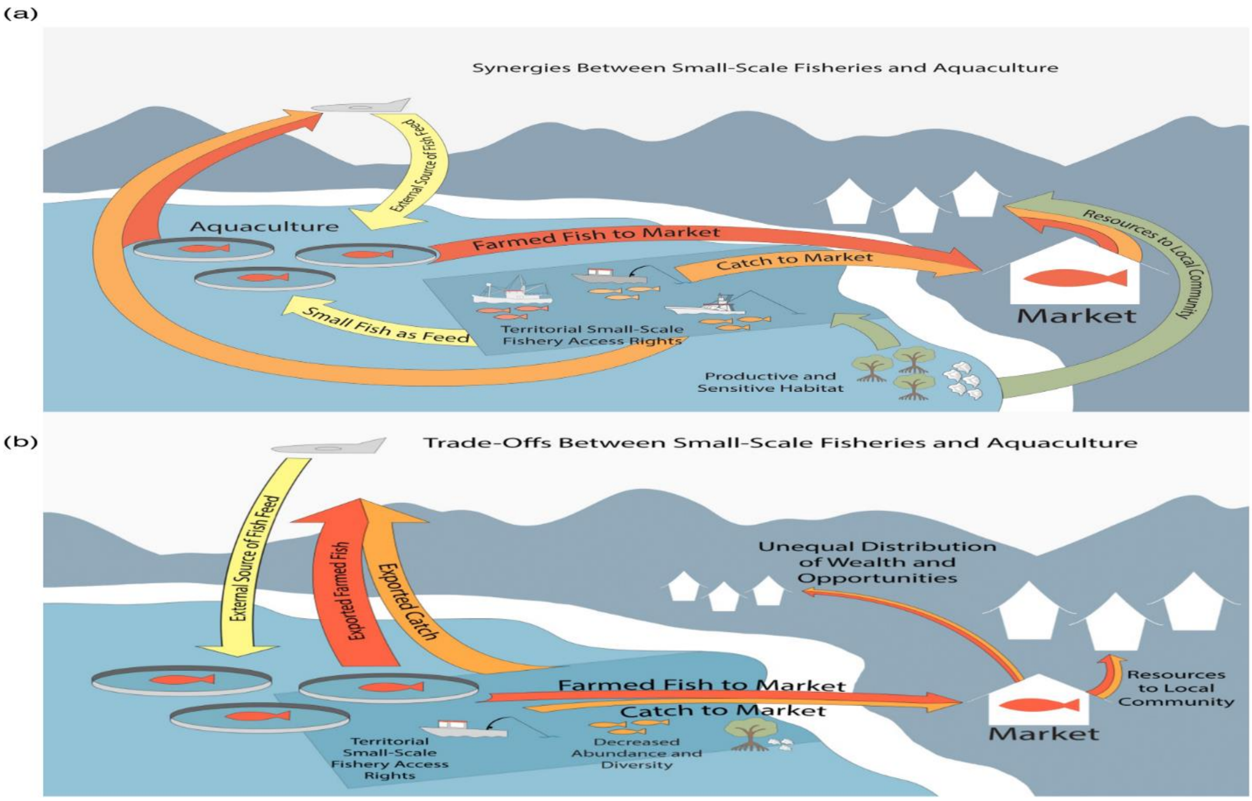


Figure 3: Hypothesized conditions leading to synergies or trade-offs between small-scale fisheries and aquaculture.
Source: Mansfield, Micheli, Fujita, Fulton, Gelcich, Battista, Bustamante, Cao, Daniels, Finkbeiner, Gaines, Peckham, Roche, Ruckelshaus, Salomon, Sumaila, White & Naylor, 2024)

d) Toward Balanced Outcomes

Recognizing that trade-offs are inevitable, the goal should not be to eliminate them entirely but to manage them transparently and equitably. Adaptive marine spatial planning, co-management institutions, and distributive justice mechanisms (e.g., livelihood transition funds, long-term ecological monitoring) can help realign project benefits toward a broader set of stakeholders. Ultimately, the political economy of OWFs must evolve from a developer-centered model to a multi-stakeholder framework that values ecological health, social equity, and long-term resilience.

10.0 Conclusion: Advancing a Just and Inclusive Renewable Energy Transition

The global shift toward renewable energy is an essential response to the climate crisis, offering a pathway to decarbonization, energy security, and long-term sustainability. Yet, as this transition accelerates, it also reveals and reshapes the political and economic fault lines embedded in marine governance. Nowhere is this more evident than in the intersection between offshore renewable energy development and fisheries sectors that share marine space but often diverge in terms of power, visibility, and institutional support.

Fisheries, particularly small-scale and artisanal operations, are highly vulnerable to exclusion, displacement, and ecological change brought about by poorly integrated energy infrastructure. Without deliberate efforts to address these vulnerabilities, the energy transition risks entrenching existing inequalities undermining the food security, cultural heritage, and economic stability of coastal communities. At the same time, fishing communities possess deep ecological knowledge, adaptive practices, and a vested interest in marine stewardship, making them indispensable partners in building sustainable blue economies.

This chapter argues for a holistic, justice-centered approach to the energy transition one that actively incorporates the rights, voices, and livelihoods of fishers into every stage of renewable energy planning and deployment. Lessons from Europe, the United States, Japan, and Norway demonstrate that when governance is inclusive, science-informed, and responsive to local contexts, both ecological and social outcomes improve. Participatory marine spatial planning, co-governance institutions, equitable compensation mechanisms, and adaptive management frameworks are not ancillary they are foundational to a just transition.

Ultimately, achieving climate resilience must not come at the cost of marine biodiversity, food sovereignty, or social equity. Instead, energy policy must be reframed to support synergies between climate action and coastal livelihoods. If implemented equitably, the renewable energy transition can be a vehicle not only for reducing emissions but also for strengthening coastal resilience, restoring ecosystems, and empowering historically marginalized communities. By centering justice and inclusion, we can ensure that the benefits of a decarbonized future are widely shared securing both planetary and human well-being.

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