



Deadlock in transition to a net-zero socially robust knowledge

Kuei-Tien Chou, Mu-Xing Lin, David Walther*

Risk Society and Policy Research Center (RSPRC), National Taiwan University 106 Nr.1, Section 4, Roosevelt Road, Taipei, Taiwan

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ABSTRACT

Although Taiwan proposed 2020 to achieve net-zero carbon emissions by 2050, it has encountered difficulties making this transition. This research argues that climate issues involve epistemic politics and competition and those different discourses require the construction of socially robust knowledge (SRK) in reflexive, contextual confrontation, and competition. A society with strong SRK can lead the country's net-zero carbon emissions decision, system, and transformation. This article analyses the types of environmental movements and the strength of their production of SRK with two cases that discusses the current lag of net-zero transition.

The study found that the elements of successful transition include the same object of resistance, based on rational risk knowledge debate, and multi-level social mobilisation, which constitutes a strong SRK. A solid SRK package successfully reframes the development thinking of Taiwanese society. The net-zero movement needs a transparent object of resistance; environmental groups need to familiarise themselves with the issue of climate warming, resulting in a gap in appeals, mobilisation strategies, stages, and dominance. Although the latter still presents a certain degree of SRK and constitutes a policy of confrontation or competition with the government, the issues of appeal are pretty diverse, showing scattered initiatives. Folk-focused issues and discourses cannot build a strong agora, thus failing to reframe the social development framework and create more elements or opportunities for social transformation to a green path; as a result, Taiwan's sluggish climate governance and net-zero transition have encountered dilemmas both at home and abroad.

1. Introduction

This study aimed to investigate why the Net Zero Emissions by 2050 Scenario, which is currently an important goal for national development, finds it challenging to reframe the framework for development during the social transition. This difficulty exists despite its ability to create dramatic economic, industrial, and social impact and transformation. Specifically, this study explores whether the deadlock in the transition toward net-zero emissions can be explained by any exogenous factors other than the long-standing brown economy of Taiwan and its path dependence on politics and economics, which have led to the reinforced carbon lock-in (Chou et al., 2022).

The issue of climate change involves epistemic politics and competition, which can shape discourse in technologies, values, socioeconomic assessments, and sustainability. Most importantly, socially robust knowledge (SRK) may be constructed in a reflexive and contextual manner to counteract, compete against, and guide a society's decision-making, institutions, and development roadmaps. Previously, scholars developed a robust, systematic risk discourse during a major

environmental movement in Taiwan to reverse the government's decision-making. Comparing and investigating the SRK in this case is important to examine the current challenges in the transition to net-zero emissions. Against this background, this study intends to analyse different environmental movements and the strength of the SRK produced therein based on the cases of the Anti-Kuokuang (No. 8 Naphtha Cracker) Petrochemical Project Movement (hereafter referred as Anti-Kuokuang Movement) and the ongoing net-zero movement. The study discusses the deadlocks and predicaments presently encountered in the net-zero transition, a few of which involve developing countries' decision-making patterns and resistance efforts.

2. Research background

2.1. Need for robust social participation

Climate change presents cross-disciplinary challenges with high levels of scientific complexity, ambivalence in norms and values, and ensuing uncertainties in scientific, social, ethical, and other aspects. In

* Correspondence to: Risk Society and Policy Research Center, National Taiwan University No. 1, Section 4, Roosevelt Rd., Taipei 10617, Taiwan.
E-mail address: waltherzion@gmail.com (D. Walther).

the face of scientific uncertainties and social and political challenges induced by climate change, self-sufficient and self-referential disciplinary perspectives are insufficient to explain all problems (Ziman, 1978; Nowotny et al., 2001, 2003).

Nowotny et al. (2001) argued that current scientific knowledge is becoming contextualised without being limited to in-laboratory production. Additionally, they proposed that society must shift from the production of reliable knowledge to that of SRK: knowledge production has a socio-epistemological meaning of contextualisation. Furthermore, society should continue to respond robustly and reflect on the diverse challenges that technology poses to the environment, ethics, health, and politics to achieve sustainable survival (Nowotny et al., 2001; Delvenne, 2010a, 2010b). Specifically, participatory knowledge presents an opportunity for society to reflect on the environmental, ethical, health, and political challenges posed by climate change, disrupt the monopoly of technocracy (Jasanoff, 2003; Stirling, 2007; Delvenne, 2010a; b), and develop co-evolution and co-production between science and society (Nowotny et al., 2001; Jasanoff, 2006). Nowotny (2003) explains SRK using the metaphor of an agora: knowledge is produced where a problem occurs and a corresponding solution is offered; therefore, it is a process of contextualization. For issues related to climate change and sustainable science, which involve high degrees of complexity, undergoing a cross-disciplinary, deliberative, and competitive process to obtain accountable science through an agora is crucial (Nowotny, Pieter, 2009; Hall and Sanders, 2015).

The core of SRK consists of acknowledging uncertainty regarding the knowledge of sustainability-related issues and recognizing the contextuality and limitation of knowledge production across realms. Therefore, mutual learning and integration across domains and disciplines are urgently required (Scholz and Steiner, 2015; Gudowsky and Peissl, 2016). Such transdisciplinary research is characterized by competition among theories in ontology, epistemology, and methodology. To address these highly complex issues on sustainability, modern science must be capable of engaging in interactive dialogues with politics, economics, media, and civil society. Moreover, it must possess the ability to undertake discourse and initiatives (Weichselgartner and Truffer, 2015). Arguably, SRK is built on the foundation of reflexivity; only through intense reflexive debates can society jointly define social problems and needs, determine a choice among differing values, and make a commitment accordingly. In summary, knowledge production, policy significance, and social practice, which are extended from SRK, share similarities with reflexive governance (Beck, 2006).

Building on epistemic citizenship, Jasanoff (2004, 2005) propounded the view of civic epistemology based on constitutional democracy adopted by Western countries. The author argued that only through institutional processes, different types of risk knowledge compete through democratic processes and institutions to facilitate the achievement of legitimacy in decision making. Civic epistemology suggests that the decision-making ability of a state regarding science and technology, under the operation of administrations, parliaments, expert committees, and civic groups, to ensure the democratic participation of the public and shape robust knowledge influences the legitimacy of national governance.

However, the concepts of SRK and civic epistemology may face further challenges after their introduction into East Asian countries. East Asian countries have long been influenced by the tendency to prioritize economic development over environmental and social equity has long dominated political agendas. Although civil societies are playing an increasingly active role in East Asian countries, wherein civic groups were gradually involved in discussions during the development toward low-carbon societies, these groups have remained excluded from major decisions as a whole (Dent, 2012, 2017; Han, 2015; Kim, 2015; Chou, 2022b). Kim and Thurbon (2015) have referred to this inertial top-down decision-making model as a typical form of bureaucratic recentralization, wherein elite policymakers lead the decision-making process. This type of decision-making model and regulatory culture strongly resemble

those practiced in Taiwan and South Korea, which frequently leads to a risk regulation culture of deferment and concealment (Chou, 2015, 2018). The latter has not only entailed the monopoly of technology decision making by authoritarian technology elites and technocracy but has also involved structural delays in civil society, civic awakening, and other aspects.

Following the logic of reflexive governance, this study examines the difficulties in the transitions in climate, energy, and net-zero carbon emission issues in Taiwan. Developmental states in East Asia typically focus on the deployment of green industries even during the energy transition, while disregarding various issues related to environmental justice and social equity encountered in the process (Chou et al., 2018a, 2018b). This tendency is analogous to the suggestion of Pisani and Kok (2017): complex climate issues require more than constructing technologically robust knowledge, which is insufficient without SRK. Both are imperative for the production, demand, transmission, communication, and interpretation of knowledge regarding complicated, delicate socioeconomic transitions.

2.2. Analytical framework

Environmental movements in Taiwan have undergone several significant transformations. Chou (2017) classified major local and national environmental protests into two types: 1) antipollution movements and 2) movements related to climate change risk, wherein environmental groups launched appeals against high carbon emissions, energy consumption, water consumption, and pollution for the first time. These two types of protest movements covered those that occurred in Taiwan from the mid-1980s to 2010 at the regional and national levels. During these movements, varying levels of SRK were developed and corresponding risk discourses were mobilized to achieve the effects of different environmental movements.

This study analyzes the Anti-Kuokuang Movement (Anti-No. 8 Naphtha Cracker Movement), which was considered a successful case. Academic communities and civil society groups in Taiwan rallied to establish the largest, most systematic SRK integrating professional risk knowledge and emotional appeals from the bottom up, which successfully led to constructing a risk discourse. The movement challenged the knowledge and rationale advocated by the government, which prompted all sectors of society to question the necessity of the government's plans to build the No. 8 Naphtha Cracker. Ultimately, the Anti-Kuokuang Movement overturned the government's decision and developed a new mindset toward sustainable development.

The target for comparison in this study is the net-zero policy (hereafter, the Net Zero Movement), which various environmental groups and academic communities have been supervising and urging the government to promote. Environmental groups launched various appeals, press conferences, and petition campaigns to urge the government into various endeavors such as amending the Greenhouse Gas Reduction and Management Act in accordance with international trends, committing to achieve net-zero carbon emissions by 2050, and formulating energy taxation. Despite these efforts, since the end of March 2022, civil society groups were unable to initiate any large-scale environmental movement, except industrial concern for the Carbon Border Adjustment Mechanism (CBAM) of the European Union (EU). During this period, the Executive Yuan released Taiwan's Pathway to Net-Zero Emissions in 2050, and the Draft for the Climate Change Adaptation Law (formerly the Greenhouse Gas Reduction and Management Act) (NDC, 2022; EPA, 2022) was submitted to the Executive Yuan in April of the same year. Such environmental movements would have brought the focus and attention of the entire society to the importance of net-zero carbon emissions, thereby reframing the transition toward sustainability.

The Net Zero Movement involves the future visions of a society and its pathway to energy transition as well as CBAM, economic competition, and industrial transformation. Specifically, carbon pricing is a powerful tool that can help countries reduce carbon emissions, which is

associated with social redistribution. Particularly, net-zero emissions require new governance institutions, such as the Climate Change Council, which was established in accordance with the Climate Change Act (UK, 2008) of the UK, and the Climate Change Consultancy Council recently founded by the EU (2022). However, the Taiwanese government’s decisions on these key issues remain unchanged despite the continued efforts of environmental groups and academic communities to launch appeals, organize press conferences, and hold public hearings.

The two environmental movements confront a synthesized body of the developmental state: recentralized bureaucracy, brown economy, and high carbon lock-in (Chou et al., 2022). This study underscores how these movements formed strong or weak SRK, constructed epistemic politics and competition, and changed or faced difficulties in altering decisions, institutions, and regulations (Fig. 1). Several complementary criteria are required. The first criterion denotes the presence of a specific, direct object of appeal or protest. The second refers to the formation of a powerful initiative alliance. The third one pertains to the mobilization strategies that these initiatives should employ to expand their capacity and scale. Last, through these strategies and in combination with competitive risk discourses, strong or weak SRK is formed to construct an agora for confronting or supervising government decisions (Nowotny, 2003, 2018). Ultimately, substantively changing or influencing the outcomes or failing to do so depends on the strength of the agora.

Furthermore, this study analyzes the variables and effects of success or failure of two cases in environmental movements, aiming to present the differences, characteristics, and structural limitations in the development of strong and weak SRK. The goal is to serve as a reflection for the future direction of mobilization in the face of increasingly complex, international, and even institutionalized reform. To achieve this, SRK needs to be built on both physical mobilization, such as marches and protests, and virtual mobilization, including discourse, emotional catalysts, and identification. Particularly in contemporary environmental movements involving transnational, diverse, and technological uncertain issues, integrating highly complex, diverse, and interdisciplinary issues into a catalytic mobilization capacity is critical in forming SRK. SRK is a reflexive, contextual, social constructing continuum, with its strength (strong or weak) depending on the scale and strategy of the event, issue, and protest. A strong SRK that creates a dominated epistemic, political frame possibly leads to the overturning of given policies, while a weak SRK may scarcely make an impact, even though it develops some issues. The challenge is even greater in East Asia or Taiwan, which belong to the development-state countries of high carbon emissions and re-centralized bureaucracy, to break through the long-term dominant political decision-making structure. The article serves as a reflection on the future of environmental movements that face

increasingly complex, international, and sometimes limited reform opportunities.

3. Method

3.1. Identification

Civil society groups in Taiwan constructed strong SRK during the Anti-Kuokuang Movement and successfully reversed the government’s industrial policy. In contrast, when the government published Taiwan’s Pathway to Net-Zero Emissions in 2050 at the end of March 2022 and subsequently introduced amendments to the Greenhouse Gas Reduction and Management Act, the Taiwanese society demonstrated a relatively weak performance in producing the SRK of climate risks. This study analyzes the two environmental movements in terms of their attributes, events, and scales; initiative alliances; and combination of various mobilization strategies to produce different risk discourses and develop strong or weak SRK. Based on the results, this study establishes whether comprehensive, bottom-up, and powerful framing was constructed to influence policy decisions.

3.2. Data collection

Fieldwork and data collection were conducted from May 2020 to June 2022. Five focus group discussions were conducted with twenty-nine participants from government agencies, industry, academia, parliament, and NGOs. Furthermore, 23 semistructured interviews were conducted. For focus groups and interviews, interview outlines were sent to the respondents beforehand, and in-depth discussions were conducted on the government’s deferment in declaring the commitment to net-zero emissions, decision-making models, regulations on high-carbon emission industries, air pollution, public participation, and absence of a comprehensive Green New Deal discourse. The interviews were recorded and transcribed. The authors also attended over 12 symposiums on net-zero emissions and carbon taxation (e.g., polling surveys, risk society forums, seminars, conferences organized by the Office of Energy and Carbon Reduction, and the Academia Sinica Net Zero Consensus Report and Sustainability Platform). Secondary data included official documents from enterprises, the Chinese National Federation of Industries (e.g., annual reports and company press releases), and grey literature (e.g., media articles, policy documents, research reports, and presentation materials) from third parties such as think tanks, government agencies, and NGOs.

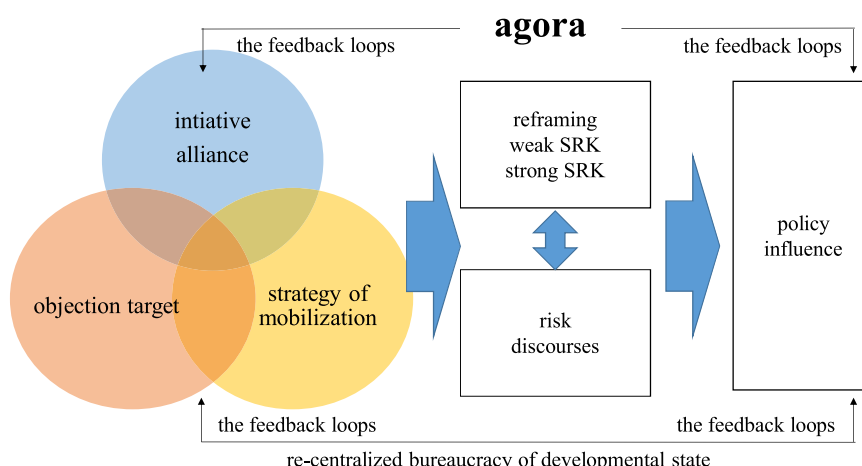


Fig. 1. Analytical framework.

4. SRK need for net zero

4.1. The Anti-Kuokuang Movement

4.1.1. Objection target

The roots of the Anti-Kuokuang Movement can be traced to 1990, when residents strongly resisted the construction of No. 5 Naphtha Cracker by a state-owned enterprise called China National Petroleum Corporation. As a result, the government pledged to terminate the operation of No. 5 Naphtha Cracker in 2015, which necessitated replanning the construction of No. 8 Naphtha Cracker as a continuation. The coastal region of Dacheng Township, Changhua, Central Taiwan, was selected as the site. Prior to the Anti-Kuokuang Movement, all movements against petrochemical or chemical engineering projects, even those escalating from regional to national environmental movements, were mainly antipollution protests. The Anti-Kuokuang Movement, which was launched in 2010, continued the appeal of the Anti-Binnan Industrial (Petrochemical and Steel) Park Movement undertaken since 1995. It advocated against high carbon emissions, energy consumption, water consumption, and pollution levels, thereby initiating climate change risk movements in Taiwan. A specific cabinet-approved, large-scale petrochemical plant construction project in an ecologically sensitive area evidently violated the resolutions passed by various conferences on national energy and industrial sustainability by the Taiwanese government over the years (Chou, 2015). Additionally, the construction plan would affect the wetlands and biodiversity at the planned site and impact the migration of white dolphins (AKPP, 2010a, 2010b). These factors quickly grew from regional environmental movements to draw national attention.

4.2. Initiative alliance

The Anti-Kuokuang Movement, which was initially launched and mobilized by local environmental groups, gradually expanded in scale and became the focus of national attention due to its involvement in diverse issues. The movement further developed to include multiple initiatives. The Changhua Environmental Protection Alliance and Matsu Fish Conservation Alliance were among the first to appeal that the wetland ecology and migration of the white dolphin, which is a rare species in the world, would be jeopardized. Eventually, akin to prior environmental movements in Taiwan, university professors and students successively joined the movement within the context of anti-authoritarianism (Lii and Lin, 2000; Ho, 2006). Their participation formed the professor-led Academic Alliance Against the KuoKuung Petrochemical Project and National Youth Alliance Against the KuoKuung Petrochemical Project (NYAP, 2010). The Changhua Healthcare Alliance, which was mainly composed of members from Central Taiwan, also joined (Cooloud, 2010a, 2010b; Wu and Hsu, 2011). The former analyzed the problems and impacts of this development project from various perspectives based on their academic professionalism, whereas the latter focused on health appeals regarding the relationship between air pollution and lung adenocarcinoma. In addition to alliances that proposed rational, epistemic discourse, local writers collaborated on emotional mobilization and discourse. They galvanized the art and literary communities to create and develop emotional, nostalgic appeals, whereby an axis of mobilization was drawn (Li, 2010; Wu, 2010).

The multiple initiative alliances encompassed scholars on local ecological knowledge, university professors, healthcare professionals, and arts and cultural workers specializing in emotional, non-epistemic debates. These rational and emotional discourses were combined to form systematic and solid SRK. Furthermore, with the adoption of mobilization strategies, the battlefield of discourses was expanded and risk knowledge was constructed to attract attention and identification from different sectors of society. From the perspective of the field of rational knowledge competition, experts in initiative alliances constructed an agora of discourse competition to counter the official

discourse. The anti-experts constructed discourses differing from the official version and confronted official and industrial experts. Chou (2017) identified the Movement as the largest, most systematic environmental movement among the multitude recently organized in Taiwan. The movement contained SRK with strategic discourse mobilization, thereby creating a favorable condition for overturning government decisions.

Fig. 2 depicts that people from local environmental groups, universities, and medical communities who are against experts rallied to construct an inner circle of powerful, solid risk knowledge. This knowledge was then combined with the emotional discourses in the outer circle constructed by arts and cultural workers (e.g., poets, musicians, and novelists) to form a strong SRK. Thus, they enabled explicit confrontation against the official scientific discourse constructed by the government, industrial experts, and official experts regarding the construction of the Kuokuang Petrochemical Plant. This situation unequivocally broke the bureaucratic, recentralized policymaking of a developmental state and challenged its legitimacy.

4.3. Strategies of mobilization and risk discourse

The mobilization strategies for the Anti-Kuokuang Movement included the executive, legislative, judicial, and risk discourse paths. In terms of executive strategies, people against experts and environmental groups were actively engaged in the environmental impact assessment (EIA) process. During the initial stage of EIA task force meetings, they systematically raised issues related to the delineation of the EIA scope, which was expanded to health risks, carbon emissions, wetland conservation, and protection of the globally rare, black-faced spoonbill (EPA, 2011). For the executive path, the development project should be approved by the Regional Planning Committee (RPC) of the Ministry of the Interior (MOI) even after passing the EIA. As such, the RPC became another crucial battlefield of participatory knowledge for environmental groups to strategically apply citizen science. In fact, several environmental groups were deployed in the RPC when the Kuokuang Petrochemical Project entered the EIA battle in 2010 (Chen, 2010).

4.3.1. The legislative path

Civic groups against the KuoKuung Petrochemical Project mobilized 40,000 citizens to participate in share subscriptions and initiated the Changhua Dacheng Wetland National Trust (Chu, 2010). This pioneering undertaking, wherein the application was submitted to the MOI in accordance with the Trust Act, successfully safeguarded the habitat of Chinese White Dolphins. Following the successful exit of the Anti-Kuokuang Movement in April 2011, the Wetland Conservation Act was formulated and adopted in mid-2013. For the judicial path, although the citizen suit system was introduced to Taiwan as early as 1999, environmental groups won the first landmark victory for administrative actions only in 2006 with the case of the Linnei Incineration Plant in Yunlin County (Shih, 2013). Lawyers, environmental groups, and local residents from against-expert alliances were prepared to launch a citizen suit against the Kuokuang Petrochemical Project. Once the project passed the EIA, they would mobilize the judicial review path (Chiu, 2013).

These mobilization strategies were closely tied to various risk discourses. Through systematic, large-scale risk knowledge production, initiative alliances strategically submitted articles to the media and created topics of public interest, which successfully attracted attention and comments from major media outlets (Chou, 2017). Environmental groups, scholars, and healthcare professionals successively accumulated analyses on climate change, carbon emissions and industrial development, air pollution and health risks, water resources, land subsidence, agricultural and food security, coastal wetlands, white dolphin conservation, and sustainable economy. Additionally, the Academia's Analysis Report Against the Construction of the Kuokuang Petrochemical Plant (No. 8 Naphtha Cracker) in Changhua (Chou et al., 2011) and the

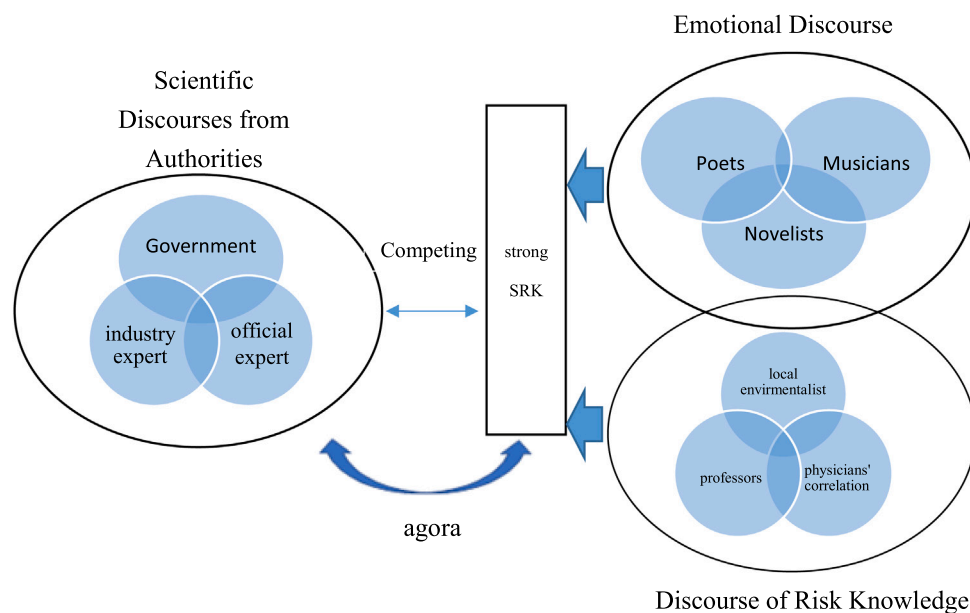


Fig. 2. agora of risk discourse struggle.

Statements Against the Kuokuang Petrochemical Project—PM_{2.5} and Health (CMA, 2010)—of the healthcare sector were published. These powerful discourses were incorporated into preparations for the executive, legislative, and judicial paths. They provided relatively solid SRK as an effective weapon to resist this development project in the processes of EIS, RPC debates, wetland national trust promotion, and potential environmental civil suits in the future.

These risk discourses fully reflected the subpolitics route (Beck, 1993). For an inertial developmental state that prioritizes economic development and adopts a decision-making model of recentralized bureaucracy, contention for hegemony in risk discourses is required to counter the authoritarian decisions made by executive departments and gain attention and support from society. Table 1 presents the positive knowledge discourses published by the government, industries, and academia on the Kuokuang Petrochemical Project and resistant risk knowledge discourses proposed by the academia-led group that is against-expert. The table presents both sides to provide conflicting views on several issues (Table 1). The initiative alliances put forward arguments systematically. Although the government promptly responded to their doubts (IDB, 2010; EPA, 2010; IDB, 2011), the initiative alliances seized the moral high ground and delivered competitive epistemic politics by highlighting structural risks. Moreover, they successfully constructed strong SRK and agora by launching press conferences, demonstrations, and campaigns, which created a favorable condition for overturning the government's decision.

4.4. Climate governance and the net-zero movement

4.4.1. Objection target

Since 2020, major states worldwide successively declared commitment to attaining carbon neutrality by 2050. South Korea, China, and Japan, three countries with a manufacturing-oriented economy and high levels of carbon emissions as Taiwan, have made such pledges (GP, 2020a, 2020b), and their actions placed Taiwan under tremendous pressure. At the end of 2020, the Taiwanese government initiated amendments to the Greenhouse Gas Reduction and Management Act and renamed it the Climate Change Adaptation Law. Furthermore, the President declared Taiwan's goal of the 2050 Net-Zero Transition on Earth Day, April 22, 2021, and the Executive Yuan released Taiwan's Pathway to Net-Zero Emissions in 2050 on March 30, 2022 (NDC, 2022). These developments broadly constituted the focus of oversight by

nongovernmental organizations (NGOs) and academia.

Taiwan's major and robust environmental movement groups gradually shifted their attention from environmental and air pollution issues to energy and climate issues. Meanwhile, related activities, such as marches, press conferences, small gatherings, and forums, were organized. Although the Air Clean Taiwan (ACT) staged anti-air pollution, counter-global warming, climate emergency, and other large-scale marches since 2019 with the appeal to de-coal fire, they were unable to shift the focus from anti-air pollution to net-zero emissions (ACT, 2019a, 2019b; Chen, 2019a; Sun, 2019).

This study summarized the types of movements, initiative alliances, appeals, and discourses put forward by several major environmental groups regarding climate issues and responses from the government (Fig. 3; Table 2). It is found that NGOs, although they played an influential role in the discussion of Taiwan's environmental issues, were unable to accumulate the capacities for discourse and public mobilization for climate governance and net-zero issues. This is mainly due to the diffused scope of issues involved and absence of a clear local or national target of resistance, which was previously the case. This finding is similar to Chou and Liou (2021), who stated that general climate governance and net-zero issues lack clear movement targets to achieve immediate effects. They are in contrast to previous movements against pollution, the Kuokuang Petrochemical Project, and air pollution in Taiwan, which contained specific and explicit targets of objection.

4.4.2. Initiatives without alliance

Seemingly, "carbon reduction," "industrial transformation," and "air pollution governance," as three concrete spiral movements for energy transition in Taiwan (Chou et al., 2018a, 2018b), should have received high attention from the public. At this stage, the Taiwanese society was also driven into anxiety to rapidly reduce carbon emissions and achieve the net-zero goal. Industries, in particular, were under mounting pressure from international net-zero requirements. However, NGOs remained unable to form robust initiative alliances with explicit targets of objection, possible immediate changes, and centralized appeals. Although placed at the core of net-zero emissions internationally (IEA, 2021), energy transition was subjected to contradictions among industries, the public, and NGOs in Taiwan. A key reason is the country's long-term reliance on brown energy and economy, which has locked industries and individuals in the cheap energy path (RSPRC, 2019, 2021).

Table 1
Competing risk discourses on the Kuokuang Petrochemical Project.

Risk discourse	Positive knowledge discourse from the government, industries, and academia	Risk knowledge discourse from people against experts
Wetland ecology	The area allocated for the Kuokuang Petrochemical Project accounted for only 13% of the wetland area in Changhua.	Loss of ecosystem diversity and services/functions of the wetlands
Conservation of the Chinese white dolphin	Establishing migration corridors for Chinese white dolphins	Possible extinction of the Chinese white dolphin population in the Eastern Taiwan Strait
Water resources	Constructing the Dadu River barrage for water supply	The water consumption by the Kuokuang Petrochemical Plant would exceed the total water resources carrying capacity of Changhua.
Land subsidence	The principal cause was the long-term groundwater pumping by local residents.	Imbalance in water resource supply and demand would aggravate land subsidence.
Air pollution	The most advanced technologies were adopted to reduce air pollution. Fine particulate matter (PM _{2.5}) levels were excluded from air quality standards.	Pollutants dispersed southward and northward. PM _{2.5} dispersion
Health risks	Environmental scholars used inaccurate assessment methods.	The number of hospitalizations and deaths associated with respiratory and cardiovascular diseases increased by 339–515 people/per year. An average of 23 days of life is lost per person in the national population.
Agriculture and food security	Risk assessment of agricultural products indicated acceptable risks	Taichung Thermal Power Plant and No. 6 Naphtha Cracker were the top two sources of dioxin emissions across the six counties/cities in Central Taiwan. The construction of the Kuokuang Petrochemical Plant would double the pollution effects.
Socioeconomic assessment	The output value of the petrochemical industry accounted for as much as 10% of gross domestic product (GDP). Average annual net benefit reached 169 billion NTW. External cost was 31.2–49.9 billion NTW per year.	The average annual net benefit was less than 50 billion NTW. External costs reached as much as 53.98–148.215 billion NTW. Contributed less than 0.4% to GDP The petrochemical industry contributed little to employment. Lack of domestic demand for ethylene products in the upstream sector of the petrochemical industry
Greenhouse gases and climate change	Adopting low-energy consumption technologies Carbon dioxide (CO ₂) emissions from the plant were estimated to be 1229 tons.	According to academic estimates, CO ₂ emissions from the plant would reach 12–23 million tons. Its CO ₂ emissions, together with those from No. 6 Naphtha Cracker, would account for 1/3 of the national total.
Impacts on coastal landforms	Four billion NTW was allocated for compensation.	Impacted fisheries along Taiwan's west coast Transformed the region into one with a high risk of floods
Rural sustainability	Downsizing development and reducing the impacts of pollution on agriculture and fisheries	The development project devastated the sustainability of agriculture and fisheries.

Source: Statements Against the Construction of the Kuokuang Petrochemical Plant (No. 8 Naphtha Cracker) in Changhua, which was published by the Academic Initiator Group Against the Construction of the Kuokuang Petrochemical Plant (No. 8 Naphtha Cracker) in Changhua (2010a); The Ministry of Economic Affairs Strikes a Balance among Industrial Development, Environmental Conservation, and Public Interests: Statements on the Kuokuang Petrochemical Project Promotion Policies published by the Industrial Development Bureau and MOEA (2010); Refuting the Statements by the Ministry of Economic Affairs—Truths on the Petrochemical Project Unveiled by the Academia () published by the Academic Initiator Group Against the Construction of the Kuokuang Petrochemical Plant (No. 8 Naphtha Cracker) in Changhua (2010b).

During the development of prior environmental movements in Taiwan, people experienced exponential economic growth at the cost of environmental degradation in the 1980s, which drove a wave of anti-pollution protests across the country. The transformation from a victimized body to a suffering body prompted collaboration among local, environmental, and university knowledge groups (Lii and Lin, 2000; Ho, 2006). In the Anti-Kuokuang Movement, university professors strategically and systematically constructed discourses and forged partnerships with local and national environmental groups to establish robust initiative alliances. Furthermore, efforts were elevated from anti-pollution protests to climate change risk movements (Chou, 2015, 2017).

In contrast, although academia and NGOs produced various discourses on climate governance and net-zero transition (e.g., net-zero institution issues, climate reports, establishment of the Climate Change Committee (CCC), de-coal fire, carbon taxation, Green New Deal, Just Transition, carbon footprint verification in response to CBAM, and the Task Force on Climate-Related Financial Disclosures, among other issues) (RSPRC, 2019, 2021; ERF, 2022a, 2022b), partnerships were not formed among environmental groups, scholars, and members of Parliament to establish robust initiative alliances. The main reason was that the transition involved a wide range of issues, which were considered important aspects of net-zero transition. Furthermore, there is a need to supervise and drive the ongoing amendments of the government to the Climate Change Adaptation Law, Net Zero Work Circle established by the Executive Yuan, and 2050 Net Zero Emissions because the absence of a specific target of objection and driving

momentum (due to the broad range of issues involved in the transition and lack of initiative alliances), and lack of initiative alliance rendered political pressure, mobilization, and goals incomparable to any previous environmental protests and movements.

These large-scale, critical issues that involved important transitions were essentially confined to the recentralized bureaucracy decision-making model of a developmental state. The government possessed complete control over the revision of the Climate Change Adaptation Law and planning of pathways to net-zero carbon emissions. Admittedly, the Environmental Protection Administration (Chiu, 2022) organized several public hearings on the Climate Change Adaptation Law from early 2020 to early 2022, and the Executive Yuan established the Net-Zero Work Circle in early April 2021. Both initiatives further established Work Circles on Decarbonized Energy, Industries and Energy Efficiency, Vehicle Electrification, Negative Carbon Technology, and Governance (NCS, 2021). Despite these efforts, major limitations existed in terms of decision making, professionalism, information transparency, and public participation. With precedence given to economic development, that is, the Net-Zero Work Circle, the Executive Yuan engaged six major sectors of the industry in communications, including petrochemicals, steel, electronics, and cement. Although this endeavor claimed to enable relevant sectors to put forward carbon reduction capacity and strategies in a bottom-up manner (interview #2), it was ridiculed as a crude version of regulation mechanisms that lacked foresight (#15). Additionally, the Governance Work Circle also reached out to NGOs in a decentralized manner and convened discussions on six topics (#23). However, the participating NGOs generally regarded the

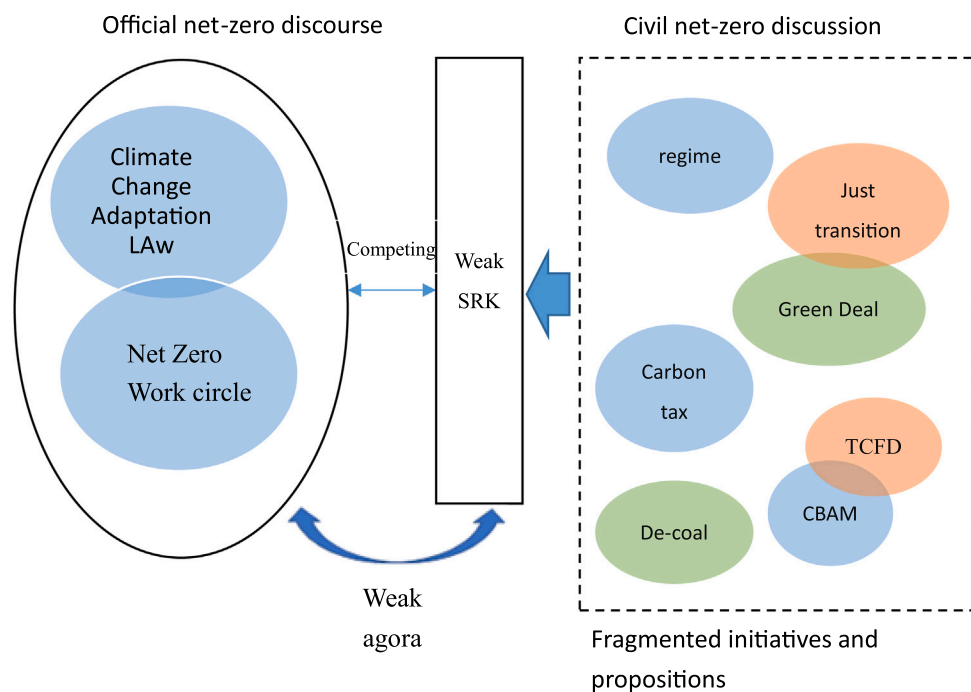


Fig. 3. Agora of discourse struggle.

discussions only as a means of collecting opinions, which did not enable participation in decision making (#18, #19). The government maintained control over amendments to the Climate Change Adaptation Law and issues and decisions discussed in the Net Zero Work Circle. The NGOs or scholars were unable to focus on one area when presented with diverse net-zero-related issues and integrate their efforts to counter the government’s hegemony. Accordingly, their weak SRK failed to form a strong agora to engage in mobilization and discourse competition.

4.4.3. Strategy for mobilization and risk discourse

The Greenhouse Gas Reduction and Management Act, which was passed in September 2015, established a fundamental foothold for Taiwan amid the international trend toward carbon reduction. Although the Act set the nation’s greenhouse gas reduction goal by 2050 to be below 50% of the 2005 level (i.e., below 260 million tons), the action of the Taiwanese government was not consistent with its statement, as over the past decade. Instead of actively promoting carbon reduction policies, the government has been delaying the transition toward climate governance (Chou, 2015).

In terms of social mobilization, the ACT, originally called the Changhua Medical Alliance, actively gathered several NGOs and the Southern Anti-Air Pollution Alliance and organized over six national or regional assemblies and demonstrations between September 2019 and 2021. Their principal appeals were to become coal free and mitigate air pollution, which were further associated with carbon reduction, and called for the government to declare climate emergency (ACT, 2019a, 2019b; Sun, 2020; Wang, 2021). These social mobilization discourses were to channel the energy for anti-air pollution into climate change and carbon reduction or even net-zero emissions or a Green New Deal (Fig. 4).

However, apart from the ACT’s continued social mobilization efforts by organizing demonstrations, NGOs that demonstrated the strongest performance in prior environmental and anti-nuclear protests (i.e., CET, GCAA, the Homemakers Union and Foundation (HUF), and Mom Loves Taiwan) failed to achieve powerful social mobilization. The reason is that the Taiwanese government began amending the Climate Change Adaptation Law and constructing pathways to net-zero emissions in 2020 followed by emerging NGOs such as Greenpeace Taiwan,

Environmental Rights Foundation, and the Taiwan Environment and Planning Association. Most NGOs focused their efforts on initiatives, forums, and advocacy (GCAA, 2019; Yeh et al., 2021; Chin, 2021; CoE, 2022a; GP, 2021a, 2022b) or on participation in in-system public hearings regarding law amendments. Although others engaged in social mobilization (Li, 2019; Lin and Chuang, 2019; GP, 2019, 2020a, 2020b; GP, 2021b, 2021c; GP, 2022c, 2022d, 2022f) or held press conferences (ETA, 2019; GCAA, 2022a, 2022b, 2022c; GCAA, 2022d; ERF, 2022a, 2022b; CoE, 2022c; Li, 2022) (Fig. 4), their actions did not increase political momentum and build political pressure. Their appeals were overlooked to urge the government to accelerate the establishment of pathways to net-zero emissions, reconstruct net-zero institutions, and expand citizen participation to legitimate decision-making.

Regarding executive path strategies for social mobilization, NGOs could only be individually and passively invited to participate in a limited number of meetings organized by the Net Zero Work Circle of the Executive Yuan. They experienced limited involvement even in important work groups, such as industry and governance groups (#12, #15, #18, #21, #23). Net-zero emissions involved a wide range of issues; thus, engaging relevant parties to provide opinions through executive processes, such as EIA or RDC meetings, as observed in the case of the Anti-Kuokuang Movement was unlikely. Similarly, for the legislative path, NGOs generally possessed inadequate capacity for active participation, boycotting, or supervision. Certain NGOs or scholars actively participated in public hearings organized by the EPA on the amendments to the Climate Change Adaptation Law (Chiu, 2022; Hsu, 2022) but had limited time for opinion presentation and had to compete with industry representatives. Regardless, the scope of risk knowledge dispersion and effects of social mobilization were extremely constrained. Regarding the judicial path, Greenpeace Taiwan mobilized students to participate in Fridays for Future, stage sit-in protests in front of the Presidential Office Building in support of the global climate strike movement (Li, 2019; Lin and Chuang, 2019), and launch petitions for climate litigation. They called on the government to tighten regulations over heavy power users (GP, 2020a, 2020b). Nevertheless, these actions failed to expand their scope and become the focus of social attention without a clear target of objection and specific litigation events.

Robust NGOs were still in the transitional stage of issue management

Table 2
Struggle of risk discourse on net-zero emissions.

Risk discourse	Governmental discourse	Nongovernmental discourse
Net-zero institution	The National Council for Sustainable Development of the Executive Yuan, as the main responsible agency, would be sufficiently capable of handling net-zero governance.	Establishing climate reports on the Executive Yuan-level as a cross-sectoral net-zero governance mechanism Establishing a Climate Change Committee to develop national carbon budgets and independently supervise the actions of executive departments Legislation on the Climate Change Adaptation Law
Climate Change Act	Making amendments to the Greenhouse Gas Reduction and Management Act and renaming it the Climate Change Adaptation Law	
Climate change adaptation	Relevant regulations were specified in a special chapter in the Draft of the Climate Change Adaptation Law, Articles 30–33. The powers and responsibilities of the central and local governments were stated in the draft.	Establishing a sub-committee on climate change adaptation under the Climate Change Committee to resolve the problem of unclear principal responsible agencies and tasks Expanding the special chapter on climate change adaptation, integrating eight acts (including the Climate Adaptation Involving National Land Plan Act, Wetland Conservation Act, and Water Act) to achieve cross-domain governance and build a vertical and horizontal governance structure The Net Zero Emissions by 2050 goal should be specified in the Climate Change Adaptation Act.
Inclusion of net-zero emissions into the law	Net zero has been included in the draft.	
Carbon taxation	Carbon fee pricing shows high feasibility. High acceptability by industries Carbon fees will be priced according to international trends and acceptance among industries.	Carbon fees are a type of administrative charge applied on excessively small scales, thereby achieving only limited effects in carbon reduction. Carbon fees (carbon pricing) were extremely low to meet international requirements. Developing carbon taxation to serve as funding for just transitions and a means of social redistribution
New Green Deal	Taiwan's Pathway to Net-Zero Emissions in 2050 has been released.	Taiwan must develop a New Green Deal. Lack of general discourses on green transition Lack of forward-looking discourses on social transition
Just Transition	<ul style="list-style-type: none"> Taiwan's Pathway to Net-Zero Emissions in 2050 was released. Among the four focuses of net-zero emissions, social transition and life transition attached importance to the issue of just transitions. No response regarding the challenges to environmental justice posed by the large projects of inward investment in Taiwan and related review and transparency mechanisms 	<ul style="list-style-type: none"> Greater importance should be attached to just transitions. Establishing a Just Transition Committee Large projects of inward investment in Taiwan have exceeded 1.7 trillion NTW, which will pose challenges to environmental justice in Taiwan regarding electricity consumption, water consumption, and waste, among others.
CBAM	Assessing the impacts of CBAM on Taiwan's industries Drafting carbon tariff clauses in the Draft of the Climate Change Adaptation Law	Paying attention to the impact of carbon tariffs on industries Assisting industries in conducting carbon footprint verifications

Sources: Citizen of the Earth, Taiwan (); Green Citizens' Action Alliance (); Greenpeace (); Taiwan Youth Climate Coalition (); Environmental Rights Foundation (); Air Clean Taiwan (); and Risk Society and Policy Research Center ().

in terms of social mobilization for net-zero issues despite their long-term and deep involvement in pollution and environmental governance issues. They were unable to entirely translate their expertise in previous anti-nuclear, anti-petrochemical pollution, and anti-air pollution movements into the issue of climate governance. They also competed with one another for leadership in issues and social mobilization routes apart from the problems of issue management and transition faced by environmental groups. Hence, actions for net-zero emissions were not connected to the anti-air pollution and counter-global warming assemblies and demonstrations led by the ACT. Unmistakably, NGOs lacked consensus on political and social mobilization for net-zero issues.

In terms of risk discourse strategies, the ACT led several large-scale marches in May 2019, September and December 2019, August 2020, and April and September 2021. In these marches, the de-coal fire appeal was associated with carbon reduction and net-zero issues (ACT, 2019a, 2019b; Sun, 2020; Wang, 2021). However, NGOs held different views on the strategies and timeline of energy transition; thus, they did not support the appeal. However, NGOs established connections with the appeals proposed by the Taiwan Youth Climate Coalition during the Taiwan Youth Climate Marches held in 2019, September 2020, and September 2021. These appeals included urging the government to revise the Greenhouse Gas Reduction and Management Act, declare net-zero emissions by 2050, and propose a Green New Deal, which became the focus of subsequent risk discourses (TYCC, 2019, 2020, 2021, 2022). In addition to appeals proposed during the marches, the major field of risk discourse presentation depended on the joint press conferences of NGOs, which gathered various groups, scholars, and legislators. They also organized forums on various issues to declare the claims for Taiwan's net-zero transition.

The joint press conferences of NGOs could be divided into two types. The first was led by the GCAA, CET, and HUF and constructed discourses

and appeals for net-zero emissions on the basis of the National Nuclear Abolition Action Platform, which previously encouraged various NGOs to stage powerful anti-nuclear movements. The second was led and held by Greenpeace Taiwan, which appealed for net-zero pathway and energy transition issues. Notably, the ACT was never invited to either to voice its opinions.

Since the end of 2020, the main focus of net-zero emissions centered on amendments to the Climate Change Adaptation Law and net-zero pathway planning undertaken by the Net Zero Work Circle, which was initiated by the Executive Yuan. The latter involved policy development, which was closely tied to legal revision. Accordingly, public attention concentrated on several issues (Table 2). Conflicting and compatible views were observed between governmental and nongovernmental discourses. The two sides proposed opposing viewpoints on the net-zero regime, climate adaptation mechanisms, carbon taxation, Green New Deal proposals, just transitions, energy/resource review mechanisms that involve the current large projects of inward investment in Taiwan, and the potential impact of environmental injustice. Regarding compatible discourses, the executive departments incorporated partial opinions from NGOs and scholars and renamed the Greenhouse Gas Reduction and Management Act the Climate Change Adaptation Law. Additionally, the Executive Yuan continued to include Net Zero Emissions by 2050 into law despite dissent by the Chinese National Federation of Industries, which is a leading representative of the industries (Hsieh and Weng, 2022).

Although the two sides appeared to hold opposing yet compatible viewpoints, the government retained the centralized model regarding the operation mechanisms for law revision and net-zero pathway planning. An example is the net-zero regime. The Executive Yuan bypassed the establishment of an independent CCC (RSPRC, 2022). Moreover, it advocated starting with carbon fees and claimed that carbon taxation

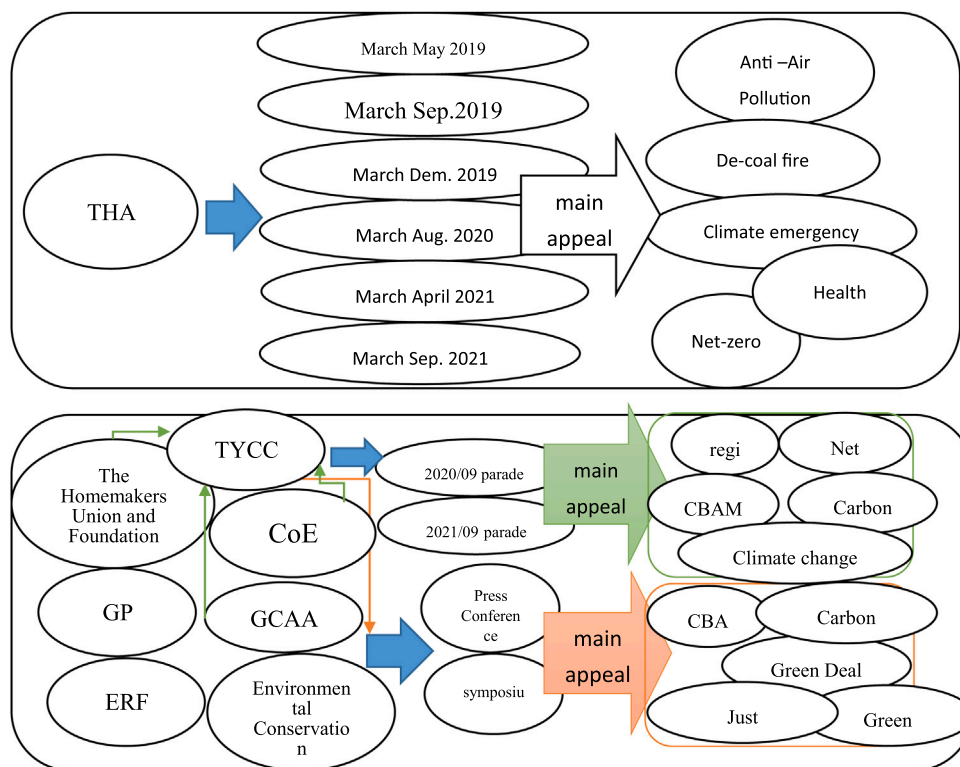


Fig. 4. Mobilization without strong SRK.

would be more likely to receive support from industries. The Executive Yuan tended to consider the fee ranges that are acceptable to the industries instead of communicating with external parties regarding the pricing of carbon fees. For climate adaptation, the government did not support the establishment of independent subcommittees under the CCC. Furthermore, in terms of just transitions, the government prioritized economic growth and investment and continued postponing public communication regarding the potential environmental impacts and social equity issues caused by large projects of inward investment in Taiwan (RSPRC, 2022).

5. Discussion and conclusion

This study provides a summary of the relevant literature on SRK and discusses its conceptual connection with Beck’s reflexive governance (Beck, 2006). It contributes to the existing literature by proposing the elements or criteria of SRK to explain how it possible to respond to climate change. Two cases of environmental movements are adopted to compare Net-Zero Emissions campaigns with Anti-Kuokuang Movement from the perspective of environmental movements. The article acknowledges the theoretical contributions of other literatures to SRK, such as Nowotny (2003), Nowotny, Pieter (2009), Hall and Sanders (2015), Scholz and Steiner (2015), Gudowsky and Peissl (2016). It also refines the theory, introduces the cases of Taiwan as examples, and attempts to verify whether the SRK theory can be used in climate change or net-zero emission campaigns in response to Pisani and Kok’s (2017) construction of SRK to respond to climate change. More importantly, this study offers a critical analysis of the high carbon lock-in (Chou et al., 2022) and the transition dilemma caused by the bureaucratic centralization decision-making model (Kim and Thurbon, 2015) from a sociology of knowledge perspective by analyzing environmental movements.

A comparison between the Anti-Kuokuang Movement and the ongoing Net Zero Movement indicates significant differences in the targets of objection, initiative alliances, and strategies of mobilization. The former protested against an explicit issue, which began from the

local grassroots level and gradually expanded to the national level. Moreover, it evolved from supervision by environmental groups to the active participation of the academic, healthcare, and even arts and cultural communities, who shared common objection targets. The participants initiated social mobilization using discourses on rational risk knowledge combined with emotional, nostalgic literary and artistic creations through multilevel, multifaceted appeals. The study focused on their multifaceted appeals, which contained systematic risk knowledge and discourses actively initiated by academia. This knowledge and discourses formed strong SRK. The study infers that the mobilization strategies at the rational, emotional, local, and national levels formed a solid SRK package and successfully reframed the cogitations of the Taiwanese society on the development of industries with high carbon emissions, energy consumption, and pollution. Editorial articles in major newspapers generally supported the need to review the impact of this major construction project on Taiwan’s sustainability in all aspects. Moreover, in a poll conducted by the China Times (2011), the public expressed their reservation and opposition to a major development project for the first time. Ultimately, the government’s decision was overturned.

The ongoing Net Zero Movement undoubtedly lacks a clear objection target, and environmental groups, which transitioned from explicit pollution protests to climate change and global warming issues, lack a comprehensive understanding of the situation. Additionally, disparities exist among different environmental groups regarding issue appeals, mobilization strategies, phases, and leadership. Furthermore, their appeals involved diverse and divergent ranges of issues from anti-global warming to net zero. These conditions create obstacles to building cohesive collaboration among environmental groups and narrowing down the targets being supervised. Consequently, this scenario leads to the loss of robust political momentum.

On the surface, nongovernmental discourses seemingly focus on various net-zero issues and share common appeals for executive departments. As a result, certain degrees of SRK were presented, and resistance or competition against government policies was constructed.

In reality, civil groups independently convene marches and launch joint press conferences; they present disconnected initiatives without forging specific alliances for a common cause because they lack consensus on the target of political mobilization. Moreover, the role of the academic community in the Anti-Kuokuang Movement is weak. Specifically, they work in close alliance with NGOs and produce specific risk knowledge to launch social mobilization campaigns, such as marches or press conferences, and create political mobilization effects through strong risk discourses. Although certain scholars or the Risk Society and Policy Research Center organized forums or conferences to supervise and urge the government to take action or participated in press conferences held by NGOs, no political momentum was generated. The issues and discourses highlighted by civic groups only delivered weak SRK in reality. Without establishing a common cause and collaborating for social and political mobilization, civic groups are unable to construct a strong agora with weak SRK.

Thus, the question emerges: what is the significance of a strong or weak agora constructed by the two movements to a developmental state that has long prioritized economic development and to a high-carbon socioeconomic body? Particularly, what inspires Taiwan's current unstable transition toward net-zero emissions?

According to the International Energy Agency (2021), Taiwan, Japan, South Korea, and China have high-carbon economies. Additionally, they are classified as developmental states in terms of climate governance. When driving green growth, they generally adopt a top-down approach, that is, the central bureaucracy leads decision making. Furthermore, they are oriented toward industrial competition (Dent (2012, 2017); Han (2015); Heo (2015); Kim (2015); Kim and Thurbon (2015); Chou (2022)). In this context, failure to construct a strong SRK and create an agora that can resist and compete against the government may not render breakthrough progress, which could result in a delayed green transition.

The Anti-Kuokuang Movement constructed highly solid SRK. Through multilevel and multifaceted social mobilization campaigns, it created robust risk discourses and social mobilization to support an agora that could compete against the government and contain tremendously powerful political momentum. Although the movement only eliminated one major national development project with high energy consumption, carbon emissions, and pollution, it urged the Taiwanese society to earnestly reflect on the development of industries and sustainability. Only when this movement gained victory did the government truly stop launching construction projects with high carbon emissions. Otherwise, the government said one thing and did another despite the countless national energy, sustainability, or industry conferences previously held. Although they pledged to make adjustments to industries with high carbon emissions, they never ceased promoting these industries (Chou, 2015, 2017).

Nevertheless, this one-off movement that shifted the focus of Taiwan from anti-pollution to climate change risks was unable to truly change the decision-making model of a developmental state and its orientation toward economic development. Although anti-air pollution movements were extended from the Anti-Kuokuang Movement in 2011 and the EPA established official standards and regulations for PM_{2.5} in 2012, further transition from anti-air pollution to climate change and carbon reduction issues remained difficult. For an economy and society with reinforced carbon lock-in, where the government, industries, and public were accustomed to low-cost electricity, water, and labor force, many obstacles and barriers remain.

Against this background, environmental groups and scholars have diverged opinions on a broad range of net-zero issues (e.g., carbon taxation, carbon tariff, climate regimes, Green New Deal, and just transitions), which presents disconnected knowledge initiatives. Social mobilization without forging an accord and establishing a common cause could only create a weak SRK and an agora that lacked political momentum. Following Messner (2015), Taiwan currently stays between Phases I (climate change and global warming initiatives) and II

(institutionalization). As such, achieving Phase III, where the society completely transitions to a green path, may take a long time. However, countries worldwide are taking rapid actions to drive net-zero transition after the 26th UN Climate Change Conference of the Parties in 2021.

Comprehensively reframing the social development framework and creating additional elements or opportunities for social transition to a green path is without strong SRK and an active agora. Similarly, forming a counter force to supervise and drive the government to promote net-zero emissions with a focus on policy and speed, thereby compelling changes in the recentralized bureaucratic policy-making model of developmental states, is difficult. Accordingly, in the process of promoting Net Zero by 2050, government authorities merely pro forma invite NGOs to participate in public hearings or discussions in the governance work circle. The process lacks transparency, democratic participation, and co-design. This scenario results in the inability of civil society groups to assist government departments in mainstreaming climate policy. Disconnected and fragmented initiatives proposed by NGOs or academia are unable to supersede the authoritarian decision-making model.

Therefore, inconsistencies are observed in government undertaking. The government is fervently promoting the use of green energy, but it is hesitating in planning the timeline and policy tools for carbon reduction (e.g., only low carbon fees were formulated) due to concerns over industrial competition and pressure from industries. This tendency results in severe delays in climate governance and further subjects Taiwan to real pressures and obstacles in its net-zero transition at the domestic and international levels.

This article examines the importance of strong or weak SRK, constructed by the Anti-Kuokuang movement and the ongoing net-zero movement, for high-carbon socio-economies. By analyzing the differences between these two movements, this study aims to contribute to the relatively lacking aspects of environmental politics and policy research by using the strong and weak SRK analytic framework. The former has succeeded in its multi-layered and multifaceted social mobilization campaign, which has created a strong risk discourse and social mobilization to support a strong dynamic of social transition that can compete with the government and contain extremely powerful political momentum. The latter case, relatively speaking, illustrates the lack of clear opposition and consensus among environmental groups on the goals of political mobilization, leading to delays in net-zero policies.

From the perspective and approach of knowledge society and civic movement, the SRK analysis framework adopted in this study is of reference value for developmental states to promote the research and practice of net-zero transition and environmental governance. Some research has shown that environmental movements and civil society in Taiwan, Japan, and South Korea have different backgrounds, structures and characteristics (Miyamoto and Nakamura, 2016; Kojima and Ozaki, 2018; Hasegawa, 2020; Lee and Min, 2016; Fan, 2017; Shin, 2017; Chou, 2018; Kao and Chen, 2018). Therefore, even though the legacy of developmental states is similar in some ways, there are significant differences in environmental awareness and activism between these countries. The above studies and this study show that Taiwan's transition to a net-zero emission society is subject to serious delayism, whether at the international and geopolitical level, the national and market level, or the civil society level. Although Taiwan has a vibrant civil society with strong public participation in environmental decision-making processes, the transition to a net-zero SRK in Taiwan has been characterized by deadlock and delayism due to several factors.

In conclusion, the SRK analysis framework provides a comparative analysis of two cases and emphasizes the importance of involving multiple stakeholders in the knowledge production process, which is both scientifically and socially relevant. The SRK analysis framework, with its social knowledge and political dimensions, is particularly beneficial for countries experiencing rapid development and complex environmental challenges. By using the SRK analysis framework, policymakers and practitioners can make informed decisions by taking into account both

scientific evidence and societal needs, thereby contributing to effective and sustainable environmental governance.

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CRedit authorship contribution statement

Kuei-Tien Chou and David Walther: Conceptualization, Methodology, Software, Data Curation; **Kuei-Tien Chou and David Walther:** Writing-Original Draft Preparation; **Mu-Xin Lin and David Walther:** Visualization, Investigation; **Kuei-Tien Chou and David Walther:** Supervision; **Mu-Xin Lin:** Software, Validation; **Kuei-Tien Chou and David Walther:** Writing-Review & Editing; **Kuei-Tien Chou:** Project Administration, Funding Acquisition.

Declaration of Competing Interest

The authors declare that they have no competing interests.

Data Availability

Data will be made available on request.

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