VISUALIZATION OF STRATEGIC FORESIGHT

— THE INTEGRATION OF SCENARIO PLANNING AND SYSTEM DYNAMICS —

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SUMMARY

- Scenario planning has proven effective for risk mitigation by encouraging actions such as envisioning multiple futures and preparing alternative strategies. However, the existing problem is that qualitative outputs do not sufficiently convince decision-makers.

- System dynamics is an highly effective method for visualizing complex causal relationships and creating quantitative simulation models. Since its conception in the US in the 1950s, system dynamics has been widely deployed in the fields of management and policy development.

- By integrating scenario planning and system dynamics, complex causal relationships associated with strategic foresight can be visually and quantitatively represented, and this can facilitate consensus building and contribute to faster decision-making. Furthermore, recent advances in generative AI have made it much easier to combine the two approaches, greatly reducing the complexities to achieving scenario quantification.

A look at the external environment in recent years reveals heightening uncertainty, and companies and organizations are being compelled to make decisions more quickly than ever before. Scenario planning, used for strategic foresight, is an effective framework for navigating an uncertain future. However, when the scenario planning centers on qualitative narratives[1], consensus building and plan execution become difficult. This report presents practical examples of combining system dynamics, used in quantitative simulation, with scenario planning, to quantitatively express future scenarios. It also discusses the impacts of the recent increasing adoption of generative AI in this field.

1. SCENARIO PLANNING

1-1. What is scenario planning?

Scenario planning[2] (hereinafter referred to as “SP”) is a foresight methodology for envisioning multiple future possibilities through the analysis of multiple highly uncertain environmental factors that could significantly impact the future. While the origins of SP can be traced back to its use by the US military during World War II, an often-cited example of its adoption is that by Royal Dutch Shell (now Shell) during the oil crisis of the 1970s. The company’s use of SP enabled it to overcome the crisis and strengthen its status as an oil major. Since then, SP has gained attention as a highly effective management tool and has been utilized by many companies. Visions

[1] A narrative-style text that establishes a timeline and characters, constructs causal logic, and depicts the future.
[2] For a detailed explanation of scenario planning, please refer to “Scenario Planning for Futures” by Akiko Fujii (2024), among other sources.

of the future are often written in narrative form, using narration to evoke anticipation or a sense of urgency in scenario readers and spur them to action.

1-2. Challenges in scenario planning

Generally, SP is utilized when considering multiple possible futures other than the most likely "main scenario." By formulating alternative strategies in advance for possible futures other than the main scenario, companies can flexibly adjust their strategies when such futures appear likely to materialize, thereby avoiding risks such as missed opportunities.

To achieve this, it is crucial that decision-makers, as scenario readers, recognize that futures other than the main scenario are possible and encourage such actions as preparing alternative strategies. However, the narrative of a typical SP process is qualitative in nature, and this poses challenges in that SP fails to resonate with decision-makers and does not directly translate into action.

To enhance decision-makers' engagement, SP practitioners have employed various approaches (Figure 1). One approach is to have decision-makers themselves participate in scenario development workshops to deepen their sense of commitment. In particular, expressing the envisioned future in quantitative terms is highly useful for eliminating differences in perception among scenario readers and facilitating consensus building.

Figure 1: Examples of approaches to enhance engagement in scenario planning

Approach	Details
Participation of decision-makers	In workshops, position management personnel as participants rather than as observers. Make them responsible for evaluating factors, ranked choice voting, and overseeing the management and presentation of strategic wind-tunneling, thereby giving them commitment over the final decision.
Agreement on agenda at the outset	At the outset, document and agree on the scenario planning agenda (issues and points for discussion) and topics (time frame, region, business domain, etc.). Align the scope of discussion points and data to minimize inconsistencies in later stages.
Narrative creation techniques	Clearly define the subject and context, and then depict the causal relationships and decision-making from initial conditions to the future in chronological order. Embed signposts and KPIs in the narrative to enable quantitative verification of branching outcomes.
Quantification	**Present key indicators (market size, capex, CO_2 emissions, etc.) within ranges and perform sensitivity analysis to quantitatively express the envisioned future.**
Monitoring	Monitor key environmental factors at fixed points, visualize observations through dashboards and regular reporting, and present findings to management.
Wargaming	Have participants play the roles of competitors, customers, and other stakeholders and simulate decision-making with respect to multiple future scenarios depicted in scenario planning, thereby experientially validating the effectiveness and weaknesses of strategies.

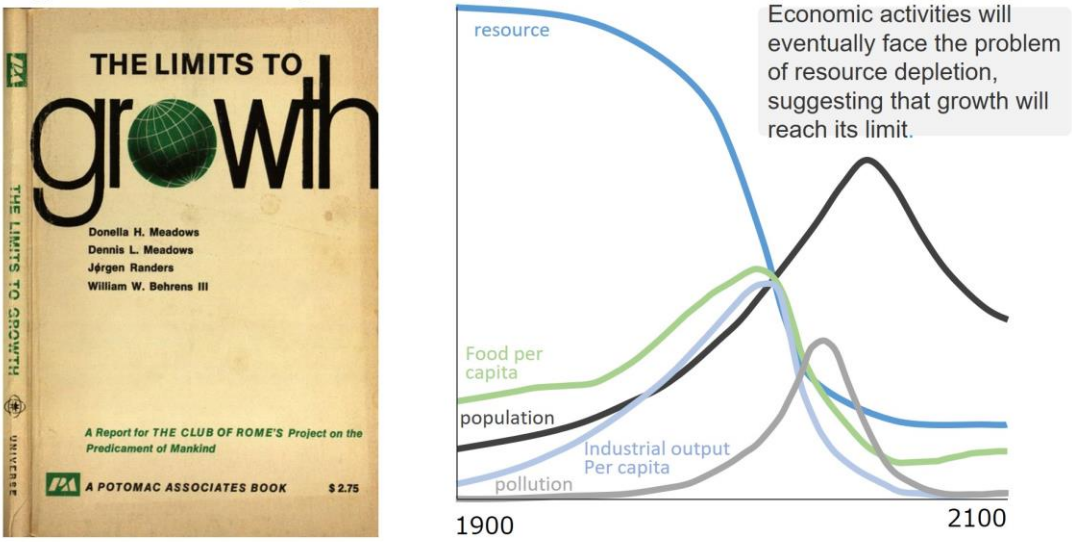
Source: Compiled by MGSSI

2. SYSTEM DYNAMICS

2-1. What is system dynamics?

System dynamics (hereinafter referred to as "SD") is a methodology proposed and systematized in the 1950s by Professor Jay W. Forrester of the MIT Sloan School of Management to understand the behavior of industrial systems using mathematical models. SD is a methodology that views diverse elements of, for example, society and ecosystems that evolve over time, as "systems" that are interconnected in a complex manner. It visually models and quantitatively analyzes these systems, making it a concept applicable across a wide range of fields in today's world where social structures undergo complex changes. Among other quantitative future analysis methods include regression analysis and linear programming, but SD is well-suited for modeling the complex structure of problems involving numerous factors and the causal relationships between them. In 1972, the Club of Rome, an international think tank addressing sustainability that brings together experts from around the world, published a book entitled, “The Limits to Growth”. The book is about modeling of economic growth and population change through the year 2100 based on the use of SD. It drew global attention for its presentation of simulation results that suggested humanity would face population explosion, worsening pollution, and limitations of economic growth (Figure 2). The book influenced the environmental movement of the time and became the foundation for global policy actions, such as the 1987 “Our Common Future” report by the World Commission on Environment and Development (WCED), known as the Brundtland Commission; the formulation of “Agenda 21” at the 1992 UN Conference on Environment and Development (UNCED), also known as the Rio Earth Summit; and the adoption of the Kyoto Protocol at the 1997 Third Conference of the Parties (COP3) to the United Nations Framework Convention on Climate Change.

Figure 2: Research publication by the Club of Rome



Source: Compiled by MGSSI based on “The Limits to Growth” by Dennis Meadows et al. (1972)

2-2. Key features of system dynamics

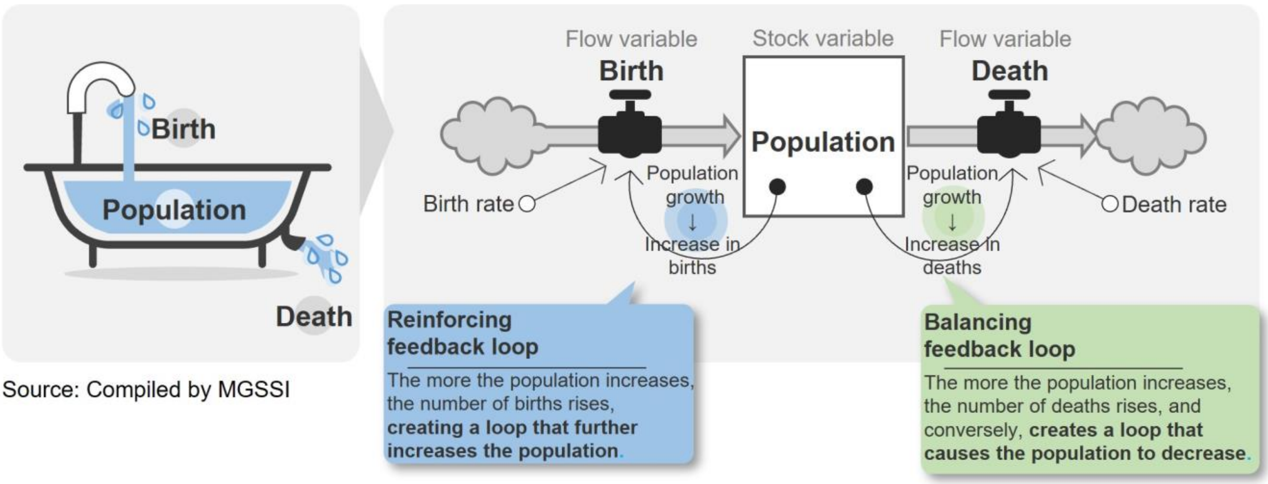
In comparison with other quantitative analysis methods used for future forecasting which feature such approaches as regression analysis and linear programming, SD has the characteristics listed below (Figure 3).

(1) Stocks and Flows: A variable representing a state is called a “stock,” and the parameter that increases or decreases that stock is called a “flow.” To increase a stock, it is necessary to increase inflow or reduce outflow. Typical decision-makers tend to focus only on one side of the flow (e.g., outflow), but classifying the variables and parameters as stocks and flows in this way makes those people realize that adjustments can also be made to the other side of the flow (inflow).

(2) Feedback loop: Refers to a state where causal relationships are not necessarily unidirectional but exist within a cyclical structure.

(3) Visualization: As shown in Figure 3, SD has systematized several techniques for visually representing complex structures encompassing the characteristics of (1) and (2) (causal loop diagrams and stock-flow diagrams are typical examples).

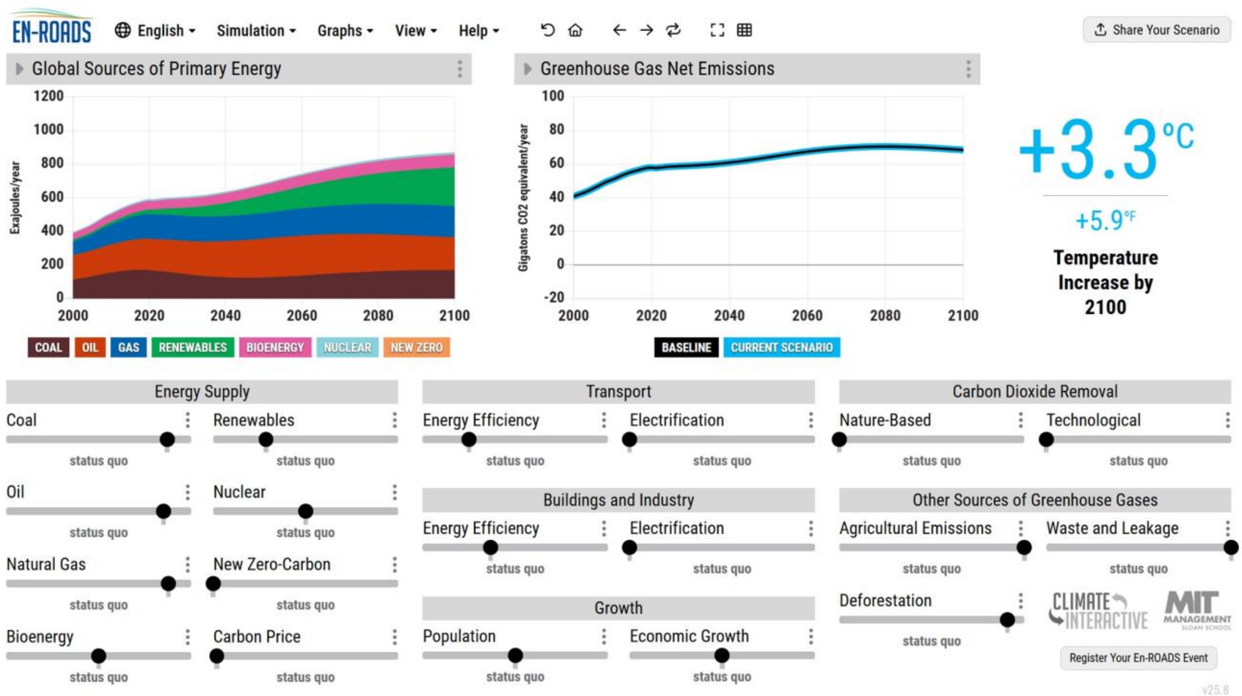
Figure 3: Stock-flow diagram illustrating the relationship between population, births, and deaths



Source: Compiled by MGSSI

In consideration of these features, the SD methodology is often applied to large-scale, long-term scopes such as climate change simulations. The climate simulator En-ROADS, jointly developed by the non-profit think tank Climate Interactive and the MIT Sloan School of Management and released in 2019, was created using SD (Figure 4). This tool is used in policy development, business, and education settings to instantly calculate the effects of climate policies, thereby serving to support scientific dialogue and decision-making.

Figure 4 : En-ROADS Simulator



Source : Climate Interactive, MIT Sloan, "En-ROADS", https://en-roads.climateinteractive.org/scenario.html?v=25.8.0&lang=ja (accessed August 18, 2025)

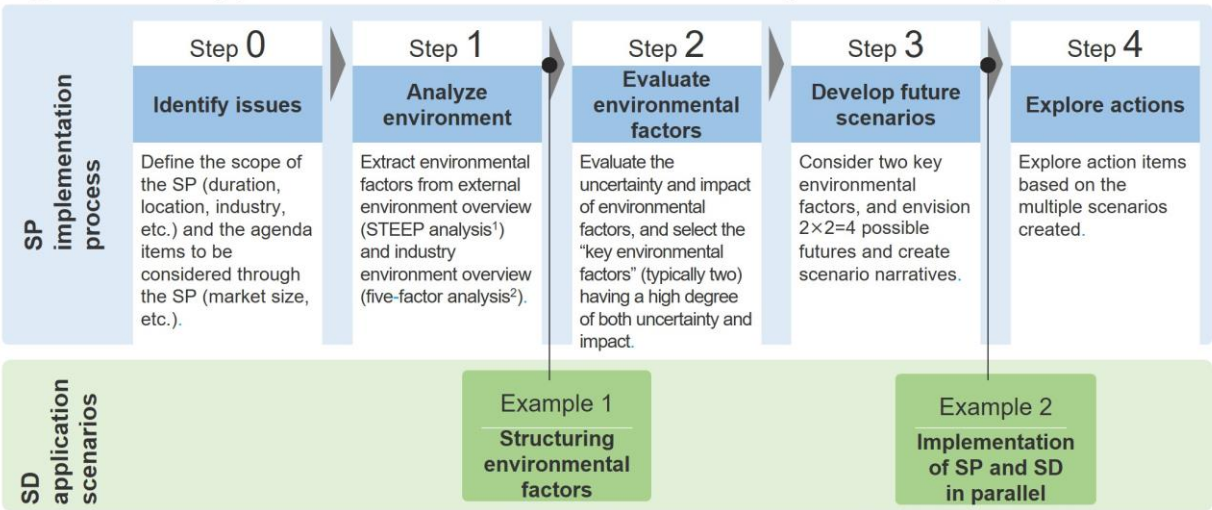
3. INTEGRATION OF SCENARIO PLANNING AND SYSTEM DYNAMICS

The application of SD allows for visualizing the structure of how diverse elements within the narrative depicted in SP interact with one another. Moreover, it can also formulate the relationships between elements into mathematical expressions and create quantitative simulation models. This allows for explanations of quantitative differences, like market size, for example, between multiple distinct future scenarios. Presented here are concrete examples to illustrate how SD is applied to SP. In addition, the contributions of generative AI to SD, especially reflecting the remarkable advancements made in the field of AI in recent years, are discussed. The aim is to explain how the integration of SP and SD is becoming increasingly feasible, using actual examples.

3-1. Examples of the integration of SP and SD

While there are numerous examples of SP and SD integration, this report presents examples of two integration cases that are relatively easy for SP practitioners to implement. Figure 5 shows a typical SP implementation process. The positioning of two example cases are shown in the figure.

Figure 5: SD application scenarios within the SP implementation process



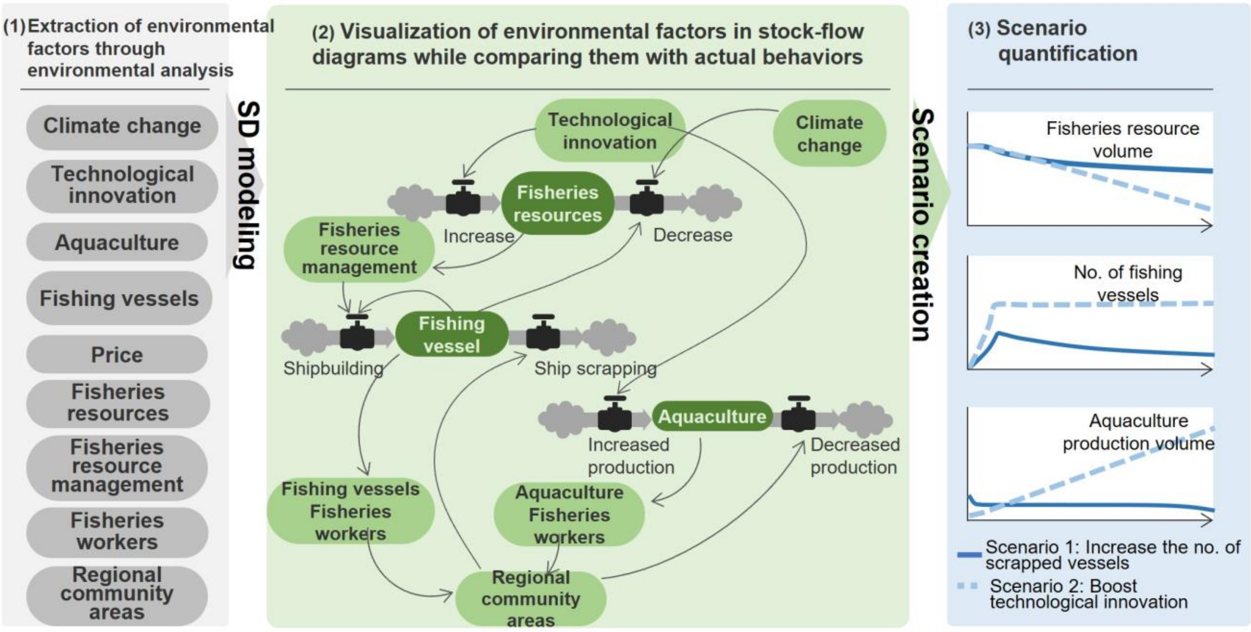
[1] A framework for organizing the external environment through the lenses of society, technology, economy, environment, and politics.
[2] A framework for organizing the industry environment surrounding a company into five stakeholder categories: suppliers, customers, competitors, substitute products, and market newcomers.
Source: Compiled by MGSSI

(1) Example 1: Structuring environmental factors

After extracting environmental factors through an environmental analysis, which is the first step of SP, SD is then applied. In a study conducted by Yamamoto et al.[3], the researchers sought to systematize the challenges facing Japan's domestic fisheries and aquaculture industries. After identifying environmental factors, the researchers mapped the factors onto a stock-flow diagram while comparing them to actual behaviors. They then conducted simulations of the relationship between fisheries/aquaculture and fisheries resources using multiple scenarios (Figure 6). In the study, "technological innovation" and "number of fishing vessels" are selected as key environmental factors, and changes in resource abundance under each scenario are quantitatively presented. For example, by constructing a 2×2 matrix based on these two factors, four possible futures can be envisioned. Compelling quantitative evidence-based scenarios can be developed by quantifying factors such as fisheries resource levels in each future scenario and constructing narratives based on these results.

[3] Shingen Yamamoto, et al., "Systematizing the Issues Surrounding the Fisheries Industry Using Stock-Flow Diagrams," JSD Conference 2025 preprint, pp.16-19

Figure 6: Schematic of SD implementation after environmental analysis



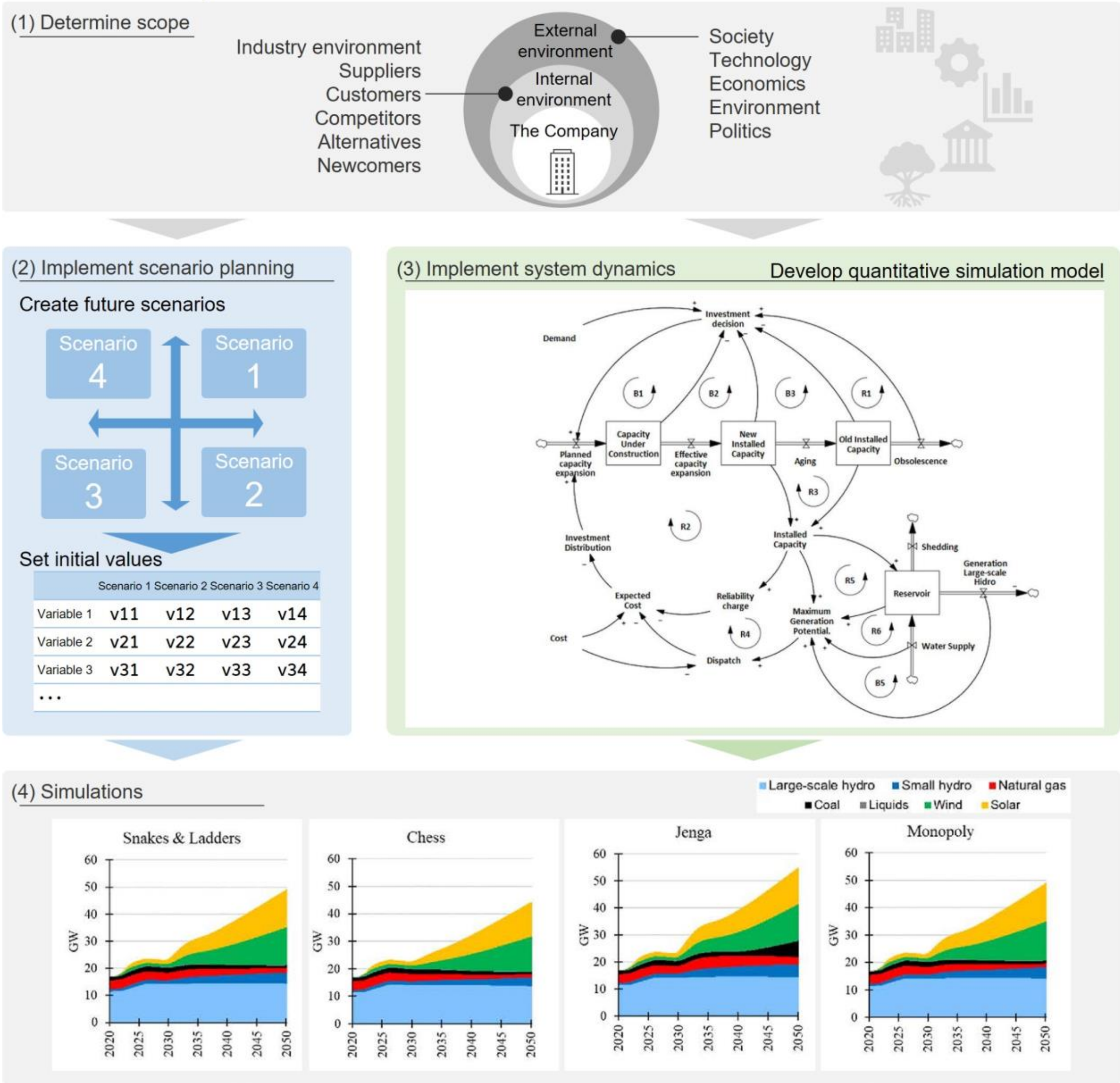
Source: Compiled by MGSSI based on the report "Organizing Issues Surrounding the Fisheries Industry Using Stock-Flow Diagrams," by Shingen Yamamoto, et al. (2025)

(2) Example 2: Implementation of SP and SD in parallel

This application example illustrates a scenario where SP and SD cover a common scope and are implemented concurrently. Figure 7 illustrates the application of SD. In this case, SP can be quantified by applying the scope defined in SP to SD and creating a quantitative simulation model based on it. Parra-Rodas et al.[4] used this methodology to develop four scenarios for Colombia's electricity supply outlook for 2050.

[4] J. F. Parra-Rodas et al. (2025), "Quantifying the 2050 scenarios for Colombia's electricity sector transition", Renewable Energy, Vol.256

Figure 7: Conceptual diagram of SD implementation when SP and SD are conducted in parallel



Source： Parra-Rodas, et al. (2025), "Quantifying the 2050 scenarios for Colombia's electricity sector transition", Renewable Energy, Vol.256
Arango, et al. (2019) "Escenarios Energéticos Seis posibilidades para la transición en Colombia" https://www.energetica2030.co/
（accessed August 18, 2025）

3-2. Impacts of generative AI

In recent years, generative AI systems such as ChatGPT have contributed to significant improvement in productivity across all business operations, including research and analysis. The contributions of generative AI are also strongly recognized in the integration of SP and SD. Stella Architect, the SD software provided by US-based isee systems, gained AI assistant functionality in February 2025. It can now generate causal loop diagrams and stock-flow diagrams when text is input (Figure 8). For example, if a qualitative narrative is created as the output of SP, simply inputting the narrative will instantly generate a draft SD model. This eliminates the need to create complex causal relationships from scratch, significantly lowering the barriers to applying SD to SP. At present, it is not possible to output high-quality models capable of immediately running simulations, and manual adjustments are required. However, the contribution of generative AI to the integration of SP and SD, and furthermore to the quantification of SP, is invaluable.

4. LEVERAGING STRATEGIC FORESIGHT FOR DECISION-MAKING

In the previous section, explanations were provided about methods for integrating SP and SD using case studies. As demonstrated, SP and SD exhibit high compatibility, and combining both in practice is entirely feasible. This fusion will enable substantiation of strong narrative scenarios based on quantitative models. By monitoring which of the numerically depicted future scenarios is most likely to materialize, decision-makers can more quickly select the action items that should be implemented. As a result, there will be greater scope for utilizing the outcomes of foresight methodologies in business management or policy development.

At the same time, to present a coherent vision of the future, it is essential to adopt an iterative approach, moving back and forth between scenario narratives and quantitative models to meticulously identify contradictions and inconsistencies, and continuously refine the vision. Therefore, mastering the theories and techniques of both approaches and developing a skill set that can utilize them in a complementary manner will become increasingly important for providing strategic foresight that can be applied to business management and other fields.