

Article

## Policy Instruments for Eco-Innovation in Asian Countries

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**Abstract:** Eco-innovation globally emerged as an effort to implement sustainable development. States and firms established and implemented policies and strategies for eco-innovation as one route to achieving sustainable development. Eco-innovation has been facilitated in developed countries, specifically OECD members and European countries, through action plans. Recently, eco-innovation policies have emerged in developing countries. Thus, this study analyzes eco-innovation policies in Asian countries. Policies related to eco-innovation in 17 Asian countries were investigated using policy instrument categories. National policies for eco-innovation were interpreted and compared with development stage classifications. The results indicate that there are similar and different policy approaches to eco-innovation in Asian countries. Given the balance between a technology push (supply side) and a market pull (demand side) in policy instruments for eco-innovation, 17 countries were identified by four categories: leaders, followers, loungers, and laggards. The results provide insight for designing national strategies for eco-innovation in Asia's developing countries. Therefore, this research contributes to facilitating and diffusing eco-innovation toward sustainability in Asia.

**Keywords:** eco-innovation; policy instruments; sustainable development; Asia

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## 1. Introduction

The global community set sustainable development as a goal for present and future generations at the United Nations Conference on Environment and Development (UNCED), which was held in Rio de Janeiro in 1992. Sustainable development is “a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development, and institutional change are all in harmony and enhance both current and future potential to meet human needs and aspirations” [1]. According to Principle 11 of Rio’s Declaration on Environment and Development, which was agreed upon by 108 states, states shall enact effective environmental legislation to achieve sustainable development and a higher quality of life for all people [1]. Agenda 21 acknowledged that business and industry play a crucial role in reducing impacts on resource use and the environment through more efficient production processes, preventive strategies, and cleaner production technologies and procedures. In this context, eco-innovation emerged as an important pathway towards sustainable development in the business sector. OECD’s report [2] clearly states eco-innovation’s important role in pursuing green growth policy agendas at the national level. Eco-innovation can be a key catalyst for promoting and implementing green growth because it promotes all forms of innovation that reduce environmental impacts and strengthen resilience to environmental pressures. As one effort toward sustainable development, eco-innovation leads the transition to a green economy. A green economy is a method to realize sustainable development at national, regional, and global levels in ways that resonate with and diffuse the implementation of Agenda 21 [3].

As the first to test eco-innovation, European countries initiated various eco-innovation tools that fostered regional programs, including an Environmental Technology Action Plan (ETAP), Eco-Innovation Action Plan (EcoAP), Accelerating Eco-innovation Policies (ECOPOL), and the Competitiveness and Innovation Framework Program (CIP). Since then, other non-European countries have followed the European Commission and European governments’ steps to develop national strategies and regional roadmaps for stimulating eco-innovation [2]. In academia, most prior research on eco-innovation examined eco-innovation in developed countries, with a focus on European countries [4–9]. There were a few case studies on eco-innovation in developing countries, such as India [10], Taiwan [11–15], Japan [16], and the Republic of Korea [17]. It is important to pay attention to eco-innovation in developing countries, especially in Asian countries. Currently, the total population of Asian countries constitutes 55.0% of the world’s population. Their total gross domestic product (GDP) reflects up to 32.7% of world’s total GDP [18]. The economic growth of emerging economies in Asia is rapidly increasing and has attracted manufacturing facilities of multinational companies. As such, Asian countries’ environmental burden is high and Asian countries’ CO<sub>2</sub> emissions from fuel combustion constitute 67.8% of the world’s CO<sub>2</sub> emissions [19]. Implementing eco-innovation in Asian countries may contribute to achieving global sustainable development as well as green growth.

The role of the government is crucial for implementing and diffusing eco-innovation at the national level. Governments can develop social structures that enable producing eco-friendly goods and services [20]. Introducing governmental policies is often required at the earliest stage of eco-innovation. Governments can establish and implement policy instruments for eco-innovation, such as environmental regulations, financial schemes, and programs for supporting R&D and fostering eco-markets [21]. Policy instruments can motivate business and industry to attempt to implement eco-innovation as a policy goal [22].

Therefore, this study identifies and compares eco-innovation policies in 17 Asian countries using an analytical framework that is based on the policy instrument type. Additionally, we propose several recommendations for governments to promote eco-innovation. This research contributes to facilitating and diffusing eco-innovation towards sustainable development in Asia.

## 2. Eco-Innovation

### 2.1. Definition of Eco-Innovation

Eco-innovation can be defined as “all efforts from relevant actors that introduce, develop, and apply new ideas, behaviors, products and processes and contribute to reducing environmental burdens or ecologically specified sustainability targets” [23]. Eco-innovation is a broad concept, comprising innovation in pollution control (new, better, or cheaper abatement technology), green products, cleaner process technologies, green energy technology and transport technologies, and waste reduction and handling techniques [24]. This term is frequently used in conjunction with “eco-efficiency” and “eco-design.” Eco-innovation creates and develops new business opportunities and benefits by preventing or reducing negative impacts or optimizing the use of natural resources. Therefore, eco-innovation is closely related to the development and use of environmental technologies as well as the concepts of eco-efficiency and eco-industry [25]. Initially, eco-innovation merely focused on production and processes [26], but has been expanded to management systems [27], creating new markets [28], organizations [29], institutions [30,31], material flow, and social eco-innovation [32].

The Eco Innovation Observatory (EIO) clarified and identified six types of eco-innovation. The first four types (production, process, marketing, and organization) were derived from the Oslo report [33]. In this report, innovation is defined as “the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations” [33]. In particular, these types of eco-innovation derived from innovation are clarified specifically by characteristics specific to target point and its effect: end-of-pipeline pollution technology, integrated cleaner production technologies, and environmental R&D [30,34–36]. By stages, eco-friendly technology has become a priority for markets and governments. The remaining two types of eco-innovation from EIO’s report include social and system eco-innovations, which emphasize economic, social, and environmental elements, the triple bottom line [37] of sustainable development. Adding these two eco-innovation types extends its scope to include institutions, markets, and social actors. Establishing sustainable production and consumption patterns is the common aim of eco-innovation. Practical examples of eco-innovation include processes to recover valuable substances from waste water, more efficient food packaging, producing construction materials from recycled waste, eco-products, and new management methods [25]. Therefore, eco-innovation contributes to an eco-friendly lifestyle by introducing new technology for reducing environmental impacts [10,25].

Eco-innovation can be implemented when regulations affect “technology forcing”. The benefits of eco-innovation include reducing the burden and costs of meeting environmental regulations. There are also secondary benefits that can increase competition between companies and countries by creating new markets for environmentally desirable products and processes that correspond to employment

effects and so on [23]. Systematic eco-innovation and its diffusion can be described as ecological modernization [38]. Ecological modernization refers to restructuring the capitalist political economy along environmentally sound lines. Ecological modernization theory has been developed and modified. From the early to late 1980s, the approach emphasized the role of technological innovations in environmental reform. The second period, which was from the late 1980s to the mid-1990s, emphasized a balanced view of the respective roles of states and the market. Since the mid-1990s, ecological modernization has broadened to an ecological transformation of consumption. These approaches indicate three aims for ecological modernization: technological innovations from industries, institutional supports from the government, and ecological consumption by citizens.

In the early 1980s, ecological modernization was primarily developed in a small group of western European countries [38], such as Norway, Germany, and Sweden [39]. Recently, ecological modernization was diffused in developing countries, such as Vietnam [40] and China [41], with different methods than in the developed countries.

## 2.2. Determinants of Eco-Innovation

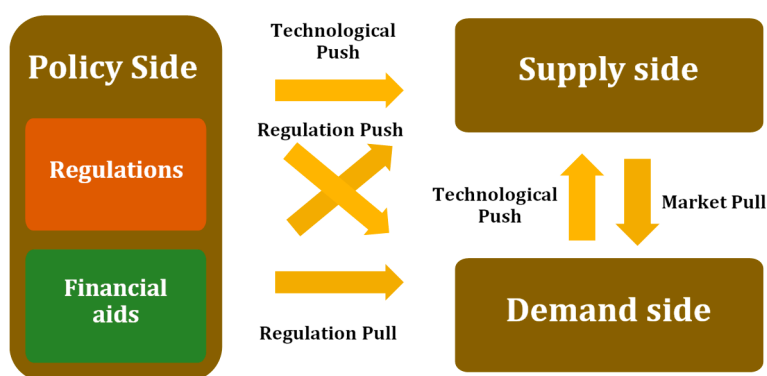
Several scholars have studied the determinants of eco-innovation given international efforts to implement and diffuse eco-innovation toward sustainable development. Horbach [42] classified the determinants into three sides: supply, demand, and policy (Table 1). The supply side includes technological capabilities for eco-innovation and possibilities for appropriating problem and market characteristics. The demand side is the expected market demand on environmentally friendly products. It reflects social needs and awareness and preferences for environmentally friendly products. The policy side includes the institutions that implement eco-innovation. It includes political opportunities for environmentally oriented groups, organizing information flow and existing innovation networks. It can be presented as a technology push, market pull, and regulation push/pull. Eco-innovation policies cover all of the determinants that were classified by Horbach [42].

**Table 1.** Three determinants of eco-innovation [42].

Elements	Contents
Supply	Technological capabilities (knowledge capacities) Appropriation problems and market characteristics
Demand	(Expected) market demand (the demand pull hypothesis) Social awareness of the need for clean production; environmental consciousness and preferences for environmentally friendly products
Institutional and political influences	Environmental policy instruments Institutional structure

Technological capabilities, including knowledge capacities, are the main determinants of eco-innovation on the supply side (Table 1). The Oslo manual [33] includes knowledge as one factor for eco-innovation. A firm that cooperates with research institutes and universities is more active in all types of eco-innovation [9]. Several studies indicate that monopolistic market structures may help to overcome problems with appropriation, specifically for large firms because they fear less imitation from competitors and gain more from the scale economies that are associated with innovation [7,42].

Currently, there is a consensus that the technology push is particularly important during the initial phase of an innovation's life cycle, which includes developing a new product, while demand factors, such as the market pull, are more important during the diffusion phase [42]. In particular, environmental regulation may lead to eco-innovation by forcing technological improvements in the initial phase of an innovation [42]. In the diffusion phase of new (environmental) products, the demand from consumers, public procurement, and other firms and exports is important [43,44]. Horbach [42] argues that positive demand expectations can trigger innovations. The best guarantee of accelerated private investment in innovation is the expectation of rapidly growing demand for products based on those new technologies [45,46]. Environmental regulations that encourage new technologies to respond and financial systems are external determinants of eco-innovation [47–50]. The Porter hypothesis [47] postulates that environmental regulations may lead to win-win situations to reduce pollution and increase profits. Therefore, environmental regulations may force firms to implement economically benign environmental innovations [42]. Furthermore, there are currently other strategies to lead eco-innovation. Encouraging soft environmental measures, such as environmental accounting systems, may improve eco-innovation's information base. In addition to environmental policy instruments and regulations, soft instruments, such as voluntary commitments, eco-audits, and eco-labels, may determine innovative behavior in firms. This typifies a new phase in environmental policies that promotes broader sustainability rather than addressing single environmental issues. From this perspective, governments rely less on regulatory tools and seek to work with industries [51]. A second component of the Porter hypothesis states that environmental policies may induce early mover advantages for regulated firms, which may lead to higher future profits.



**Figure 1.** The interactions among the determinants of eco-innovation. Note: modified from Horbach [42].

Interactions among the determinants of eco-innovation are represented in Figure 1. Governmental policies function in two ways: regulation push and market pull. Regulations provide an environmental technology push to the supply side. Regulations require the supply side to meet standards. Financial aids, such as R&D investments or fiscal benefits, can help to develop eco-technologies. In addition, the policy side offers programs for environmental procurement and consumer awareness to create eco-innovation markets. Financial aids contribute to forming and supporting eco-innovation markets. Therefore, as one determinant of eco-innovation, environmental policies stimulate and support the two other determinants: supply and demand. Consequently, environmental policies establish an enabling environment toward

eco-innovation. The supply and demand sides interact with each other. Technological progress facilitates creating and activating markets through products and services. Markets stimulate technological development. Therefore, the supply and demand sides motivate each other towards eco-innovation. The diagram of interaction among determinants of eco-innovation will be applied to this study on interpreting policy instruments for eco-innovation in selected countries.

### 3. Policy Instruments

In the process of policy making, policies are formed and implemented by selecting and using policy instruments. Public policy instruments are “the set of techniques by which governmental authorities wield their power in attempting to ensure support and effect or prevent social change” [52]. Governments play a crucial role as policy-makers who use policy instruments. There are three types of public policy instruments: regulatory, economic, and informational [53–55]. In this study, we added planning instruments based on Park’s study [56] (p. 38). Regulatory instruments comprise all regulatory political interventions that formally influence social and economic action through binding “regulations” [55]. These instruments are traditional government instruments that are used to solve social and economic conflicts. They suggest norms and acceptable behaviors while limiting certain activities in a society [57]. Regulations refer to the obligatory rules, orders, directives, norms, standards, and statutory provisions that are backed by negative or positive government sanctions [52]. Thus, they are described as the “governments’ stick” [57].

Economic instruments are fiscal and other economic incentives and disincentives to incorporate environmental costs and benefits into the budgets of households and enterprises, with the objective to encourage environmentally sound and efficient production and consumption. Economic instruments include effluent taxes or charges on pollutants and waste, deposit-refund systems, and tradable pollution permits [58]. Subsidies for environmental R&D and investments can also be viewed as an economic instrument as they rely on the use of economic incentives.

Informational instruments are political intervention methods that formally influence social and economic action through information [55]. Such information includes the measures undertaken to influence the addressees through knowledge transfer, communicating an argument, persuasion, advice, moral appeal, and so on [52].

Planning instruments are political mechanisms that aim to solve problems in planning through innovative designs [56,59]. A plan is a sort of consciously intended course of action [60]. The national plans present policy goals and strategies, steer certain policies, and initiate a policy dialogue. They indicate co-ordination of other policy instruments including regulatory and economic instruments [2]. Similar to regulatory instruments, politicians and administrations dominate planning instruments. Planning instruments include national plans, programs, and roadmaps that the governments create, such as national plans on sustainable development or eco-innovation roadmaps.

### 4. Method

This study aimed to analyze eco-innovation policies in Asian countries. 17 countries in Asia that were in different stages of economic development, according to the WEF [61], were selected as target countries (Table 2). The selected countries are Asian members of the Asia-Europe Meeting (ASEM),

which was established in 1996. ASEM has initiated several platforms for dialogue on sustainable development and environment between Asia and Europe. The selected countries participate in communicating issues on sustainable development and environment, including eco-innovation through ASEM. This study investigated the eco-innovation policies of 17 countries. Eco-innovation policies were examined with six categories that were organized by sector: environmental protection and management, waste, renewable energy, purchase or procurement, clean technology, and climate change. This paper collected and analyzed policy documents, including national plans, legislation texts, national and international policy reports, and research articles on eco-innovation. The review of the documents is a vehicle to gather information on eco-innovation policies. Given time and budget limitations, we excluded face-to-face interviews with local experts. Content on eco-innovation policies was categorized in relation to public policy instruments (Table 3). Regulatory instruments include laws, regulations, orders, and decisions. Economic instruments include financial schemes that are related to funds, grants, subsidies, and taxes. Informational instruments include several types of networks among actors and communication activities, such as forums, conferences, workshops, and exhibitions. Planning instruments include national plans, strategies, programs, actions, and roadmaps. Due to the limited availability of data written in English, informational instruments were excluded in this research. Six sectors were used to interpret plans and regulatory instruments: environmental protection and management, waste, renewable energy, purchase or procurement, clean technology, and climate change. As shown in Figure 2, these sectors cover the social, economic, and environmental dimensions. This study investigated the national plans, regulations, and financial mechanisms as institutional interventions for eco-innovation.

**Table 2.** Economic development stages in selected Asian countries [61].

Stage	Countries
1	Vietnam, Lao PDR *, India, Pakistan, Cambodia *, Bangladesh *, and Myanmar *
1–2	Mongolia, Philippines, and Brunei Darussalam
2	China, Thailand, and Indonesia
2–3	Malaysia
3	Singapore, Japan, and Republic of Korea

\* Least Developed Countries (LDC).

**Table 3.** Types of policy instruments.

Type	Content
Regulatory instruments	Laws, regulations, orders, and decisions
Economic instruments	Grants, taxes, and subsidies
Informational instruments *	Training, forums, conferences, workshops, and exhibitions
Planning instruments	National plans, strategies, programs, actions, and roadmaps

\* Excluded in this research.

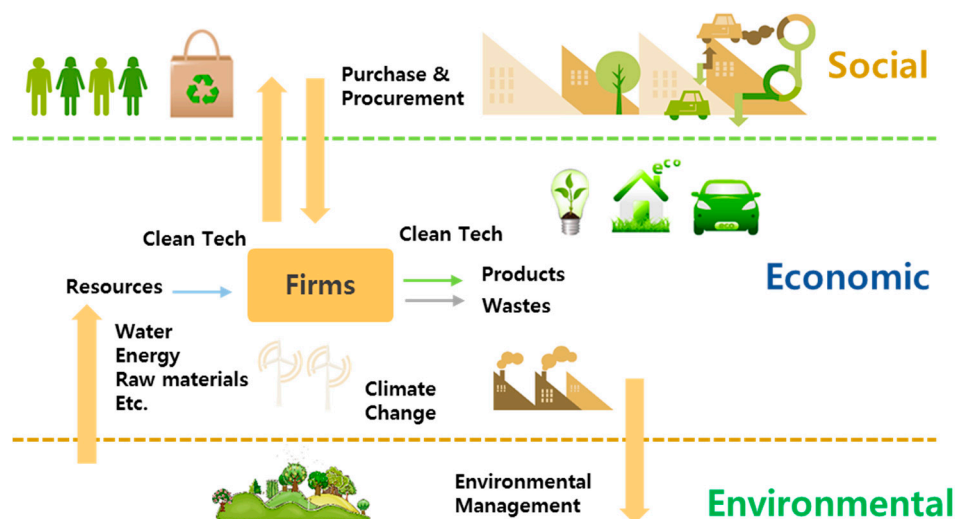


Figure 2. Eco-innovation sectors.

## 5. Results

Eco-innovation policies in 17 Asian countries were described with three public policy instruments: planning, regulatory, and economic. The sectors are subject to national plans and programs as planning instruments, legislation as regulatory instruments, and financial mechanisms as economic instruments.

### 5.1. Planning Instruments: National Plans and Programs

National plans and programs on sustainable development and eco-innovation were investigated in the selected 17 countries. We also examined plans and programs supported by international organizations and other countries. The plans reflect policy priorities. Each country established a national sustainable development strategy or a national Agenda 21 after the 1992 UNCED (Table 4). Most of the selected countries initiated national plans for green growth and innovation in the 2000s. National plans include several sectors that are related to eco-innovation, such as environmental protection, waste, renewable energy, purchase/procurement, clean technology, and climate change. However, Mongolia, Brunei Darussalam, and Myanmar have not yet initiated national plans that are directly related to eco-innovation. All target countries emphasized innovative green technologies in their national plans. Except for Brunei Darussalam, all countries introduced strategies for vitalizing renewable energy and mitigating and adapting to climate change. Several countries established policies for green purchasing or green procurement, which can be referred to as integrating environmental considerations into purchasing policies, programs, and actions [62]. Green procurement is also used to promote the development of green innovation [63]. Compared to private businesses, governments can be more effective through public procurement in initiating green purchasing [21] (p. 9). Governments play a key role as large-scale purchasers in the market economy [64]. Therefore, they can support sustainable public procurement start-up phases. In Thailand, in 2008, cabinet resolutions endorsed the National Green Procurement Plan and required government sectors to implement the plan [21] (p. 18). In Malaysia, the Ministry of Finance plays an important role as the largest buyer in advancing green procurement [21] (p. 18).



**Table 4.** Planning instruments for eco-innovation.

Economic Stage	Country	National Plan and Strategy		Sector						International Support		
		Sustainability	Eco-Innovation	I	II	III	IV	V	VI			
3	Singapore	Singapore Green Plan (1992, revised 2012)			0	0	0	0	0	0		
		Sustainable Singapore Blueprint 2015 (2009)			0	0	0	-	0	0		
		Maritime Singapore Green Initiative (2011)			-	0	-	-	0	0		
			Top Runner Program (1998)			-	-	0	-	0	0	
			Japan's Strategy for a Sustainable Society (2007)			0	0	0	0	0	0	3Rs (Reduce, Reuse, Recycle) Initiative (2005)
		Japan	New Growth Strategy (2009–2010)			-	-	0	-	0	-	
			Strategic Energy Plan (2010, 2014)			-	0	0	0	0	-	
			Green Innovation Strategy (2010)			-	-	0	-	0	0	
			Third Science and Technology Basic Plan (2006–2010)			-	-	0	-	0	-	
			Fourth Science and Technology Basic Plan (2011–2015)			-	-	0	-	0	-	
		Republic of Korea	Green Vision 21 1996–2005 (1995)			0	0	-	-	0	0	
			National Action Plan for the Implementation of Agenda 21 (1996)			0	0	-	-	0	0	
			Ten-Year National Plan for Energy Technology Development 1997–2006			-	-	0	-	0	0	
			Ten-Year Basic Plan for the Development and Dissemination of New and Renewable Technologies (2003)			-	-	0	-	0	0	
			First National Energy Master Plan 2008–2030 (2008)			0	-	0	0	0	0	
	Green New Deal (2009–2012)				0	0	0	-	0	0		
	Five-Year Plan for Green Growth 2009–2013				0	0	0	0	0	0		
	Five-Year Plan for Green Growth 2014–2018			0	0	0	0	0	0			
		Green Growth Strategy (2009–2050)			0	0	0	0	0	0		

Table 4. Cont.

Economic Stage	Country	National Plan and Strategy		Sector						International Support	
		Sustainability	Eco-Innovation	I	II	III	IV	V	VI		
2–3	Malaysia	10th Malaysia Plan (2011–2015)		0	0	0	0	0	0	0	Switch-Asia Project
			National Renewable Energy Policy and Action Plan (2009)	-	0	0	0	0	0	-	
			Green Technology Master Plan 2030 (2013)	0	0	0	0	0	0	-	
			National Strategic Plan for Solid Waste Management (2005)	-	0	-	-	-	-	-	
			Master Plan on National Waste Minimization (2006)	-	0	-	-	-	-	-	3R (supported by Japan's International Cooperation Agency)
	China	China's Agenda 21 (1994)		0	0	0	0	0	0	0	Switch-Asia Project
			Energy Saving and New Energy Vehicle Development Plan 2011–2020 (2009)	-	-	-	0	0	-		
			Agenda 21 (1993)	0	0	0	-	0	0		Switch-Asia Project
			Plan for Enhancement and Conservation of National Environmental Quality (1997)	0	-	-	-	0	-		
2	Thailand	Thailand Climate Change Master Plan 2013–2050 (2012)		0	-	0	-	0	0		
			National Green Procurement Plan (2008)	-	-	-	0	-	-		
			National Science Technology and Innovation Policy 2012–2021 (2011)	0	-	0	0	0	0		
			Thailand 20-Year Energy Efficiency Development Plan (2011–2030)	0	-	0	0	0	0		
			Green Growth Strategic Plan 2013–2018 (2013)	0	0	0	-	0	0		
	Indonesia	Indonesia Agenda 21 (1992)		0	-	-	-	0	0		Indonesia-Singapore Environmental Partnership (ISEP) (2002)
			National Action Plan on GHG Emission Reduction (2010)	0	0	0	-	-	0		
			National Energy Policy (2006)	-	-	0	0	0	-		APEC Policy Partnership on Science, Technology and Innovation (PPSTI)
			Indonesia's Energy Vision 25/25 (2011)	-	0	0	0	0	0	0	Eco-Industry Program (2009) Green Investment Program (2010–2011) Switch-Asia Project
											GIZ Forests and Climate Change Program (FORCLIME) (2008–2010)

Table 4. Cont.

Economic Stage	Country	National Plan and Strategy		Sector						International Support
		Sustainability	Eco-Innovation	I	II	III	IV	V	VI	
1–2	Mongolia	Mongolian National Sustainable Development Agenda (2005)		0	0	0	0	0	0	Switch-Asia Project
		Philippines Agenda 21 (1996)		0	0	-	-	0	-	Switch-Asia Project
	Philippines	Philippine Development Plan 2011–2016 (2011)		0	0	0	-	0	0	
		National Climate Change Action Plan 2011–2028 (2011)		0	0	-	-	0	0	
		Philippine Energy Plan 2008–2030 (2008)		-	-	0	-	0	0	
		National Action Plan on Sustainable Public Procurement 2010–2012 (2010)		-	-	-	0	-	-	
		Wawasan Brunei 2035 (Vision Brunei 2035)		0	-	-	-	0	-	
		Socio-economic Development Strategy for 1991–2000		0	0	-	-	0	-	
1	Vietnam	Five Year Socio-economic Development Plan 2006–2010		0	0	-	-	0	-	
		The Socio-Economic Development Strategy for 2011–2020		0	0	-	-	0	0	Sustainable Product Innovation Project (SPIN) VCL (Vietnam, Cambodia, Laos) (2010–2013)
		Strategic Orientation for Sustainable Development (Vietnam Agenda 21) (2004)		0	0	0	-	0	0	Vietnam Energy Efficiency and Cleaner Production (EECP) Financing Program (2010–2011)
		Climate Change Adaptation (2011)		0	-	-	-	0	0	Vietnam Energy Efficiency Program (VNEEP) (2006)
		National Energy Master Plan (2007)		-	-	0	0	0	-	Vietnam Clean Production and Energy Efficiency Project (2011–2016)
		National Green Growth Strategy for the Period 2011–2020 with a Vision to 2050 (2013)		0	0	0	0	0	0	
				0	0	0	0	0	0	

Table 4. Cont.

Economic Stage	Country	National Plan and Strategy		Sector						International Support	
		Sustainability	Eco-Innovation	I	II	III	IV	V	VI		
1	Lao PDR	Strategic Framework for National Sustainable Development Strategy (2008)		o	o	o	-	o	o	Sustainable Product Innovation Project (SPIN) VCL (Vietnam, Cambodia, Laos) (2010–2013)	
		Ecotourism Strategy and Action Plan 2005–2010 (2004)		o	-	-	o	-	-		
		Sustainable Transport Strategy 2020 (2005)		-	-	-	-	o	-		
		Renewable Energy Strategy to 2025 (2011)		-	-	o	-	o	o		
		Ninth Five-year Plan with SD recognized (1997-2002)		o	o	o	o	o	o	Switch-Asia Project	
	India		Science, Technology and Innovation Policy (2013)		-	-	-	-	o	o	
			National Biofuel Policy (2008)		-	-	o	o	o	-	
			Strategic Plan for New and Renewable Energy Sector (2011–2017)		-	-	o	o	o	-	
		Agenda 21		o	-	-	-	o	o	Switch-Asia Project	
		National Sustainable Development Strategy (2012)		o	o	o	o	o	o		
Pakistan		Alternative and Renewable Energy Policy (2011)		o	-	o	o	o	o		
		Pakistan Energy Vision 2035 (2014)		-	-	o	o	o	o		
Cambodia		National Strategic Development Plan 2009 - 2013 (2009)		o	o	o	o	o	o	Sustainable Product Innovation Project (SPIN) VCL (Vietnam, Cambodia, Laos) (2010–2013)	
		National Green Growth Roadmap (2010)		o	o	o	o	o	o		
Bangladesh		National Sustainable Development Strategy (2009)		o	o	o	-	o	o	Switch-Asia Project	
		Bangladesh Climate Change Strategy and Action Plan (BCCSAP) (2008)		o	-	o	-	o	o		
Myanmar		Myanmar Agenda 21 (1997)		o	o	o	-	-	-	Switch-Asia Project	
		National Sustainable Development Strategy (2009)		o	o	o	o	o	o		

I: Environmental protection and management; II: Waste; III: Renewable energy; IV: Purchase/ Procurement; V: Clean technology; VI: Climate change; “o”: recognizable; “-”: not recognizable.

The national programs in the selected countries mostly emphasize carbon reduction and renewable energy. Brunei Darussalam, Lao PDR, Cambodia, Bangladesh, and Myanmar did not initiate national programs for eco-innovation. Except for Brunei Darussalam, four of the least developed countries lacked institutional approaches to eco-innovation.

Japan initiated eco-innovation-related national programs earlier than other Asian countries. Japan started the Top Runner Program in 1998 to improve the energy efficiency of end-use products. The Top Runner Program is evaluated as an effective approach for setting mandatory energy efficiency standards based on the most efficient products on the market [65]. Japan internationally introduced its excellent experiences on the 3Rs (Reduce, Reuse, and Recycle) in waste management and attempted to be a leading nation for creating a sustainable materials cycle through the 3Rs in Asia [66]. Japan's government proposed the 3Rs initiative during the G8 summit in 2004. The 3Rs activities are widespread in Asian countries. All countries selected in this research participated in the Regional 3R Forum that was launched in 2009. The Fourth Regional 3R Forum, which was held in March 2013, adopted the Hanoi 3R Declaration, Sustainable Goals for Asia and the Pacific for 2013–2023, which aims to provide a basic framework for Asia-Pacific countries to develop measures and programs to promote the 3Rs towards transitioning to a resource-efficient and green economy [67]. Japan supported establishing a national plan on waste management, including the 3Rs, in other Asian countries such as Malaysia.

Internationally, European countries contributed to introducing eco-innovation to Asia. The European Union made the issue of sustainable consumption and production a priority in its regional cooperation strategy from 2007 to 2013. In 2008, the European Commission launched the SWITCH-Asia program to promote sustainable products, processes, services, and consumption patterns in Asia. As of 2015, a total of 86 grant-funded projects have been initiated in 16 Asian countries [68]. Additionally, the “Sustainable Product Innovation Project (SPIN),” as a SWITCH-Asia Program, has been conducted in Lao PDR, Cambodia, and Vietnam. SPIN contributed to improving innovative power for industry, targeted food processing, textiles, footwear, handicraft, and furniture [69]. Foreign investment flows can contribute to diffusion of eco-innovation from the developed to developing countries [70].

## *5.2. Regulatory and Economic Instruments*

Each country established environmental laws (Table 5). Japan, Malaysia, and Thailand introduced environmental protection and conservation laws in the 1970s and other countries followed in the 1990s and 2000s. Environmental laws began with laws that controlled environmental pollution, such as the Environmental Quality Act (1974) in Malaysia and the Basic Law for Environmental Pollution Control (1967) in Japan.

Table 5. Legislation for eco-innovation.

Economic Stage	Country	Environmental Protection and Management	Waste	(Renewable) Energy	Purchase/ Procurement	Clean Technology	Climate Change
	Singapore	Environmental Protection and Management Act (1999, revised 2002) Environmental Pollution Control Act 1999	Hazardous Waste Act (1998)	Energy Conservation Act (2012)	-	Agency for Science, Technology and Research Act (1990, revised 2002)	-
3	Japan	Basic Law for Environmental Pollution Control (1967) Nature Conservation Law (1972) Basic Environmental Law (1993)	Waste Management and Public Cleansing Law (1970)	Renewable Portfolio Standard (2003)	Green Purchasing Law (2000) Act on Special Measures Concerning Procurement of Renewable Electric Energy Operators of Electric Utilities (2012) Act on Purchase of Renewable Energy Sourced Electricity by Electric Utilities (2012)	Science and Technology Basic Law (1995)	Act on Promotion of Global Warming Countermeasures (1998) Law Concerning the Promotion of Contracts considering Reduction of GHG Emissions by the State and Other Entities (Green Contract Law) (2007)
	Republic of Korea	Natural Environment Conservation Act (1991) Environment Health Act (2008)	Waste Control Act (1986)	Act on the Promotion of the Development, Use and Diffusion of New and Renewable energy (2004) Basic Law on Low Carbon Green Energy (2010)	Act on Promotion of Purchase of Green Products (2005) Renewable Portfolio Standard (RPS) (2012) Renewable Energy Certificates (REC) (2013)	Development of and Support for Environmental Technology Act (2000, revised 2008)	Act on the Allocation and Trading of Greenhouse-Gas Emission Permits (2012) Framework Act and Low Carbon and Green Growth (2010)

Table 5. Cont.

Economic Stage	Country	Environmental Protection and Management	Waste	(Renewable) Energy	Purchase/ Procurement	Clean Technology	Climate Change
2–3	Malaysia	Environmental Quality Act (1974)	Solid Waste and Public Cleansing Management Act (2007)	Renewable Energy Act (2011) Sustainable Energy Development Authority Act (2011) Malaysia Biofuels Industry Act (2007) Efficient Management of Electrical Energy Regulations (2008)	-	Environmental Quality Act (1974, revised 2012)	-
	China	Environmental Protection Law (1989)	Law of the People's Republic of China on the Prevention and Control of Environmental Pollution by Solid Waste (1995)	Renewable Energy Law (2005) Energy Conservation Law (2007)	Government Procurement Law (GPL) (2003) Cleaner Production Promotion Law (2002 issued; 2012 revised)	Clean Production Promotion Law (2003, revised 2012) China Science and Technology Promotion Law (2007)	Law of the People's Republic of China on the Desert Prevention and Transformation (2001))
2	Thailand	Enhancement and Conservation of National Environmental Quality Act (NEQA) (1975, revised 1992) Thailand Constitution (1997)	-	Energy Conservation Promotion Act (1992, revision 2007)	-	Enhancement and Conservation of National Environmental Quality Act (NEQA) (1975, revised 1992)	-
	Indonesia	Act No. 4 (1982, revised 1997) Law No. 32/2009 on Environmental Protection and Management (2009)	Waste Management Law No. 18	Geothermal Law No. 27/2003 (2003) MEMR decision No. 2/2004 (2004) Presidential Regulation No. 5/2006 (2006) Governmental Regulation No. 70/2009 (2009)	-	Law of the Republic of Indonesia No. 27 (2003)	Presidential Regulation of the Republic of Indonesia No 61 (2011)

Table 5. Cont.

Economic Stage	Country	Environmental Protection and Management	Waste	(Renewable) Energy	Purchase/Procurement	Clean Technology	Climate Change
1–2	Mongolia	Environmental Protection Law (1995, revised 2007)	Law on Prohibition and Export of Hazardous Waste (2000) Law on Household and Industrial Waste Management (2003) Law on Payment of Package and Case Imported Goods (2005)	Energy Law of Mongolia (2001) Renewable Energy Law (2007)	-	Law on Technology Transfers (1998)	-
	Philippines	Wildlife Resources Conservation and Protection Act (2001)	Ecological Solid Waste Management Act (2000)	Biofuels Act (2007) Renewable Energy Act (2008)	Executive Order No. 301(1987, revised 2004)	Philippines Technology Transfer Act (2009) Philippines Clean Air Act (1999)	Climate Change Act of 2009
	Brunei Darussalam	Wildlife Protection Law (1981)	-	-	-	-	-
1	Vietnam	Environmental Protection Law (2005)	Regulation of Management of Hazardous Waste (1999) National Technical Regulation on Hazardous Waste Threshold (2009)	Law on Energy Efficiency No: 50/2010/QH12 (2010)	-	Law on Science and Technology (No. 21/2000/QH10) (2000)	Decision No. 158; QD-TTg Approving the National Target Program on Response to Climate Change (2008)
	Lao PDR	Environmental Protection Law (1999)	-	-	-	Environmental Protection Law (1999)	-
	India	EIA Notification for Environmental Clearance (2006) National Green Tribunal Act (NGT) (2010) National Environmental Assessment and Monitoring Authority (2014)	Air (Prevention and Control of Pollution) Act (1981) Recycled Plastics Manufacture and Usage Rules (1999)	Energy Conservation Act (2001, revised 2010)	-	Motor Vehicles Act (1988) Air (Prevention and Control of Pollution) Act (1981)	-



Table 5. Cont.

Economic Stage	Country	Environmental Protection and Management	Waste	(Renewable) Energy	Purchase/Procurement	Clean Technology	Climate Change
	Pakistan	Pakistan Environmental Protection Act (1997)	Hazardous Substances Rules (1999)	Renewable Energy Technologies Act (2010)	-	National Clean Air Act	-
	Cambodia	Law on Environmental Protection and Natural Resource Management (1996)	-	-	-	-	-
1	Bangladesh	Bangladesh Environment Conservation Act (1995)	Bangladesh Environment Conservation Act and Rules (1995)	Bangladesh Water and Power Development Boards Order (1972)	-	Bangladesh Water and Power Development Boards Order (1972)	Climate Change Trust Fund Act (2010)
	Myanmar	Environmental Conservation Law (2012) Environmental Conservation Rules (2014)	-	-	-	Science and Technology Development Law (1994)	-

“-”: not recognizable.

Japan, the Republic of Korea, and China established laws for green purchasing: the Law Concerning the Promotion of Procurement of Eco-Friendly Goods and Services, the Act on Promotion of Purchase of Green Products, and the Government Procurement Law. In China, according to the Government Procurement Law that was enacted in 2003, government green procurement has been implemented since 2005 [21] (p. 13). Central governmental agencies and provincial-level governments have been required to preferentially purchase energy-saving labeled products that are listed in the Government Procurement List on Energy-Saving Products that is released by the Ministry of Finance and the National Development and Reform Commission [64].

Except for Brunei Darussalam, Cambodia, Lao PDR, and Myanmar, all countries established legislation on energy efficiency and renewable energy. Japan, the Republic of Korea, Malaysia, China, Mongolia, the Philippines, and Pakistan initiated specific acts on renewable energy. Ten countries (Japan, the Republic of Korea, Malaysia, China, Thailand, Indonesia, Mongolia, Philippines, Vietnam, and India) introduced a feed-in-tariff (FIT) scheme for renewable energy. The Republic of Korea replaced the renewable portfolio standard (RPS) with a FIT scheme. A FIT is a form of price regulation in which the government purchases electricity at a fixed price. By contrast, RPS is a quantity regulation that lets the market determine reasonable prices for power. In this approach, governments set targets or quotas to ensure that a certain market share of electricity capacity or generation comes from renewable energy sources [71]. Singapore offers tax incentives for renewable energy. This indicates that renewable energy is recognized as a key sector for eco-innovation in Asia.

Japan, the Republic of Korea, and the Philippines initiated specific laws on climate change. Vietnam and Indonesia established regulations on climate change. Specifically, Bangladesh, which is ranked 1st in the 2015 climate change vulnerability index [72], established the Climate Change Trust Fund Act in 2010. Some countries established climate change funds (Table 6). China established the China Green Carbon Fund in 2008. This fund encourages enterprises to invest in afforestation to reduce carbon emissions and mitigate climate change [69,73,74]. Bangladesh, Cambodia, and Indonesia established climate change funds. The Bangladesh Climate Change Resilience Fund is a country-led financing mechanism. Development partners, including Denmark, the European Union, Sweden, the United Kingdom, and Switzerland provided financial support for this fund [75].

Almost all countries (except for Brunei Darussalam, Lao PDR, India, Cambodia, and Myanmar) initiated financial schemes for promoting green technology (Table 6). Singapore provides funding through a Grants for Energy Efficient Technologies (GREET) program and China provides energy service companies with tax incentives (tax reductions) and subsidies [76] (p. 12–13). Singapore and Japan fund environmental R&D, including the field of energy. The Republic of Korea implemented the 21st Century Frontier R&D Program to develop technologies such as hydrogen energy and carbon dioxide reductions from 1999 to 2010 [51]. The Republic of Korea provides a tax credit of 20% (30% for small and medium-sized companies) for R&D activities in four areas: electric, hybrid, plug-in or clean diesel vehicles; solar batteries; wind and geothermal energy; and carbon capture and storage [76] (p. 17).

**Table 6.** Economic instruments for eco-innovation.

Economic Stage	Country	Title of Economic Instruments		
3	Singapore	Innovation for Environmental Sustainability (IES) Fund (2001)		
		3R Fund (2009)		
		Energy Efficiency Improvement Assistance Scheme (EASe) (2005)		
		Grant for Energy Efficient Technologies (GREET)		
		One-Year Accelerated Depreciation Allowance for Energy Efficient Equipment and Technology (ADAS)		
		Design for Efficiency Scheme (DfE) (2008)		
		Clean Energy Research and Testbedding Program (CERT) (2007)		
		Energy Research Development Fund (ERDF) (2008)		
		Pilot Building Retrofit Energy Efficiency Financing (BREEF) Scheme (2011)		
		Green Mark Incentive Scheme for Existing Buildings (GMIS-EB) (2015)		
		Green Mark Incentive Scheme—Design Prototype (GMIS-DP) (2015)		
		Sustainable Construction Capability Development Fund (SC Fund) (2010)		
		Water Efficiency Fund (WEF) (2007)		
		Clean Development Mechanism Documentation Grant (2008)		
Tax Incentives for Renewable Energy (2014)				
3	Japan	Japan Fund for Global Environment (JFGE) (1993)		
		JPMorgan Japan Technology Fund (2005)		
		Japan's Voluntary Emissions Trading Scheme (JVETS) (2005)		
		Global Environment Research Fund (2010)		
		Environment Technology Development Fund (2010)		
		Grant-in-Aid for Scientific Research (about stabilizing a sound material-cycle society) (2011)		
		Green Fund (2013)		
		Green Vehicle Purchasing Promotion Program (2009)		
		Eco-Car Tax Breaks (2009)		
		Feed-in-Tariff Scheme for Renewable Energy (2009)		
		Tax for Climate Change Mitigation (2012)		
		Funding Program for World-Leading Innovative R&D on Science and Technology (FIRST Program) (2009)		
		3	Republic of Korea	Environmental Improvement Fund (1992)
				21st Century Frontier R&D Program (1999)
Eco-Technopia 21 Project (2001)				
Environmental Venture Fund (2001)				
Environmental Industry Promotion Fund (2009)				
Recycling Industry Promoting Loan (2012)				
Fiscal Incentives for Renewable Energy (2009)				
Feed-in-Tariff Scheme for Renewable Energy (replaced by the RPS) (2006)				

Table 6. Cont.

Economic Stage	Country	Title of Economic Instruments
2–3	Malaysia	Incentives for Building obtaining GBI (Green Building Index) Certificate (2009)
		Green Technology Financing Scheme (2010)
		Renewable Energy Fund (2011)
		Feed in Tariff for Renewable Energy (2011)
		GEF UNIDO Global Clean Tech Program for SMEs (2013)
		Malaysia-Japan Clean Tech Fund (2013)
2	China	Green Investment Tax Allowance (GITA) (2014)
		Golden Sun Program (2009)
		Tax Rebate for Wind Energy Producers (2013)
		Renewable Energy Development Fund (2008)
		China CDM Fund (2006)
		Green Carbon Fund (2008)
	Thailand	Mobilizing financing from National New Products Program & National Key Technologies R&D Program (1986)
		National Basic Research Program of China (973 Program) (1997)
		National Hi-tech R&D Program (863 Program) (1986)
		Innovation Fund for Technology-based Firms (1986)
		Feed-in-Tariff Scheme for Renewable Energy (2011)
Indonesia	Energy Conservation Promotion Fund (ECPF) (1993)	
	Power Development Fund (2010)	
	Clean Technology Fund (2009)	
	Feed-in-Tariff Scheme (2006)	
Mongolia	Fiscal incentives for sale of carbon credits (2009)	
	Eco-industry Program (2009)	
	Green Investment Program (2011)	
1–2	Philippines	Environmental Soft Loans(for SMEs) (2008)
		The Indonesia Climate Change Trust Fund (2010)
		Feed-in Tariff Scheme for Renewable Energy (2012)
		GEF Small Grants Program (2002)
		Feed-in-Tariff Range for Renewable Energy (2007)
1–2	Philippines	Philippines Sustainable Energy Finance Program (2008)
		Sustainable Entrepreneurship Enhancement and Development Program (SEED) (2004)
		Clean Technology Fund Investment Plan for the Philippines (2012)
		Fiscal incentives for Renewable Energy (2008)
1–2	Brunei Darussalam	Feed-in-Tariff Scheme (2012)
		-

Table 6. Cont.

Economic Stage	Country	Title of Economic Instruments
1	Vietnam	Vietnam Energy Efficiency and Cleaner Production (EECP) Financing Program (2010)
		Feed-in-Tariff for Renewable Energy (2011)
		Fiscal Incentives for Renewable Energy (2008)
	Lao PDR	-
	India	Feed-in-Tariff scheme for renewable energy (2010)
	Pakistan	Provincial Sustainable Development Funds (2011)
	Cambodia	Cambodia Climate Change Alliance (CCCA) Trust Fund (2011)
	Bangladesh	Clean Technology Fund (2008)
		Bangladesh Climate Change Resilience Fund (2010)
	Myanmar	-

“-”: not recognizable.

## 6. Discussion and Conclusions

This study elucidated eco-innovation policies in 17 Asian countries by policy instrument type and economic development stage. This study investigated three types of policy instruments: planning, regulatory, and economic. The selected countries had similarities and differences in arranging policy instruments for eco-innovation. Similarly, all 17 countries initiated planning instruments such as national plans for sustainable development or eco-innovation that included six sectors: environmental protection, waste management, renewable energy, green purchases/procurement, clean technology, and climate change. The national plans indicate that the 17 countries have a political desire to implement eco-innovation policies. The national plans include national strategies for environmental protection and green technologies in all target countries. All countries established and implemented strategies related to renewable energy and climate change, except for Brunei Darussalam. This result is similar to European cases. According to the review of ETAP roadmaps [8] (p. 61), European countries give technological priority to climate change mitigation and energy conservation/renewable energy generation in eco-innovation policies. The planning instruments indicate that governments introduce regulatory and economic instruments to accomplish policy objectives. It takes time to establish and implement legislation and financial schemes after initiating a national plan. Each country differently introduced regulatory and economic instruments for eco-innovation based on its own resources and capacities. In this study, institutional approaches were explained and linked to five development stages (1, 1–2, 2, 2–3, and 3). In the countries in stages 1 and 1–2 (transition countries from stages 1 to 2), eco-innovation policies are being developed as part of sustainable development visions and strategies. Lao PDR, Myanmar, and Brunei Darussalam did not establish specific national regulations and economic mechanisms for eco-innovation. For these countries, it is necessary to provide strategic consultation and supports for technological innovation in the early stage of eco-innovation as the first step toward ecological modernization [38]. The countries in stages 2 and 2–3 (transition countries from stage 2 to 3) established and implemented national visions and plans for eco-innovation and developed specific eco-innovation policy instruments. In particular, Malaysia, China, and Thailand initiated green

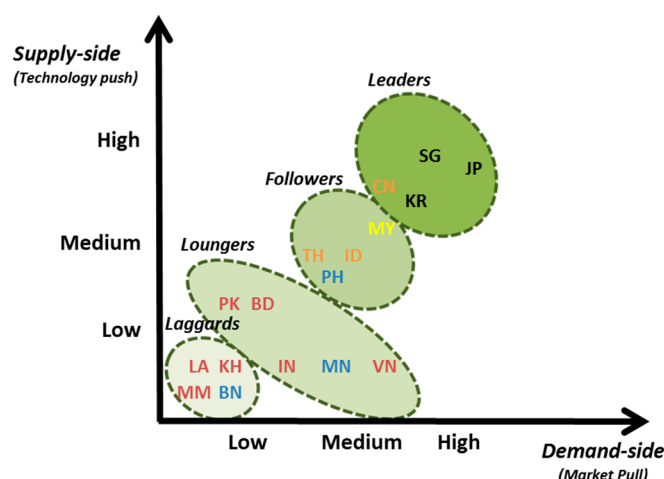
public procurement systems and FIT schemes for renewable energy. They are investing several sectors into eco-innovation while introducing national green markets. The countries in stage 3 promoted eco-innovation based on high economic and technological development. They established long-term plans related to eco-innovation and green economies. They adopted several policy instruments in multiple sectors to achieve eco-innovation. Japan, the Republic of Korea, and Singapore contribute to promoting eco-innovation in other Asian countries. Japan made efforts to create a sustainable material cycle through the 3Rs in Asia. The green growth national strategy of the Republic of Korea [77] can be a model for designing national strategies for green growth in other Asian countries.

As the national plans reflect policy priority of energy conservation and renewable energy generation, most of the selected countries established regulations in the energy sector. In particular, Japan and the Republic of Korea introduced more regulations in the energy sector than other Asian countries. Energy-sector based environmental policy stringency in OECD countries was measured with the number of market-based and non-market regulations in 2012 [78]. Japan's and Korea's scores of environmental policy stringency are close to the average of other OECD countries.

Given the interactions among the determinants of eco-innovation (Figure 1), policy instruments for eco-innovation have two approaches: technology push (supply-side instruments) and market pull (demand-side instruments). The technology push concept assumes a supply-side-driven and mainly linear process from research to development and ultimately to diffusion [79]. The supply-side instruments include investment in innovation activities such as research and development (R&D) support. The market pull concept postulates anticipated market demand as a key determinant of innovation [79]. The demand-side instruments include incentives to create markets for innovative products [2]. The selected Asian countries adopted both approaches. 11 countries in development stages 1 to 3 established R&D programs and financing mechanisms for developing clean technologies as a supply-side instrument. Singapore, Japan, the Republic of Korea, and China established specific funds for R&D on pushing clean technology. As demand-side instruments, these countries introduced grants and subsidies to create markets for innovative products. FIT schemes and green public procurement (GPP) programs were established and implemented in many of the selected countries. Ten countries in development stages 1 to 3 adopted a FIT scheme for renewable energy. Several countries in development stages 1 to 3 (Japan, Republic of Korea, Malaysia, Thailand, China, India, Vietnam, Singapore, the Philippines, and Indonesia) are members of an International Green Purchasing Network, which was founded in 2005 [80]. They introduced GPP to enhance producing green products to increase green growth. GPP is one of several practices that is linked to ecological modernization [64]. It indicates government institutional support in the second scope of ecological modernization [38].

Given the balance between the technology push (supply side) and the market pull (demand side) in policy instruments for eco-innovation, the selected Asian countries can be mapped as shown in Figure 3. The three levels of supply-side and demand-side instruments are based on this study's results that were reported in Section 5. We did not consider the size and scale of the policy instruments but the number of policy instruments. The levels are classified by the number of economic instruments in Table 6 into low, medium, and high. The levels of policy instruments indicate relative positions among the selected countries for establishing and implementing eco-innovation policies. In the progress of eco-innovation, 17 countries can be related to all four categories: leaders, followers, loungers, and laggards [81]. Singapore, Japan, the Republic of Korea, and China are leaders in Asian eco-innovation.

They introduced technology push (supply side) and market pull (demand side) instruments in balance. They have the financial capacity to facilitate technological progress and market development. They are regarded as pioneers of ecological modernization in Asia [39,41,82]. Japan, with its high level of technical and financial resources, is a front-runner in Asian eco-innovation. Remarkably, China, one of the middle-income countries, also emerged as a leader. Thailand, Indonesia, Malaysia, and the Philippines follow the trend of eco-innovation policies. Pakistan, Vietnam, India, Mongolia, and Bangladesh are loungers that slowly catch up to eco-innovation approaches. Myanmar, Lao PDR, Brunei Darussalam, and Cambodia are laggards in eco-innovation. They lack both the technology push (supply side) and the market pull (demand side) instruments for eco-innovation. They have insufficient resources to achieve eco-innovation. In economically and technically less advanced countries, technology transfer is the principal source of innovation [8]. They have conducted eco-innovation projects by depending on external financial and technical support, such as the SWITCH-Asia program from the European Commission. The laggard group, which has low economic development needs, external inputs for introducing policy instruments for eco-innovation. The result of mapping indicates that higher income countries in stages 2, 2–3, and 3 established more policy instruments than countries in stages 1 and 1–2. The choice of instruments to support eco-innovation is related to a country's level of development [2]. Following the Environmental Kuznets Curve hypothesis [83], we can assume, when a certain level of income per capita is reached, that economic growth leads to environmental improvements due to environmental regulations, better technology, and higher environmental expenditures [70]. In this study, higher-income countries actively initiated supply-side instruments to support eco-innovation and preferred R&D support. Less advanced countries tend to rely more on demand-side instruments. This trend is similar to European countries [2]. These results of mapping might be a meaningful tool for Asian governments to understand the status quo for eco-innovation and improve their capacity for coordinating the mix of policies while balancing supply-side and demand-side instruments.



**Figure 3.** Mapping supply- and demand-side instruments for eco-innovation in 17 Asian countries. [Note] Bangladesh: BD; Brunei Darussalam: BN; Cambodia: KH; China: CN; India: IN; Indonesia: ID; Japan: JP; Republic of Korea: KR; Lao PDR: LA; Malaysia: MY; Mongolia: MN; Myanmar: MM; Pakistan: PK; Philippines: PH; Singapore: SG; Thailand: TH; Vietnam: VN. The color used for the name of the country indicates its economic development stage: red: stage 1; blue: stage 1–2; orange: stage 2; yellow: stage 1–2; black: stage 3.

In conclusion, this study focuses on co-ordination of policy towards eco-innovation. It provides information on institutional framework conditions for eco-innovation in Asian countries by analyzing policy instruments. It helps us to understand the different approaches and efforts to eco-innovation by Asian countries. The research findings contribute to extending our knowledge about the combination of policy instruments in Asia [24].

However, there are several limitations in terms of data collection and interpretation. Publicly available data on eco-innovation policies in the selected Asian countries are scarce. We primarily depended on data that was written in English to analyze eco-innovation policies in the selected Asian countries. Given the lack of data, we could not conduct in-depth analyses of eco-innovation policies. Eco-innovation policies in the developing and least developed countries can be known through case studies. In future research, case studies on eco-innovation should be conducted through collaborations with local experts. The analysis of cross-country patterns of eco-innovation adoption should shed light on different contexts and socioeconomic factors [70]. This study examined the structure of policy instruments for eco-innovation in selected countries. Policy instrument choice does not directly affect environmental performance [24]. Further research is needed to investigate how policy instruments were implemented in each country. This research focused on state-led eco-innovation. The eco-innovation activities of private sectors, such as enterprises and civil associations, should be investigated to gain a better understanding of eco-innovation in practice. Despite these challenges, this study provides insight into designing national strategies for eco-innovation in Asia's developing countries. Therefore, it contributes to facilitating and diffusing eco-innovation toward sustainability in Asia.

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### **Author Contributions**

The manuscript was collaboratively written by Eun Kyung Jang and Mi Sun Park. Tae Woo Roh and Ki Joo Han contributed to designing the study and interpreting the results. All authors have read and approved the final manuscript.

### **Conflicts of Interest**

The authors declare no conflict of interest.

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