



Developmental netzeroism

Kuei-Tien Chou

Risk Society and Policy Research Center, National Taiwan University, Taiwan

ARTICLE INFO

Keywords:

Developmental environmentalism
Path dependency
Net zero emissions transition

ABSTRACT

This research examines the persistent constraints faced by Taiwan's government in its departure from a high carbon economic pathway, resulting in a climate governance lag, despite robust international climate regulations, decarbonization value drivers, a global market, and civil society influences. This research in the study investigates Taiwan's national carbon reduction targets across various stages of climate proposals (1998, 2005, 2010, 2015, and 2022), focusing on symbolic formalism rather than genuine efforts to curb carbon emissions. Additionally, this research contends that green energy policies linked with carbon reduction targets have evolved into primary objectives competing for the forthcoming wave of technological industries. Consequently, national carbon reduction strategies have succumbed to the logic of economic competition rather than tangible carbon reduction initiatives; namely, they portray the typical approach of East Asian developmental environmentalism. Owing to geopolitical and economic competition, the Taiwanese government did not declare net zero carbon emissions until April 2021, later than South Korea, China, and Japan. Furthermore, the government presented only a vague 2050 net zero roadmap, limited carbon fee, and scaled back 2030 carbon reduction objectives. When combined with nontransparent energy reviews for new investment in Taiwan, a conservative Climate Change Act, and limited civil society participation, these factors demonstrate the continuing influence of the government's authoritarian, centralized, and bureaucratic policy-making model. This research coins the term "developmental netzeroism" to describe the transformational thresholds and structural impediments that a society characterized by a high carbon emissions regime encounters, resulting in transitional delays and governance deficiencies that necessitate bold breakthroughs.

1. Introduction

Events such as the 2015 Paris Agreement at the United Nations Climate Change Conference (COP21) that declared the end of the fossil fuel era [1], the Intergovernmental Panel on Climate Change (IPCC) experts' advocacy of "deep decarbonization" in 2018 [2], COP26, wherein the United Nations (UN) proclaimed "2050 Net Zero Emissions" in 2021 [3], and COP27 that focused on climate compensation [4] indicate a great transformation across the world. Amid this wave of net zero transition, what are the challenges faced by the newly industrialized countries that emerged in the late 1980s, especially Taiwan, an entity of developmental state in East Asia, in reaching these goals?

According to this research, developmental states in East Asia have proposed countermeasures in the face of international climate governance pressures to comply with the global trend toward low carbon development. For example, Japan introduced carbon tax in 2012 [5], and South Korea launched carbon trading in 2015 [6]. Meanwhile, Taiwan, which lacks membership in the UN and is a non-state actor of

the Paris Agreement, announced its "intended nationally determined contribution" (INDC) to the world before the 2015 Paris Agreement [7]. These developmental states, embedded in the manufacturing sector of the global supply chain, with energy intensive, high carbon-based manufacturing at their core, are an essential component of the global division of labor. These achievements have been hailed as the miracle of East Asian developmental states [8]. Nonetheless, the following questions remain: what are the mindsets, strategies, and policy orientations of the social transformations in high-carbon manufacturing-based countries, and what are the bottlenecks?

This research investigates how structural conditions and constraints shape climate governance, focusing on Taiwan as a case study. It reflects Taiwan's response to stricter global carbon reduction standards and the need for net zero carbon emissions by 2050. The research examines Taiwan's climate policy, encompassing national climate and energy conferences, domestic carbon reduction targets, green energy industry plans, regional market competition strategies, and the role of participatory communication in policy-making. This analysis aims to elucidate

E-mail address: ktchou@ntu.edu.tw.

<https://doi.org/10.1016/j.rser.2024.114319>

Received 17 April 2023; Received in revised form 6 February 2024; Accepted 6 February 2024

Available online 4 April 2024

1364-0321/© 2024 Published by Elsevier Ltd.

the Taiwanese government's operational logic and the challenges it is encountering, especially in the context of developmentalism, international carbon reduction pressures, industrial competition, and citizen participation.

2. Literature review

Previous studies have indicated that, despite global climate governance pressures, developmental states would still prioritize economic development while promoting green industries to compete in low carbon technology. Carbon reduction is not their primary concern; restraining carbon emissions is considered a secondary, trivial goal. Scholars have conducted varied analyses of Singapore, South Korea, Japan, China, and even Taiwan in terms of carbon-pricing mechanisms, political and economic lobbying, and economic leadership [9–12], “new developmentalism” under global climate politics [13,14], “environmental developmentalism” that ignores environmental and social well-being in green growth strategies [15], and “neoliberal developmentalism” [16–18]. Other studies have found that some countries claim to be engaged in carbon reduction, while, in reality, they continue to be focused on triggering competition in the green industry rather than engaging in climate governance or “developmental environmentalism” [19].

Recent research has demonstrated that South Korea and Taiwan are following the bureaucratic, elite decision-making regarding fiscal and industrial policies, proposing transformation and certain growth strategies, suggesting a robust development-oriented mindset [20]. These countries have adopted different approaches from traditional regulatory states, forcing transformation through regulations that penalize high carbon emission industries. At the same time, they leverage subsidies, tax breaks, and feed-in tariff schemes as incentives to promote green energy industries and create economic benefits. The governments encourage polluting industries to invest in green technologies while creating an environment that supports climate regulation [21], designating green technology as an internationally competitive next-generation industry [22]. This mechanism involves two aspects: creation, designed to guide green industries' establishment and development, and destruction, encouraging investments in transforming high carbon industries and deconstructing their structure [23]. For example, this dual track can be seen in encouraging fossil fuel companies to invest in wind power [24] or motivating Hyundai to invest in hydrogen vehicles [23]. Broadly speaking, these analyses support the argument of developmental environmentalism [21,24,25].

Notably, developmental environmentalism has been associated with geopolitics and geoeconomics; moreover, promoting green industries is not only the object of next-generation industrial competition but is also interrelated with geopolitical and geoeconomic competition [25,26]. Thurbon et al. [23] found that the South Korean government's initial promotion of hydrogen and hydrogen vehicles between 1988 and 2015 was unrelated to environmental concerns. Instead, it stemmed from the country's long-standing developmental strategy of pursuing “frontier technology” to maintain economic competitiveness. While the government vigorously developed fossil fuel industries in the 1980s, whether its dependence on fossil fuel energy imports would present an energy security issue became a domestic concern. Additionally, China's rising auto industry forced the South Korean government to start a hydrogen vehicle program to ensure the competitiveness of its auto industry.

These arguments support developmental environmentalism. First, the government's investment in green industries under the national development strategy to draw even with international competition, which is not directly related to environmental concerns, is emphasized. Second, transitioning to green industries allows the government to avoid imposing direct regulation or pressure on high carbon emission industries as a way to reduce carbon emissions; additionally, these sectors are directed to invest in green technology, which not only creates new industries but also undermines the structure of energy intensive

industries. Third, these development strategies pertain to geoeconomic competition to an extent.

These discussions are largely centered on creating structural opportunities for transformation. However, the developmental environmentalism vision still requires attention to the relationship between state, business, and society—the three subjects of concern for developmental states [26–32]. Moreover, authoritarian policy-making should be considered primarily in some cases of Asia or East Asia. Scholars have researched authoritarianism and civil society in Asian countries [33]. Kalinowski's [22] study on South Korea's promotion of the green industry suggests that strong corporatist interests between the state and business and a weak civil society characterize the country. Dent [13] analyzes Japan's economic and industrial policies regarding renewable energy—the New Growth Strategy—highlighting the new developmentalism style of its bureaucracy. Trencher et al. [34,35] explain that the Japanese government and industry claim the technical advancement of new coal-fired power to facilitate carbon emission reductions, thus, maintaining the legitimacy of national thermal power generation. Mathews et al. [24] analyze how Japan, China, South Korea, and Taiwan foster offshore wind power expansion by leveraging government policies, industrial strategies, and market forces, demonstrating a commitment to developmental environmentalism.

Beeson [36] discusses how East and Southeast Asian governments, especially China, prioritize economic growth and industrial competition over environmental protection, known as authoritarian environmentalism. Gilly [37] examines how China, a leading carbon dioxide emitter, uses top-down environmental policies and regulatory controls to reduce its carbon intensity under pressures from the global climate convention. Lo [38] and Shen and Jiang [39] criticize China's environmental authoritarianism, observing that the central government's coercive regulatory actions necessitate party rule to effectively enforce compliance by local governments and enterprises with central government policies. However, this has partially weakened legal enforcement or the inability to effectively achieve environmental governance collaboration between the central and local governments, resulting in a split phenomenon.

Teo and Amir's [40] study of Singapore's climate politics highlights the relationship between its authoritative regime and weak civil society in climate subpolitics. Furthermore, studies by Dent [13], Han [41], Kim [19], and Chou [42] of South Korea and Taiwan show that, although these states have active civil societies after democratization, non-governmental organizations (NGOs) are excluded or marginalized in important decisions on matters relating to climate or low carbon policies. Similar to the above findings, Kim and Thurbon [19] highlight the bureaucratic recentralization characteristic of the decision-making process for green transition in Korea. David and Chou's [43] study of Taiwan's Environmental Protection Administration in 2018 found that, in promoting green transformation and air pollution control, the government lacked communication with grassroots stakeholders, leading to the cancellation of these regulations after intense protests by diesel truck drivers, akin to Taiwan's version of the yellow vest movement.

Several other factors must not be overlooked. First, in addition to considering geoeconomics, East Asian countries are, in fact, the most important players in the global supply chain, carrying energy intensive, high carbon, manufacturing roles. Second, as export-oriented economic entities in the global supply chain, they must suppress the prices of production (low electricity prices, low water prices, and low labor costs) to maintain competitiveness within the East Asian geoeconomics sphere. Third, such an environment has long been shaped as brown growth [19] or a brown economy [42,44]. Fourth, the government, industry, and society are steering toward a high carbon path, caught in a cognitive, institutional, and techno-institutional complex [44]. Fifth, these portfolios create a peculiar relationship between the state and civil society, characterized by recentralized, authoritarian, bureaucratic policy-making and an ambivalent civil society. In Taiwan, the key drivers of climate governance and energy transition in the past decade

include environmental movements against the eighth Petrochemical Project [42], nuclear phase-out advocacy after the Fukushima disaster [45], anti-air-pollution groups [46], and renewable energy promotion alliances [47]. Despite their robust capacities, civil society is currently not effectively monitoring net zero carbon policies and climate legislation due to the lack of specific events or manufacturing sites to trigger political mobilization [48]. Thus, the global supply chain, competition, and policy-making are geared toward the negative side of the development mindset, forcing East Asian countries into a dilemma and challenges in the transition to climate governance.

Finally, the study aims to enlarge our view on developmental environmentalism. On the one hand, East Asian governments guide green industries to generate structural opportunities, wherein a developmental mindset is considered positive and creative. On the other word, the study cannot be overly optimistic that the transition from brown to green growth in these countries will be smooth. Correspondingly, the study examines the barriers to the transformation that occur under long-term carbon lock-in and the dilemma and challenges Taiwan faces as a high carbon emitting country in East Asia under global pressure to move toward net zero carbon emissions.

3. Analytical framework

This research has designed an analysis framework. In Fig. 1, the left side shows that Taiwan has been grappling with international carbon reduction and domestic energy transition pressures in recent years. These challenges have triggered four transition-driven powers: first, international climate regulation-driven powers, i.e., the Paris Agreement, carbon border adjustment mechanism (CBAM), and the 2050 Net Zero claim; second, decarbonization driven power, i.e., deep and rapid decarbonization due to extreme climate disasters; third, society-driven power, i.e., for energy transition by strong social alliances; and fourth, market-driven power, i.e., vigorous global green technological competition and the green global supply chain (RE100 claim). The entanglement of these powers contributes to constructing and hybridizing the government, industry, and society by either slowing or rejecting the transformation or, alternatively, promoting and stimulating transformation.

In the context of these four transition-driven powers, this research observes the roles of the state and industrial policy and civil society's

oversight of climate governance. Additionally, this research in the study investigates how the state's developmental mindset influences the overall national net zero climate transition. This research explores the role of the state in this transition. First, how will such a hybrid of a recentralized bureaucracy and a high carbon regime correspond to international climate reduction requirements? Second, how will its green energy policies respond to the international climate convention at different stages? Third, how will its carbon-pricing strategy sustain its (high carbon) manufacturing competitiveness, and what conflicts will it face? Fourth, how can it be paired with energy transition to meet the greening requirements of the international division of labor and grow geoeconomic competitiveness in green technology? Fifth, considering the relationship between the state and civil society, what problems have the weak participation of civil society in these transformational decisions caused? By examining these issues, this research considers the implications for expanding from a developmental environmentalism to a developmental netzeroism structure—reinterpreting the proposition of the developmental state in the context of the global transition to net zero emissions.

4. Method

4.1. Identification of developmental netzeroism

This research defines developmental netzeroism by reviewing the Taiwanese government's introduction of carbon-reduction and net zero policies and governance strategies at different stages under the transition-driven powers, including the relationship between the state and civil society. Through policies, regulations, and green-industry initiatives, this research explores the structural constraints and delays in transitioning toward net zero carbon emission of a reinforced carbon lock-in society [44].

4.2. Data collection

Fieldwork and data collection took place from May 2020 to October 2022. Five focus groups with 29 participants from governmental agencies (Environmental Protection Agency (EPA), National Energy Administration, Industrial Development Bureau, and National Development Council), industry (petrochemical, iron, and steel industry, and

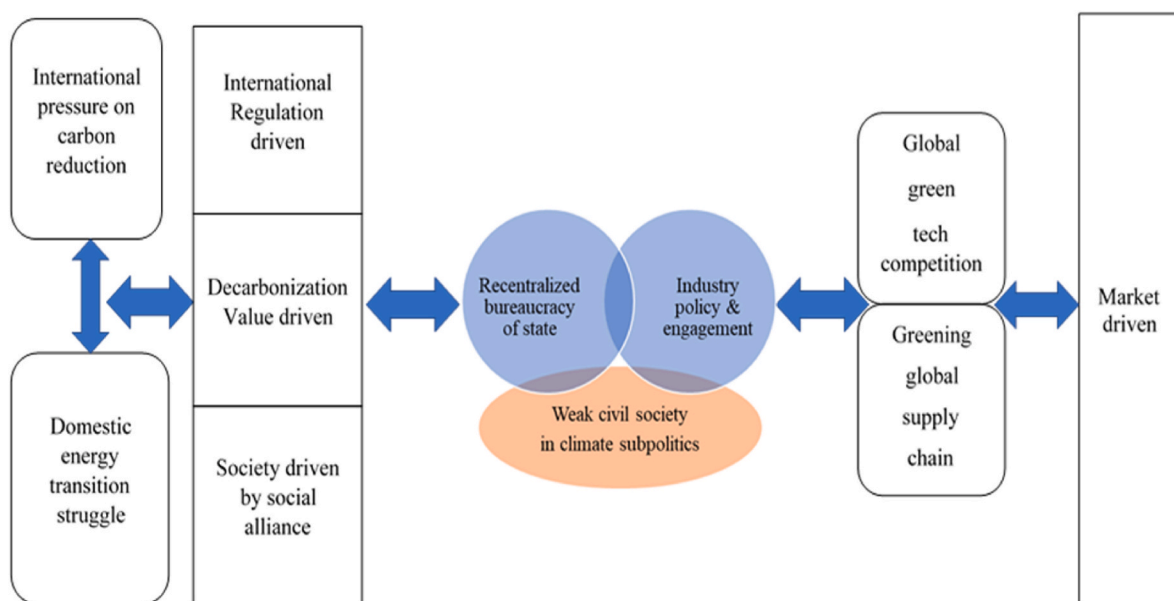


Fig. 1. Developmental environmentalism (netzeroism) in Taiwan.
Source: made by author.

the Chinese National Federation of Industries), academic scholars, parliament members), and NGOs were created. In total, 32 semi structured interviews with respondents were conducted. Focus groups and interview outlines were sent to the respondents in advance. During the sessions, in-depth questions were asked regarding net zero policy, response to carbon fees, decision-making models, and citizen communication. All interviews were recorded and transcribed. This research in the study participated in more than 18 net zero carbon emissions and carbon tax symposiums, including poll analysis, risk society forums, seminars, the Office of Energy and Carbon Reduction meetings, and EPA public hearings.

The secondary data include official documents from enterprises, the Chinese National Federation of Industries (e.g., annual reports and company press releases), and gray literature (e.g., media articles, policy documents, research reports, and presentation materials) from third parties, such as think tanks, government agencies, and NGOs.

5. Developmental netzeroism

5.1. Failed carbon reduction targets from 1998 to 2015

In response to the international climate conferences, which started with the 1997 Kyoto Protocol, the Taiwanese government formulated proposals in 1998, 2008, 2010, 2015, and 2022 that defined national carbon-reduction targets. Although Taiwan is not a UN member, it closely follows international conventions on carbon reduction to keep up with international climate norms and ensure its competitiveness in the international labor division are summarized in Fig. 2.

The 1998 proposal is the resolution of the first National Energy Conference that established a benchmark for reducing CO₂ emissions to the 2000 level by 2020. The 2008 proposal was formulated within that year's Sustainable Energy Policy Framework, whereby the CO₂ emission target was to return to the level of 2008 between 2016 and 2020, to the level of 2005 in 2020, and to 214 million metric tons, the level of 2000, by 2025. The 2010 proposal, a resolution of the 2009 National Energy Conference that was confirmed by the 2010 Cabinet Energy Conservation and Carbon Reduction Promotion Council, has the same carbon-reduction target as the 2008 proposal. The 2015 proposal is the INDC announced by the Taiwan government to all countries in the world before COP21 in September 2015; the proposal aims to reach 80% of the 2005 baseline of CO₂ emissions of 269 million metric tons by 2030, and further reduce them by 50% of the baseline, to 134 million metric tons, by 2050.

In reviewing the failure of implementing these carbon reduction proposals, Chou [42,49] criticizes them for being formalistic. While the

government proposed various carbon reduction agendas, it failed to provide concrete implementation plans. Furthermore, during this period, the government continued to propose energy intensive industrial policies, particularly the petrochemical and steel-based Binan Development Project in the late 1990s and the eighth Petrochemical Project in 2010. It is difficult for a regime with high carbon emissions to transform into having a low carbon footprint, as required by international standards. Through low electricity prices and fossil fuel subsidies, Taiwan has developed a brown economic package that has not only created a rent-seeking model, forming a tricky path of dependence, but has also shaped a carbon lock-in effect, where economic and social development is achieved at the expense of the environment and social equity, seriously hindering Taiwan's low carbon transition [44]. Moreover, this endogenous model has become embedded in the system's mentality, making it difficult to change.

Such a developmental mindset substantially hinders governments from implementing carbon reduction policies and causes systemic delays in climate governance. Schweizer [50] argues that systemic risks occur when there is a lag in regulation and perception of climate governance in a society's transition process. In Taiwan's case, the lag in climate governance occurred at many moments when essential policies were being promoted. For example, in June 2012, the National Development Council announced the Climate Change Response Policy Framework, formulating an implementation-focused Response Action Plan (2013–2017), but the Cabinet waited until May 22, 2014, to approve the announcement. Similarly, the National Climate Change Response Action Plan (2018–2022), which had already been prepared, was not released by the Cabinet until September 9, 2019. Moreover, the Greenhouse Gas Emission Control Action Plan of Central Ministries (2018–2020) prepared by the EPA in 2016, was announced by the Cabinet on October 3, 2018, and the Greenhouse Gas Control Action Plan (2018–2020), which was to be implemented at the local level, was delayed and promulgated by the Cabinet in May 2019. While the Bureau of Energy drafted a White Paper on Energy Transition at the end of 2018, inviting many citizens to participate, the Cabinet did not approve its publication until the end of 2020. These episodes indicate that previous administrative cabinets overlooked climate issues, which were not prioritized for governance. Despite some public policy involvement by civil society groups, they were categorically not involved in core policy decision-making.

As with previous annual carbon reduction agenda proposals, these major climate governance lags indicate that climate policy cannot be made mainstream, and its implementation is completely excluded from the government's priorities. In other words, the developmental mindset is based on the existing brown economy as a meta-thought, resulting in a

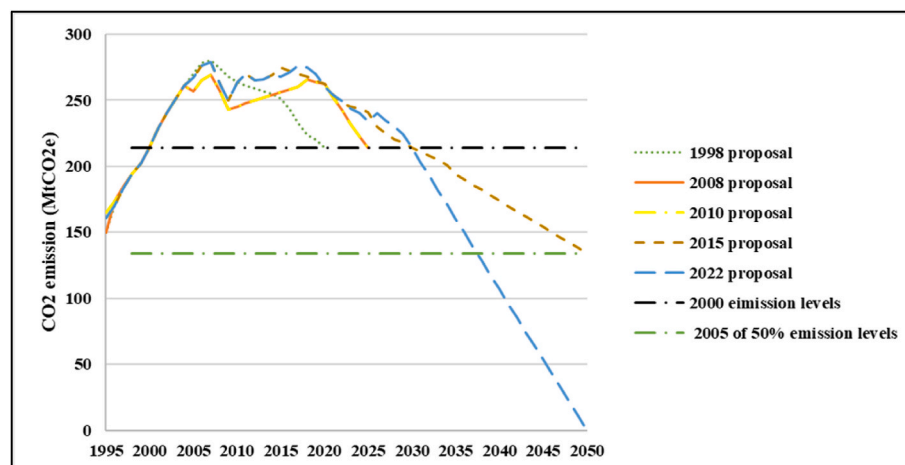


Fig. 2. Emissions baseline for difference in years from 1998 to 2022.

Source: made by author.

formalistic carbon reduction plan and policy agenda. More importantly, reflected in the actual governance and operations of economic development, these proposals have failed to deliver global climate carbon reduction values and cannot be converted into forward-looking operations and mainstream policies for national development. Such a development model may survive in the short term within the global division of labor; however, once robust climate norms and requirements are established, the governance deficit is likely to deepen.

5.2. Industry policy of developmental state

5.2.1. Responding 1998–2008 proposal: Checking low carbon industry

South Korea has been encouraging fossil fuel industries since 1988 and has invested in hydrogen vehicles as “frontier technology”; moreover, President Lee Myung-bak proposed the green growth strategy in 2009 in an effort to lead the world [22–25]. In contrast, the Taiwanese government initially had little ambition. To understand whether green technology is prioritized by industrial development or carbon reduction, this research reviews the policy evolution since the 1st National Energy Conference (1998 proposal) and observes the policies from four dimensions, namely, international regulation-driven, decarbonization value driven, society and market driven, according to different timelines (Table 1).

Considering the National Energy Conference in 1998 (1998 proposal) and 2005, the National Conference on Sustainable Development and Conference on Sustainable Economic Development in 2006, and the Sustainable Energy Policy Framework in 2008 (2008 proposal), despite the 1998 and 2008 proposals establishing the carbon reduction goals, did not formulate any specific promotion targets at the industrial level. In contrast, they merely encouraged high-value-added industries and excluded high carbon and high energy consuming industries such as petrochemicals and steel from new major investment projects. In this period, except for the Kyoto Protocol [12] and the European Union Emissions Trading System (EU ETS), no other international regulatory pressure impacted economic competition, and the value of carbon reduction was only gradually established. Although Taiwan's government has noticed the international trend of carbon reduction, it has only gradually adjusted its industrial planning. Compared with South Korea, where hydrogen vehicles have been promoted in response to geo-economic competition, Taiwan did not face much market-driven green-industry pressure. Regarding society-driven forces, despite Taiwan's two major parties adopting a nuclear free homeland policy by compromise in 2001, this did not lead to rapid renewable energy development by triggering an energy transition [51]. Furthermore, the energy tax bills introduced by parliament members from both major parties in 2006 and 2007 failed because industry and society were locked into a high carbon path [44], which was unsuccessful at driving a green transition.

5.2.2. Responding 2010 proposals: Rising domestic green industries

In 2009, the 3rd National Energy Conference resolved to establish a low-energy consumption and low carbon industrial structure, and the Cabinet officially adopted the Green Energy Industry Sunrise Project in October, the first time Taiwan followed international trends and launched a national target. Subsequently, under the framework of the National Energy Conservation and Carbon Reduction Master Plan, the Cabinet proposed the 2010 proposal carbon reduction program. In terms of the international regulation-driven force, although no significant agreement was reached at the COP15 in Copenhagen owing to the conflict between the two groups led by the US and China, the value of low carbon was more firmly established. Regarding market-driven forces, the energy transition in various countries was gradually accelerating, which triggered Taiwan to launch the green industry. In June 2009, the Taiwanese government passed the Renewable Energy Development Act to respond to the international and domestic market- and society-driven transition.

Table 1

Carbon reduction proposals and industrial policies.

| Year | National Energy Conference/Carbon reduction policy/regulation | Responding to international climate change convention | Industrial Policy |
|------|---|---|--|
| 1998 | 1st National Energy Conferences. | Responding to Kyoto Protocol. 1998 proposal: Reduce CO ₂ emission to the level of 2000 by 2025. | Energy intensive industries to supply domestic demand. |
| 2005 | 2nd National Energy Conferences. | None. | Develop high value-added, low energy-consuming industries and technologies. |
| 2008 | The Target of Sustainable Energy Policy Convention. | 2008 proposal: Reduce CO ₂ emission to the level of 2005 by 2020 (214 MtCO ₂ e). | Adjustment in the direction of high value-added and low energy-consuming industries. |
| 2009 | 3rd National Energy Conferences. Green tax reform Conferences. Renewable Energy Development Act. | None. | Green energy promotion project. |
| 2010 | National Energy Saving and Carbon reduction Plan. National Industrial Development Conference. | 2010 proposal: Reduce CO ₂ emissions to the level of 2005 by 2020. | To scale low carbon practices in the industry. |
| 2012 | Energy Development Framework. | None. | SME counseling program. PV energy project. Wind Turbines project. |
| 2015 | 4th National Energy Conferences. Greenhouse Gas Reduction and Management Act (GGRMA). | Responding to Paris Agreement. Announced INDC. 2015 proposal: Reduce CO ₂ emissions to 50% of 2005 level of 2050. | 4th National Energy Conferences core issues: Energy conservation, increase in power, and low carbon sustainable. |
| 2016 | Nuclear-free homeland policy. | Adjusted the Energy Structure: LNG 50%, Fossil fuel 30% and Renewable energy 20% by 2025. | 5 + 2 Industry Innovation and Green Energy technology promotion plan + Asia-Pacific Green Energy Development Center. |
| 2017 | Revised Guidelines on Energy Development. | Drafted Energy Transition White Paper by BOE at the end 2018. | None. |
| 2020 | Phase II Action Program on GHG Control for Manufacturing Sectors. | Requiring the industrial sector to reduce CO ₂ by at least 0.22% of 2005 levels by 2025. | Six Core Strategic Industry Promotion Programs + Asia-Pacific wind turbines supply chain. |
| 2021 | Revised GGRMA. | President Tsai announced net zero emissions by 2050 on Earth Day 2021. | None. |
| 2022 | Taiwan's 2050 net zero emissions pathway. Manufacturing and Business sector's 2030 net zero emissions pathway. | 2022 proposal: Reduce CO ₂ emissions to the 24% ± 1 levels of 2005 by 2030, responding to the COP26, net zero emissions by 2050. | Initiation 12 Key Strategies for achieving net zero emissions by 2050. |
| 2023 | Passed Climate Change Response Act by renamed GGRMA. Carbon price. | Limited carbon fee instead of carbon tax. Established the Taiwan Carbon Solution Exchange. | None. |

Source: made by author.

In 2010, the Cabinet further revised the Guideline on Energy Development and established policies promoting the growth of the green energy industry. Accordingly, the government released the Million Sunshine Rooftops Project, the Thousand Wind Turbines Project, and the Green Little Giant Coaching Program for small- and medium-sized enterprises in 2012, and the last project was further upgraded to the Green Energy Industry Advancement Plan in 2014. These initiatives focused on four industries—photovoltaic, wind power, LED light, energy information, and communication technology—all of which support industries or are part of the supply chain and, thus, are not sufficiently ambitious to lead the global green energy industry. These promotion policies have three implications: first, international carbon reduction and energy transition drive international norms and value formation and are mutually influential; second, the international green technology industry has formed a market-driven power, compelling Taiwan to join quickly; third, Taiwan's energy transition requires acceleration, especially with adopting the Renewable Energy Development Act in 2009. In other words, international regulations, low carbon value, the international market, and society-driven power have merged, compelling Taiwan to advance to the next stage of the low carbon transition.

Nevertheless, those green energy technology policy enhancements have not, in fact, resulted in a substantial carbon reduction. Although Taiwan's government launched the eighth Petrochemical Project in 2010, an energy intensive industry plan, the project failed due to resistance from the academic and NGO sectors. Subsequently, even though the government stopped advocating for large-scale industrial plans that contradicted the carbon reduction strategy, it did not actively propose substantial approaches for reducing CO₂ following the 2010 proposal.

5.2.3. Responding 2015 proposal: Promoting green industry

The government enacted the Greenhouse Gas Reduction and Management Act (GGRMA) in June 2015 and pledged an INDC (2015 proposals) in September 2015 under pressure from an expected Paris Agreement at COP21. Similarly, despite releasing the latest carbon reduction agenda, explicit and tangible policies had still not been implemented [42,52]. Even with the adoption of the Renewable Energy Development Act in 2009 and the subsequent launch of several policies that aimed at driving the green energy industry in 2012, the proportion of renewable energy was still quite limited, only increasing from 1.77% to 2.34% of the total national electricity generation (excluding conventional hydro) between 2009 and 2016 [53].

5.2.3.1. '5 + 2' Innovation Industries program. In May 2016, the Democratic Progressive Party assumed power and strongly propelled the nuclear-free homeland policy and energy transformation strategy, setting the energy ratios for 2025 at 50% LNG, 30% coal fire, and 20% renewable energy. In October 2016, the ruling party unveiled the 5 + 2 industrial innovation policy, in which green energy was one of the five key pillars of comprehensive energy transition, encompassing energy conservation, energy generation, energy storage, and smart system integration. Accordingly, the Ministry of Economic Affairs proposed a program stimulating the green energy technology industry, aimed at meeting the goals of the energy ratio for building a nuclear-free homeland and establishing a green energy center in the Asia-Pacific region.

This marked the first time Taiwan declared its green industries as the manufacturing and production hub of the Asian region. Foreign investors in the wind power sector were requested to use a certain percentage of national components to support the local wind power industry. Thus, Taiwanese manufacturers in the Photovoltaic (PV) industry already have some advantages when entering the international arena.

5.2.3.2. Six Core Strategic industries. In response to the geoeconomic competition of the US-China trade war and the impact of COVID-19, the

Taiwanese government announced Six Core Strategic industries in December 2020, including the green energy and renewable energy industries, with the latter aiming to "capture the opportunity of global supply chain restructuring in the post-epidemic era" [54], and its vision is to "make Taiwan a model of green energy in the Asia-Pacific region." The strategy was to "establish a renewable energy industry zone to form a national team for offshore wind power, enter the Asia-Pacific wind power industry, and export Taiwan's wind power industry internationally." This policy orientation is a continuation of the 5 + 2 program, accelerating the upgrade of local industries with green technology. With the US-China technology and trade war, the Taiwanese government also proposed major investments in Taiwan, as a solution to the division of labor in the global short supply chain. By December 2020, investments in Taiwan's program had exceeded NT\$1 trillion, a significant breakthrough compared with the past 30 years, when less than NT\$10 billion had been invested annually owing to the China magnet effect [55].

Under this structure, geopolitical economic factors coincided with the international climate control trend, creating a strong market drive and forcing the government to scale up its green industry and join the international industrial competition. At the same time, concerning value- and social-driven transitions, the global supply chain is starting to face the Renewable Energy 100 (RE100) initiative [56], requiring 100% green electricity to reach the net zero emission target.

5.2.4. Responding 2022 proposal: 12 Key Strategies for net zero emissions

East Asian countries declared their carbon neutrality targets after mid-2020, and Taiwan was under considerable pressure as a member of the same circle of carbon-intensive manufacturing countries. Under this geoeconomic pressure, on March 30, 2022, the Cabinet announced Taiwan's Pathway to Net Zero Emissions in 2050 (TWI Net Zero Emissions) [57], declaring the four major transition pillars, involving energy, industry, life and social, supplemented by 12 Key Strategies and NT\$900 billion budget investment planned until 2030, six of which are closely related to the energy industry [58]. Typically, the net zero target is not achieved through strict environmental regulation or carbon pricing, but rather from a technological approach, through which technological changes are applied to solve the carbon-emission problem. Simultaneously, it corresponds to an industrial niche strategy, attempting to establish the tone for transformation through technological research, development, and industrial innovation. Nevertheless, scholars questioned relying on the technological solution [59].

The consensus on achieving net zero emissions by 2050, agreed upon during COP26 in 2021, directly pressured Taiwan to move quickly toward a net zero transition. This implied that international regulations drive the decarbonization value and signaled that Taiwan was ready to accelerate the transition process. Additionally, RE100 drives the greening of the global supply chain and the international competition of the green energy industry, both of which contribute to the market-driven conditions and accelerate Taiwan's energy transition. According to the Taiwan Institute of Economic Research, Taiwan's green energy received 764 million US dollars in investment, an increase of 91.8% over the previous year, amounting to 291 programs. These programs were dominated by the technology industry (accounting for 32.3%), followed by traditional industries (19.2%) [60], indicating that Taiwan's technology and traditional industries are tapping into the competitive clean industry.

To summarize, from the 1998 to the 2022 proposal, the government fundamentally adhered to the international climate regulation process: it proposed a low carbon transition to substantive green industries and enhanced its renewable energy growth. Furthermore, it developed its 12 Key Strategies, embedded in the global low carbon value, domestic social expectation, and market-driven forces (global green industrial competition and greening global supply chain). Although these strategies were proposed in reaction to the international climate conventions, they are essentially a move toward strengthening internationally competitive green industries, demonstrating a developmental mindset

and prioritizing economic growth over carbon reduction.

5.3. Lag in net zero emissions transition governance

5.3.1. Only 0.22% of carbon reduction is required for the industrial sector by 2025

At the end of 2020, the Cabinet announced the second phase of the Greenhouse Gas Reduction Program by Sector, proposing a 0.22% reduction for the industrial sector by 2025. Given that the industrial sector accounted for 51.3% of the country's greenhouse gas emissions in 2019 [61], the Cabinet's plan was severely criticized by academia and environmental groups, which did not believe the government is committed to reducing emissions [62]. Even though the Greenhouse Gas Reduction and Management Act was enacted in 2015, the government did not reinforce its regulatory policies, rendering carbon reduction ineffective. Furthermore, in October 2018, the US–China trade war was prolonged, drawing huge investments back to Taiwan. However, a lack of transparent and strict energy consumption reviews resulted in serious concerns regarding Taiwan's energy consumption and carbon emissions.

5.3.2. Geopolitical impact of 2050 net zero emissions

Moreover, geopolitical and geoeconomic competition is apparently involved, where the leaders of South Korea, China, and Japan have already announced carbon neutrality after mid-2020. However, the ruling party, boasting of its green administration, is still tied to the economic development path. Several key geopolitical factors have led to these changes. First, the election of a proclimate policy candidate as President of the United States, in which the democrat Joe Biden won the presidential election at the end of 2020. After that, Taiwan's government changed its position and shifted to a net zero emissions target. The second factor was the declaration of climate governance by G8—the eight industrialized countries assembled in London in June 2021 and pledged to be actively involved in climate policy [63]. Then, COP26 focused on the 2050 Net zero carbon plan and initiated international alliances, for example, the Glasgow Financial Alliance for Net Zero [64]. Finally, in 2021, the International Energy Agency published its “Pathway to Net zero Emissions in” [65], which triggered a global transition. In response, Taiwan's President Tsai Ing-wen initially declared the nation's 2050 Net Zero emissions commitment on Earth Day, April 22, 2021; however, the Cabinet postponed releasing the general TWI Net zero Emissions 2050 framework until the end of March 2022. This initial framework, however, was criticized by the public for lacking a clear roadmap [66].

5.3.3. Limited carbon fee replacing carbon tax

In the amendment of Greenhouse Gas Reduction and Management Act in 2020, the EPA proposed a carbon fee for the first time at the end of the year, owing to the draft CBAM plan proposed by the EU in 2019 [67], forcing Taiwan's industry to consent to levy the fee. The Chinese National Federation of Industries, which has opposed energy taxes in the past, emphasized in its Annual Policy Proposal in August 2021 that the government should actively develop carbon-pricing mechanisms to promote industry compliance with international climate norms for maintaining global competitiveness [68]. The government has initiated the planning of an energy tax since 2006, which was met with opposition [44]. Evidently, global climate norms strongly influence the establishment of carbon pricing; even a highly carbon lock-in brown economy needs to address these exogenous factors that impact its industries' competitiveness.

However, the brown economy continued to limit the net zero transition. Although Taiwan has lagged behind other East Asian countries in the transition, it has opted for a carbon fee rather than a carbon tax policy. In addition to avoiding assigning the carbon tax a social redistribution function, the EPA planned to allocate the carbon fee to the industry for upgrading their carbon reduction technology and equipment [7]. This action received considerable criticism from scholars and

NGOs, who emphasized that a carbon tax should be used to promote energy efficiency, energy conservation, and social equity (focus group 5 Nr. 24 = F5#24; F5#27, 28, and 29) [69] they lobbied various opposition parties (Interview 5 = #5; F3#13). Scholars published an article advocating that the government establish a sunset date for the carbon fee and initiate a carbon tax in the Climate Change Response Act [70–72]. The secretary general of the Taiwan Climate Partnership, comprising eight major electronics industries, criticized Taiwan's government for not being determined to implement carbon pricing and for making slow changes even in the face of carbon tariffs from the EU (F4#22).

5.3.4. Only 24% ± 1% of carbon reduction by 2030

When the government announced the TWI Net zero Emissions framework in 2050, a clear roadmap was absent; therefore, the 2030 carbon reduction pathway announced at the end of December 2022 took the spotlight. However, compared with the 2015 proposal, aimed at reducing carbon emissions by 20% by 2030 over 2005, this roadmap only established a 24% reduction plan. Environmental groups and academia have heavily criticized this measure as conservative, backward-facing, and falling seriously short of international standards [73–75].

One reason is that geopolitical competition has led to a large increase in international investment returning to Taiwan, accelerating electricity consumption island wide. Therefore, with the increase in carbon emissions and the limited growth of green energy, achieving a high carbon-reduction target appears to be impossible [76]. Nevertheless, analysis shows that, with the returned foreign investment, businesses in Taiwan are holding on to the developmental mindset of the high carbon, brown economy. In particular, Taiwan lacks forward-facing strategies, and the net zero transformation has been excessively sluggish [77].

6. Recentralized bureaucracy and weak civil society

While starting the net zero transition, the government established the concept of participatory governance early in the White Paper on Energy Transition [78]. The key decisions on the Climate Change Response Act, carbon pricing, TWI Net-Zero Emissions, and 2030 Net zero roadmap tended to adopt a centralized bureaucratic decision-making model, with limited civil society and academia participation.

Case 1. Limited public participation in the net zero taskforce: 2050 pathway

Influenced by geopolitical factors, Taiwan lags behind other East Asian countries by nearly a year. The Cabinet set up five net zero carbon emission working circles in April 2021—decarbonized energy, industry and energy efficiency, transportation electrification, carbon-negative technology, and governance. During this period, the Cabinet announced more than 60 external exchanges took place [79,80]. Nonetheless, most involved industries, while exchanges with civil society were limited [81]; furthermore, the public had no access to relevant internal government evaluation information, leaving minimal room for participation. Many scholars engaging in the issue were not invited to participate in the evaluation, and even they had little information on how the Cabinet's net zero carbon emission working circle formulated the four main pillars, i.e., industrial transition, energy transition, lifestyle transition, and social transition, or the 12 Key Strategies. Although these major net zero emissions transformative frameworks involve cross-disciplinary assessments, social scientists were rarely asked to participate [65].

Additionally, citizen groups invited to the communication participated in fewer than 10 meetings. Most did not have the opportunity to follow up or create the final pathway after providing their opinions (#15, #18, #19) [77]. Some criticized that their participation in the communications was fragmented and piecemeal [82]. Thus, on March

30, 2022, when the government officially announced the TWI Net zero Emissions 2050, the former EPA administrator criticized the plan for being linear and technology-oriented [83]. Scholars strongly demanded establishing a long-term, transparent communication mechanism for major national transition policies and development plans [65].

Case 2. Limited social communications on the 2030 net zero roadmap

After COP26, countries were required to achieve a 43% reduction of emissions by 2030 according to international standards [84], which placed huge pressure on Taiwan. Various sectors requested the government to engage in dialogue with society, industry, and academia to propose a resolution [85]. After TWI Net zero Emissions 2050, the Cabinet launched the 12 Key Strategies, and different ministries were in charge of the related areas and external communication. Nonetheless, it was not until December 30, 2022, that the Cabinet announced the 2030 Carbon-Reduction Pathway; however, both the target and the communication were lambasted. The concerned ministries conducted between 9 and 12 social communication sessions, yet most of the invited environmental groups criticized these meetings as being little more than policy announcements, with insufficient discussion and participation in the decision-making process on the transition pathway (#25, #30, #32). Similarly, the MOEA announced the Transition Pathway to Net Zero Emissions of Manufacturing Sector [86] and the Transition Pathway to Net Zero Emissions of Business Sector in September 2030 [87], but no specific carbon reduction timeline was disclosed before the announcement of the 2030 pathway. Moreover, implementing the net zero pathway requires collaboration between central and local governments; however, local governments were not invited to join the discussions. Many local representatives believe that the lack of prior planning and communication with the local administration will lead to shortfalls in future implementation [88] (#36; 38; #40).

Case 3. No-transparency on screening—Three major investment programs in Taiwan

In response to the restructuring of the global supply chain due to the US–China trade war, Taiwan's government actively promoted three major programs for investing in Taiwan as a means of encouraging the return of Taiwanese businesses. As of January 5, 2023, 1305 companies passed an audit, with a total investment amount of approximately NT \$1.9153 trillion [54]. Statistics from this investigation show that 53.3% of these enterprises belong to high power-consuming industries. However, the MOEA has not been transparent in its review mechanism of the cases, especially in screening energy consumption, water consumption, and waste. According to preliminary investigations conducted by Business Weekly and Commonwealth Magazine journalists [89,90], up to 40% of the invested companies had been previously fined for improper waste disposal.

Before the 2030 pathway announcement by the Cabinet, the public requested that the government transparently announce the review mechanism for energy and water consumption and waste by the three major investment programs and to explain how this relates to the net zero carbon-emission target. Nevertheless, no clear feedback has been provided. Everything remains a mystery. Scholars and environmental groups have continuously demanded that the evaluation information, procedures, and results be made public to avoid black-box operations [91].

Case 4. Limited public hearing on Climate Change Response Act draft

Although the EPA revised the Greenhouse Gas Reduction and Management Act in mid-2020, held several public hearings consecutively, and conducted the climate change citizens' dialogue platform [92], the central bureaucracy-led decision-making model remained unchanged after April 2022 when the Cabinet proposed the revised Climate Change Response Act (CCRA), especially on the issues of the climate mechanism, the Climate Change Commission, and carbon fee. Given the urgent need for a net zero transition, researchers and environmental groups have

repeatedly advocated that the Executive Yuan Council for Sustainable Development, in operation since 2001 and in charge of CCRA, be replaced by a robust, inter-ministerial climate council to directly guide and respond to the changes (#15, #18) [65]. However, the Cabinet responded that a working panel on climate change, established under the Council for Sustainable Development, was sufficient for addressing the net zero target [93]. Furthermore, as ministries have implemented Taiwan's carbon reduction program according to the "greenhouse gas reduction timeline for each ministry," the results were ineffective. Scholars suggested establishing an independent climate change commission based on international best practices to create a carbon budget monitoring the executive authorities [69]. Even though, the Cabinet refused to consider this initiative. Similarly, while claiming that the issue of climate governance demands civil society participation, the central government has avoided adopting substantive communication and monitoring mechanisms.

Case 5. Confront communication on carbon fee and tax issue

The same centralized bureaucratic decision-making mindset can be seen in the carbon tax issue. Under CBAM pressure, the Cabinet adopted a carbon fee to suppress carbon emissions. Although environmental groups have made repeated appeals and lobbied political parties, they conceded to explicitly state in the CCRA that a carbon fee will be collected for three years before introducing the carbon tax in 2026 [94]; however, the Cabinet did not accept the proposal. Only in the Legislative Yuan negotiation on January 4, 2023 did the Cabinet agree to the environmental groups' request to specify transition in Article 33 of the CCRA for the use of the Greenhouse Gas Management Fund [95].

The CCRA passed on January 10 did not include a carbon tax provision [96]. Although the EPA commissioned the London School of Economics and Political Science to conduct a study in 2021; the report recommended that Taiwan's carbon fee should start at NT\$ 300 and increase yearly. However, under pressure from industrial and commercial groups, the government ignored the repeated appeals of environmental groups and researchers [97]; the assessment of the carbon fee was never disclosed, nor was there any active dialogue with the public. This action, conversely, caused tension in the industry. The industrial group, Chinese National Association of Industry and Commerce resolved in November 2022 that the government should establish a carbon price that aligns with CBAM to maintain the industry's global competitiveness [98].

7. Conclusion and policy implication

Considering this research's analysis, despite driving forces from robust international regulation, decarbonization value, and society, the Taiwanese government is constrained by its reliance on a high carbon, brown economy, resulting in governance deficiencies in net zero carbon emissions. National carbon reduction targets over the years have been subject to formalism or failure, climate policies have been stagnant or withered, and social engagement and communication have been limited. Conversely, various types of industrial policies are driven by national carbon reduction goals at different stages. For example, the recent 5 + 2 IIP, the Six Core Strategic Industries, and the 12 Key Strategies of net zero carbon emissions are market-driven transitions were proposed under a developmental mindset. In other words, although the government is attempting to meet the international demand for carbon reduction through green energy construction and energy transformation, it is using these developments to establish a green technology industry to become a leader in the Asia-Pacific region and create a globally competitive industry in the new era.

This developmental environmentalism with East Asian characteristics is shifting toward net zero emissions governance. Whether it is geopolitically influenced declarations on net zero carbon emissions, conservative climate policies, limited carbon fees, scaled-down 2030 carbon reduction targets, nontransparent reviews of incoming

investments in energy industries, or limited social participation, the established authoritarian, centralized bureaucratic policy-making model continues to dominate. This East Asian developmental environmentalism, or, to coin a new term, developmental netzeroism, is embedded in and locked into the high carbon pathway, leading to thresholds in the transition process. Such structural impediments have led to the transitional lag that this research has documented, which is not only the case today but has been present for the past 20 years or more in the form of climate governance delays, policy contradictions, and energy transition conflicts. Many studies in Taiwan, Korea, and Japan [12,14,15,52,99,100] demonstrate dependence on the high carbon pathway, developmentalism, shriveled climate policies, complex energy interests, and conservative and authoritarian brown economic regimes that have long dominated this region and state in the global industrial supply chain.

However, how should structural opportunities be created to overcome the structural constraints caused by these transformation lags? This research reveals that Taiwan, similar to South Korea and Japan, did not adopt the traditional regulatory state approach, which drives carbon reduction directly through strict regulations. South Korea's Green Growth Strategy in 2009, the emission trading system in 2015, and Japan's carbon tax since 2012 prioritize low carbon pricing. Taiwan's delayed carbon pricing and limited carbon fees also follow the same policy direction. All three favor protecting businesses with a lower regulatory density for climate carbon reduction. Obviously, such policy actions indicate typical developmental environmentalism. Furthermore, subsidies and tax reductions are comprehensively used by South Korea and Taiwan to indirectly boost the green energy industry.

On the one hand, it follows up and creates a new generation of technology industries to establish the foundations, and on the other word, it is a strategy to respond to global climate regulation requirements. The study shows that under various international climate convention frameworks, the government has introduced different green energy development plans; however, Taiwan is relatively less ambitious than South Korea, and merely announced the Asia-Pacific Green Energy Center plan in 2016 under the 5 + 2 IIP. Developmental states have indeed proven to be successful in driving green technology by creating policies encouraging the polluted sectors to invest alternatives to guide the deconstruction of their high carbon, energy intensive industries. For example, Taiwan Cement Corp. has declared that its revenue share of green energy and energy storage will reach more than 50% in 2025 [101].

Nevertheless, this research should not be overly optimistic about such creation and deconstruction. On the one hand, Taiwan has a strong nuclear complex closely associated with the brown economy, where people use various strategies to delay the energy transition [102]. If society continues to be drawn into the nuclear energy controversy, conditions will not be conducive to meeting the international requirement that industries that are part of the global supply chain must use 100% green energy, slowing the growth of renewable energy in response to net zero carbon emissions. Moreover, under the long-term effect of carbon lock-in, even though the Taiwan government has proposed a carbon-pricing mechanism in response to the EU CBAM, it has ignored the demands of scholars and civil society to impose a carbon tax and has only moderately proposed a limited carbon fee. In addition to the fee being introduced at a low price, it agrees that the funds collected can be used to subsidize the technology or equipment upgrade for achieving industry carbon reduction, which violates the polluter pays principle. It is clear that the pressure and bottleneck of its transition are strongly influenced by the brown economy and related mindset.

Developmental states have previously strongly promoted high carbon emissions and polluting industries. However, because the installation of sites directly affected people's health and livelihoods, it often led to local or nationwide resistance and the cumulative creation of a robust civil society. These protests focused on specific development plans and sites. Nevertheless, in the face of more abstract, complex, and long-term

climate and carbon reduction issues, which are difficult for the layperson to understand, civil society experiences difficulty in mobilizing large-scale social movements, despite holding several marches. When environmental groups monitor and criticize climate regulations and policies such as the governance system and carbon tax, protests take the form of press conferences to gain public support or lobbying political parties, both of which have limited impact [48]. Similarly, civil society is weak in the face of the same authoritarian, centralized, and bureaucratic government that has seen large environmental protests in the past and in the context of the current government-led approaches to carbon reduction. Although some measures proposed by the government today, such as the TWI Net zero Emissions 2050, carbon fee, climate participatory governance, 2030 Carbon-Reduction Program, 12 Key Strategies, and the Major Investment Program in Taiwan, have involved civil society, most participation has been a mere formalism. In fact, in terms of information transparency, stakeholder communication, and policy-making participation, civil society is relatively weak to challenge or overturn government decisions. This type of relationship and governance suggests the return of a strong state and weak society. Finally, the government, concerned that strict regulation may affect the economy or receive industry protests, is only considering the green technology industry as their priority. Consequently, a new wave of developmental netzeroism is clearly forming.

CRediT authorship contribution statement

Kuei-Tien Chou: Conceptualization, Methodology, Writing – original draft, Investigation, Data curation, Writing – review & editing, Supervision, Project administration.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

No data was used for the research described in the article.

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