Net-Zero Main Campus: Virtual-Physical Integration and Coordinated Implementation Plan

Background

The Net-Zero technology ecosystem comprises diverse organizations that provide critical support to startups. By guiding innovators through complex and dynamic technological, financial, organizational, and commercial landscapes, the ecosystem facilitates the transition of conceptual ideas into practical, real-world innovations. Net-Zero technology incubators often serve as pivotal hubs that strengthen regional innovation ecosystems, encompassing a wide range of roles and stakeholders. While technological innovation pathways differ case by case, Net-Zero entrepreneurs typically face extended development timelines and significant systemic challenges.

To address these challenges, the "Net-Zero Technology Innovation Program" seeks to implement the Net-Zero Main Campus, which aims to bridge the gap between laboratory-stage innovation and industrial-scale commercial verification, accelerating the deployment and diffusion of innovative green technology. Centered on specific industrial clusters and integrated with regional supply chains, the Campus is expected to establish a comprehensive environment for technology demonstration and adoption. By operationalizing a seamless mechanism from R&D through Verification to Commercialization, the program intends to deliver co-benefits for both green growth and a sustainable net-zero society.

Global Outlook and Domestic Progress

1. Introduction to Net-Zero Technology Innovation and Development Mechanisms

The Net-Zero Technology Incubation Network comprises diverse support organizations dedicated to Net-Zero startups. By facilitating enhanced regional coordination and international cooperation, the network advances the collective interests and well-being of the Net-Zero entrepreneurial community. This framework enables the Innovation Programs to expand outreach, connections, and collaboration, both domestically and internationally, thereby establishing a robust global support architecture to drive development at scale.

The Net-Zero technology startup trajectory and the various organizational entities that provide critical support in transforming conceptual ideas into practical applications and services. It is noted that only a limited number of entrepreneurs successfully navigate this protracted journey. While these stages are presented sequentially, the actual path toward commercialization is inherently non-linear and may involve intermittent progress. Iterative cycles within specific stages are frequently required to ensure that innovative solutions fulfill technological and commercial objectives, regulatory standards, and market demands.

A closer examination of Technology Readiness Levels (TRLs), funding accessibility, and the Net-Zero technology innovation roadmap reveals that technology transfer and the broader commercialization process overlap across the three primary stages of Research, Development, and Deployment. During the development and deployment phases, public funding typically declines, while the engineering complexities

and financial requirements of prototype development and pilot demonstrations in real-world environments remain substantial. Without access to commercial financing, many innovative technologies fail to navigate the "Valley of Death" due to inherent investment risks. Net-Zero technology incubators are designed to bridge the gap between public and private funding while providing essential technical and business services to facilitate a smoother transition.

The following sections will respectively outline the implementation strategies for the Research, Development, and Deployment (RD&D) stages within the Net-Zero technology startup trajectory.

A. The Research Phase

During the research phase, a wealth of resources for exploratory research, conceptualization, and Proof of Concept (PoC) testing is available to support entrepreneurs. Startup teams typically leverage support from multiple organizations. In addition to their foundational ties with universities, these teams often transition to incubators and independent testing laboratories during early stages. They receive technical transfer support from various entities within the regional innovation ecosystem and, bolstered by funding from relevant institutions, work to implement their Net-Zero innovations through real-world demonstrations.

B. The Development Phase

Once a Net-Zero innovation project completes its PoC and enters the development phase, participants within the Net-Zero technology incubation network step in to support technology transfer. The incubation resources provided, ranging from verification testing to technical and business services, can be categorized into four primary models:

(1) Lab-Embedded Incubation: These programs center on providing access to experimental or testing facilities at national laboratories, while others operate in close coordination with universities. Funding is provided to facilitate collaborations with academic institutions, enabling technology transfer or technical assistance that effectively de-risks technological development.

(2) Physical Incubators: Certain Net-Zero incubators provide dedicated physical spaces to support technology entrepreneurs through residency and centralized resources.

(3) Grand Challenges: Through "Grand Challenges," business plan competitions, and other competitive events, entrepreneurs present their innovations at Demo Days or pitch events. These platforms connect them with investors, corporations, and strategic stakeholders who can facilitate development and deployment, ensuring entrepreneurs are market-ready and competitive.

(4) Pilot Demonstrations: These programs focus on helping entrepreneurs secure funding sources and cultivate strategic partnerships necessary for field-scale validation.

C. The Development Phase

The Net-Zero technology industry requires significant time and capital to scale innovations and replace incumbent technologies. This capital-intensive nature often leads to unfavorable risk-return profiles for traditional capital sources; consequently, conventional venture capital models may not be fully effective in this sector. In response, governments and the private sector globally have launched long-term funding programs. Lead innovators are increasingly committing to support Net-Zero solutions, providing the programmatic stability required to nurture, accelerate, and rapidly scale these technologies for widespread adoption. Furthermore, robust and sustained policy commitments and pricing signals are pivotal to driving market transformation and reducing cost barriers to large-scale deployment.

As entrepreneurs focus on securing capital, acquiring customers, and scaling production, they must iteratively refine their solutions based on operational insights and customer feedback from real-world demonstrations. Engaging in partnerships with corporate groups and trade associations can significantly streamline this transition.

2. Implementation Strategies for Net-Zero Technology Innovation

To align green growth with the Net-Zero transition, it is imperative to cultivate a comprehensive international business ecosystem. A robust framework and promotion mechanism must be established among the government, academia, startup support organizations, investment entities, corporate partners, and professional service providers. Furthermore, the planning and operation of this ecosystem should adopt a corporate-led, market-driven operational logic.

Frontier technology development serves as the bedrock for future industrial innovation. Consequently, research and academic institutions must proactively showcase R&D breakthroughs for industrial utilization, while the industry should provide insights into current market demands and the technological requirements for future products. To address the strategic gaps within Taiwan’s domestic Net-Zero startup environment, the following

measures are recommended:

A. Phase-Specific Support Frameworks and Subsidiary Mechanisms

The economic ecosystem for innovative Net-Zero technologies requires distinct implementation strategies across the seedling, early, and mature stages of development. Support programs and subsidiary mechanisms should be tailored to these specific development phases to effectively support Net-Zero innovation.

B. Mission-Oriented Innovation Programs to Facilitate Market Entry

Currently, most Net-Zero research in Taiwan is conducted through government subsidies to universities or research institutes. Without a subsequent startup mechanism, it remains challenging to deliver these technologies into a viable Net-Zero industry. It is recommended that the government implement mission-oriented innovation programs to provide targeted support for Net-Zero startups and enterprises as they navigate market entry.

C. Multi-Stakeholder Engagement in Net-Zero Innovation

Unlike conventional businesses, green energy technologies require protracted testing and validation in coordination with public utilities. Given the inherent risks of Net-Zero solutions, Taiwan should leverage international best practices by actively inviting domestic and foreign public utilities and venture capitalists to participate in or provide strategic support for the innovation process.

D. Transition Towards Self-Sustaining Operational Models for Support Units

International startups supporting organizations typically possess the capacity for commercialization and financial self-sufficiency. Moving forward, the management of domestic Net-Zero innovation support units should establish commercial models that follow those of international incubators and accelerators. By empowering teams with strong R&D support capabilities to manage these units, Taiwan can establish a self-sustaining, domestic Net-Zero startup ecosystem.

Promotion Strategies and Planning for the Net-Zero Campus

Strategies for Advancing Technological Innovation and Industrial Implementation via the Net-Zero Campus

The Net-Zero Technology Innovation Program is designed to catalyze technological breakthroughs by leveraging the Net-Zero Campus as a central node to cluster innovative industrial ecosystems. This program facilitates cross-disciplinary collaboration and real-world field verification through the adoption of Public-Private Partnership (PPP) models. By integrating

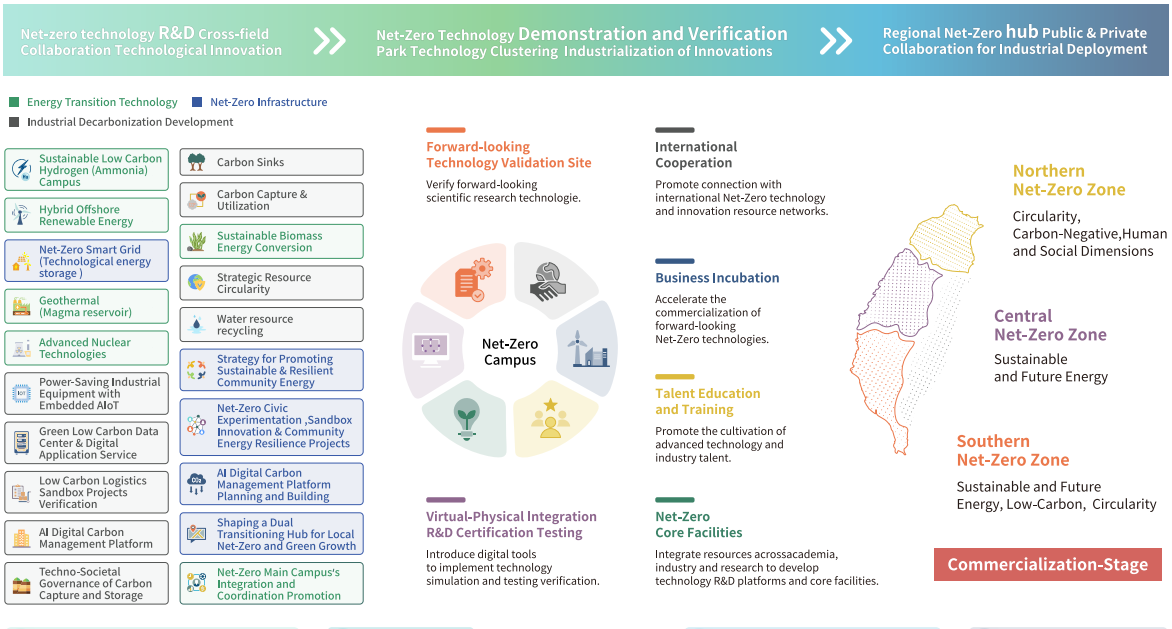

Figure 2 Pathways for Advancing Technological Innovation and Industrial Implementation via the Net-Zero Campus

local industrial characteristics to establish regional Net-Zero technology hubs, the program accelerates technology industrialization and large-scale deployment, ultimately ensuring successful, sustainable industrial deployment (Figure 2).Centered on the Net-Zero Campus, this program constructs a systematic pathway from technological innovation to industrial deployment. Through the centralized coordination of the Main Campus, the development of specialized net-zero technology verification parks is driven. The specific implementation strategies are as follows:

A. Integration of Cross-disciplinary Technologies

(a) Establish institutionalized coordination mechanisms to prevent resource overlap and "technology silos," facilitating information sharing across various projects and regions.

(b) Integrate key technology pathways, including sustainable low-carbon hydrogen, hybrid offshore energy, net-zero smart grids, and carbon capture and storage (CCS).

B. Virtual -Physical Integrated Commercial Verification Mechanism

(a) Construct a virtual platform for commercial verification, introducing digital simulation tools to complete technical modeling and assessments prior to physical field testing.

(b) Accelerate the transition from R&D to Commercialization, providing the necessary support for innovative technologies to successfully navigate the "Valley of Death."

C. Strengthening Regional Hubs and Industrial Matching

(a) Directly link verification outcomes to regional net-zero hubs, such as Taoyuan Aerotropolis, Taichung Port, etc., utilizing these sites as primary cases for demonstration and commercial application.

(b) Engage domestic and international public utilities and venture capitalists through Public-Private Partnership (PPP) models to catalyze technology industrialization.

D. Optimizing the Regulatory Environment for Innovation Experiments

Propose the "Net-Zero Technology Innovation Experiment Act" to provide regulatory flexibility through sandbox mechanisms, establishing experimental spaces tailored to the requirements of emerging technologies.

Conclusions and Recommendations

Through the operation of this national-level field verification platform, the project is expected to deliver the following strategic benefits:

(1) Developing a Sustainable Supply Chain Architecture: By systematically introducing technical solutions, such as Carbon Capture and Utilization (CCU) and renewable energy integration, the program seeks to catalyze green growth and cultivate new economic paradigms.

(2) Strengthening International Competitive Advantages: The main campus platform will strengthen Taiwan's strategic positioning within the global green supply chain and facilitate seamless integration with international net-zero technology innovation networks.

(3) Driving Regional Industrial Transformation: By leveraging regional specializations, such as Northern Taiwan's Carbon-Negative Circularity, Central Taiwan's Sustainable Energy, and Southern Taiwan's Low-Carbon Circularity, the project provides scalable paradigms for local low-carbon transitions.

(4) Cultivating a Self-Sustaining Operational Ecosystem: By guiding startup support units toward corporate and autonomous operational models, the program aims to shape a long-term, viable net-zero technology commercial ecosystem.

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