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Article

Citizen-Participatory Scenario Design Methodology with Future Design Approach: A Case Study of Visioning of a Low-Carbon Society in Suita City, Japan

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Abstract: A scenario approach is often used to envision sustainable futures. Several important scenario design factors are identified in the literature, which include the demonstration of deliberation and the participation of stakeholders; however, specific methodologies of scenario design are yet to be established. Accordingly, in this study, we demonstrate a series of workshops involving ordinary citizens for energy visioning in Suita city, Japan, and propose a new citizen-participatory scenario design methodology based on the combination of scenario design and future design approaches. It is shown that the inclusion of future generations in deliberation is effective for creating future visions in a specific context and deriving policy implications. Specifically, by analyzing the deliberation process and the proposed scenarios, it was confirmed that the scenarios proposed by future generations were proactive in terms of paying the costs incurred to facilitate the realization of policies toward achieving a long-term vision. Furthermore, even though the proposals made by the future generations imposed additional burdens for current generations, post-workshop scenario assessment revealed that current generations are supportive of these scenarios. It is concluded that the proposed methodology is effective since it can overcome uncertainties, include holistic scopes, and consider a long-term time horizon.

Keywords: scenario design; future design; energy vision; pathway

1. Introduction

The international community has reached a general consensus on the aim of halving global CO_2 emissions from their 1990 levels by 2050. The Paris Agreement of 2016 represents a step in this direction, and many countries around the world have signed the agreement and established various targets [1]. For example, Japan considers an 80% reduction of its CO_2 emissions by 2050 as one of its official long-term goals, based on which domestic actors such as municipal governments have established their own long-term goals [2]. Although most domestic entities, such as local governments, citizens, and business sectors acknowledge these long-term goals, many consider the proposal and selection of specific mitigation policies a continuing challenge. IPCC (Intergovernmental Panel on Climate Change) synthesis reports do not provide specific guidance for local governments in regard to what strategy and actions should be taken by local governments. Indeed, it is necessary to bridge the gap between global visions and specific actions at the local and field levels [3].

A scenario approach is one of the most effective methodologies for addressing climate change issues since it can deal with future uncertainties, include holistic scopes, and consider a long-term time horizon [4]. Although several important scenario design factors are identified in the literature, including the demonstration of deliberation and participation of stakeholders [5–8], specific methodologies of scenario design have not yet been established [4,9]. Specifically, such a methodology should at least clarify the questions of who should participate in the deliberation and decision-making processes and how deliberation should proceed [4]. Meanwhile, another fundamental challenge when envisioning futures is the non-existence of future generations in the envisioning process. When considering strategies and visions in pursuit of sustainability, taking into account the benefits for and perspectives of future generations is critically important to overcome potential intergenerational conflicts and trade-offs. However, it is difficult to bring the perspectives of future generations into present-day decision-making processes [10,11] given the typical human characteristics regarding aspects such as impulsivity [12] and optimism about the future [13]. Some studies and practical applications have involved the introduction of imaginary future generations to incorporate the viewpoints of future generations into present-day decision-making processes as a promising social system to activate the futurability of individuals, which is referred to as "future design" [10,11,14–16]. Imaginary future generations refer to present-day people who are assigned to be responsible for the rights and/or profits of people in the future. Because future generations do not exist in the present, they are represented in the decision-making process by imaginary future generations played by members of the current generation.

Although future design has been applied to various societal problems and some characteristics of decision-making by imaginary future generation groups have been clarified, as of yet, no study has explicitly addressed the effectiveness of combining the scenario design approach with future design. In this study, we posit that the inclusion of future generations in deliberation is effective for creating future visions in a specific context and deriving policy implications. To examine our claim, we conducted a series of participatory workshops focused on the creation of energy visions for Suita city, Osaka Prefecture, Japan, and assessed the feasibility of the visions created and the visioning processes. After analyzing the deliberation process and the scenarios proposed by imaginary future generations, we confirmed that a combined scenario design and future design approach can effectively handle uncertainties, include holistic scopes, and enable the consideration of a long-term time horizon to provide specific policy implications. In addition, our proposed approach is valid in the sense that ordinary citizens sufficiently supported the proposed scenario, even though it explicitly imposed substantial costs for them in the future.

The structure of this paper is as follows. The following section explains the combination of scenario design and future design approaches. Section 3 introduces our scenario design methodology. Section 4 provides the background information of the workshop for visioning a low-carbon society in Suita and Section 5 presents the outcomes of the workshop as the proposed energy scenarios. Section 6 details the assessment of these scenarios, and the findings and limitations of this study are discussed in Section 7.

2. Why Combine Scenario Design and Future Design Approaches?

In this section, scenario design studies are reviewed, revealing the limitations of the current approach and then claiming that the combination of scenario design and future design approaches is both novel and critical for overcoming these limitations.

In general, scenarios refer to narratives that describe multiple possible futures in order to better understand future uncertainties [4,17]. When it comes to sustainability issues, a scenario is often constructed as the combination of a future vision and the pathway to reach the vision from the present, wherein a series of milestones toward the achievement of future goals are clarified. Figure 1 depicts the two basic approaches to scenario design, i.e., forecasting and backcasting. These approaches differ in their starting points; forecasting begins at the present and describes possible futures, whereas backcasting starts from a particular future end-point and works backward to the present. Forecasting scenarios tend toward environmentally unsustainable states because they are heavily influenced by existing social and economic systems [18,19]. One of the typical forecasting scenarios is the business-as-usual (BAU) pathway, denoted by (i) in Figure 1. It should be noted that, even with a forecasting approach, society might follow pathway (iii), in which the future sustainable vision is realized under the assumption that cutting-edge technologies will be developed and implemented to bring about social changes toward sustainability.

A backcasting approach, on the other hand, aims to bridge the gap between a desirable future state and the current state [7,20–22]. In other words, a future sustainable society is first discussed as a future vision, and then the pathways by which the future vision can be realized from the present state are explored. Such pathways, denoted by (ii) in Figure 1, provide informatioan on relevant countermeasures and policies necessary to achieve the vision. An important point is that with a backcasting approach, planning and management can reflect relevant scenarios, such that a society can check whether or not it is on the appropriate trajectory in its efforts to realize the future vision.

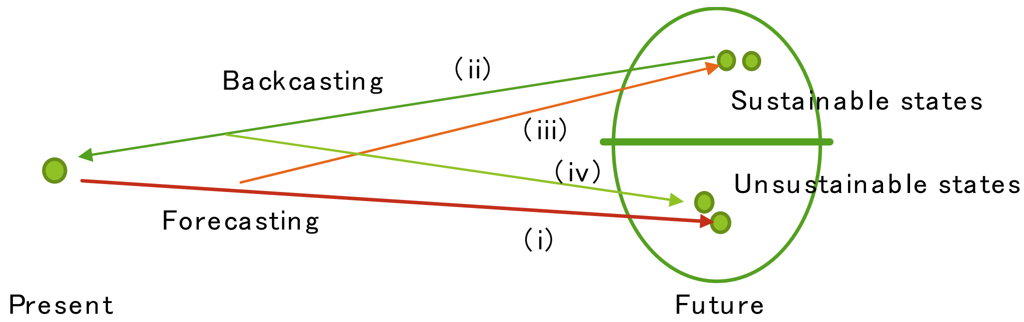

Figure 1. Scenario design: Forecasting and backcasting approaches.

Now, we argue that either of these two approaches could lead to the achievement of sustainable states. It should be noted that the existing social and economic systems primarily focus on benefits to the current generation, and therefore tend to delay the adoption of countermeasures for sustainability problems because they incur considerable costs for the current generation; this is referred to as a future failure [10,23].

Recent studies have revealed that the adoption of a participatory approach with deliberation will make the final decisions more desirable and legitimate in comparison to those reached by other approaches, by ensuring the inclusion of the voices of all possible stakeholders [6,24–26]. As many sustainability challenges, such as climate change, involve high degrees of complexity and uncertainty [27,28], collaboration among academia, industry, and civil society is necessary. The results of these studies imply that deliberations involving different domains of people reduce the adverse effects of those characteristics [29]. In fact, many practical applications using scenario approaches have adopted deliberation [8,24,25,30–32].

To summarize the above discussion, the current form of scenario approach may be insufficient when applied alone because it has the following limitations. First, it does not provide a systematic method for describing future visions and pathways, and second, the scenario approach by itself does not ensure the feasibility of the necessary actions to be taken by the current society. Finally, existing approaches consider only the current generations as stakeholders, and there is thus a barrier against bearing the substantial costs associated with adopting future-oriented measures. The first limitation points to the importance of deliberation in scenario design, and the second and the third limitations indicate that it is critical to invite future generations into deliberations for scenario design.

Therefore, in this study, a novel scenario design methodology is proposed by examining the hypothesis that the inclusion of an imaginary future generation in deliberation is an effective method for avoiding the future failure described above. Specifically, our scenario design approach employs supporting tools such as logic trees for visioning and path-making. While these tools enhance the efficiency of visioning and help in the identification of paths, they are insufficient for overcoming future failures. Regardless of whom they represent in the present state, current generations may have limited scope or imagination in terms of visioning and creating pathways toward the goals. This limitation may come from the psychological nature of humans, including aspects such as status-quo bias, typicity, and optimism [12,13,23]. In fact, a case study of deliberation in a municipality in Japan showed that the inclusion of an imaginary future generation in deliberation and negotiation processes can overcome these limitations by creating a sort of sympathy toward both future and current generations [11,15].

In the next section, we introduce our scenario design methodology and then discuss a series of workshops conducted in Suita city, Japan, to examine the impact of a future generation on scenario design. We subsequently analyzed the deliberation and assessed the proposed energy scenarios to validate our hypothesis.

3. Scenario Design Methodology with the Inclusion of Imaginary Future Generations

Figure 2 illustrates our scenario design methodology. The major role of the scenario designers (e.g., experts) was to organize the participatory workshop by inviting citizens to represent current as well as future generations. The scenario designers also provided supporting tools to facilitate the scenario design by the workshop participants. Among these tools, learning materials were provided to equip the workshop participants with basic knowledge on energy and the local situation. The logic trees and CO_2 simulator helped them check the feasibility and effectiveness of the proposed scenarios. Further details are provided later in this section. It should be noted that in our scenario design methodology, the scenarios were proposed by the workshop participants themselves. The proposed scenarios consisted of visions, storylines, and roadmaps. In this study, the third party will demonstrate an evaluation of the proposed scenarios to see to what extent and how they are supported. This evaluation process created feedback for the scenario designers to improve the scenarios, although we do not demonstrate the feedback process in this paper.

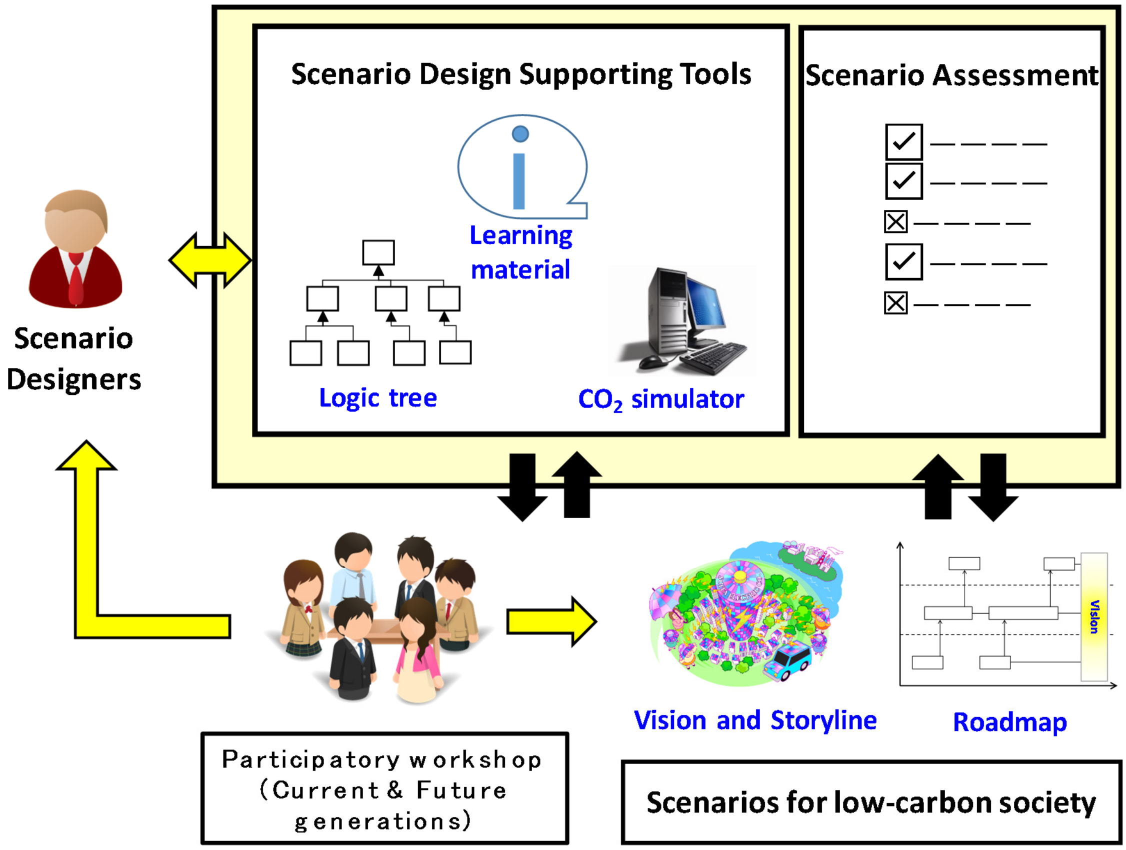

Figure 2. Scenario design methodology for a low-carbon society.

Figure 3 shows the procedure followed for our scenario design methodology. In the first step, the scenario designers set up the main theme of a scenario through problem-framing, in which they collected and summarized information necessary to understand the situation of the target field. In the second step, the information was analyzed to understand the current situation. We employed a participatory approach, in which ordinary citizens representing both current and future generations were recruited to analyze the situations. In the third step, the participants constructed a vision along with a storyline to contextualize the vision. In the fourth step, they provided details of the scenario to demonstrate the feasibility of the proposed vision. For example, in this study, we proposed a vision for a low-carbon society, and in this fourth step, they checked if and how the proposed energy vision could meet the CO_2 emission reduction target given in the problem-framing step. The investigation of the feasibility of a scenario sometimes yielded some lessons which could then be applied in a reconsideration of the original vision. This was followed by the construction of a roadmap, identifying the timelines of necessary policy instruments, market conditions, etc. In the final step, a scenario assessment was carried out by the third party to obtain feedback for the proposed scenario.

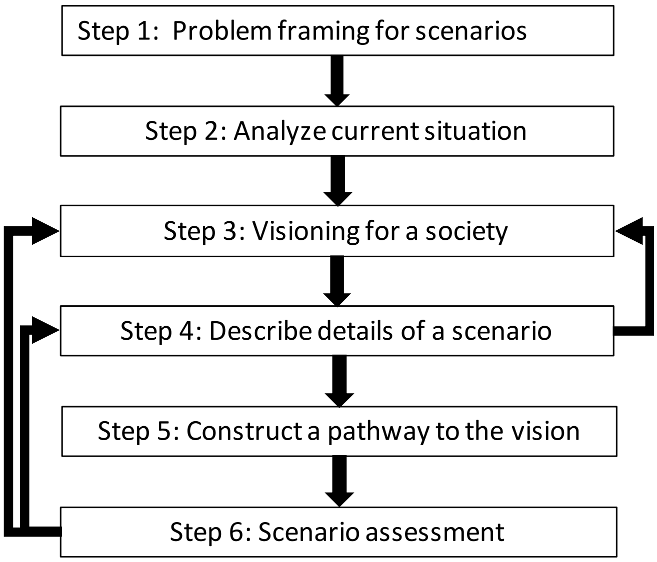

Figure 3. Scenario design procedure.

4. Energy Vision Workshops in Suita City

In this study, we demonstrated the use of a scenario design approach to develop energy visions for Suita city in collaboration with Suita's municipal office. Suita city is located in the western part of Japan in Osaka Prefecture, adjacent to Osaka city. It has a population of approximately 370,000, which is expected to peak sometime in the 2020s. The city has a balanced industrial structure, housing the head offices of both manufacturing companies and universities, with a similar nighttime and daytime populations. In conformance with its socioeconomic conditions, Suita has established a climate action target to reduce its greenhouse gas (GHG) emissions by 75% relative to its emissions in 1990 [2]. However, no specific action plans or energy visions have been adopted yet. Hence, it is necessary to create specific visions and approaches to achieve this target.

For this purpose, we conducted four experimental workshops and recruited 28 participants for each workshop from among residents of Suita or those who regularly commute to Suita for purposes of education or employment (Table 1). As this study involves analysis of the data obtained from the workshops, we had our study investigated by the Institutional Review Board at the University of Tokyo, and obtained ethical approval (Approval number KE17-29).

In each workshop, 25-28 people signed a consent form and participated in the workshop. We aimed for a balance in the gender of the participants, and also maintained an appropriate age distribution.

For example, in the first workshop, 28 participants signed, 13 of which were female, and 11 were in their 20s, 10 were in their 30s–50s, and 7 were 60 years old or older. To observe the effects of imaginary future generations in the visioning process, the participants were divided into four small groups (A–D). Of the groups, two represented future generations (i.e., treatment groups) and the remaining two were controlled groups representing current generations. The participants in Groups A and B, which represented future generations, were required to participate in deliberations acting as residents of year 2050. In the workshop, the facilitators explained to the participants the meaning of being representatives of future generations. The participants were requested to consider that they had traveled in time to the year 2050 without aging [15]. In principle, group members were fixed through the workshop series.

To confirm the validity of including future generations in the visioning process, in each session, participants were assigned to one of the four groups to discuss energy visions (i.e., ideal energy futures) for Suita city. The uniqueness of our workshop design lies in the fact that two of the four groups (Groups A and B) were asked to represent future residents of Suita (in the year 2050), whereas the other two groups (Groups C and D) were considered controlled residents, which enabled us to compare the two sets of groups to reveal generational differences.

The flow of the workshops, shown in Table 1, depicts our scenario design process. The process followed through the four workshops was as follows. In the first workshop, the participants discussed energy and societal visions for the year 2050. In the second workshop, they proposed measures that should be implemented to realize the CO_2 reduction target by 2050 by completing a logic tree, which facilitated the participants' understanding of the structure of relevant measurements and their impacts on the achievement of the established goals [33,34]. In the third workshop, participants created a storyline as a scenario by executing a simple simulation using spreadsheets to estimate the extent to which individual measurements would contribute to CO_2 emission reductions [35]. Finally, in the fourth workshop, the participants followed the storyline to propose a roadmap to bridge the gap between the vision and the current situation, and prioritized individual policy instruments.

Table 1. Details of the energy vision workshops conducted in Suita.

Date	Workshop Process
1st WS Dec. 2016	• Learn basic information about Suita city and energy • Create energy visions
2nd WS Mar. 2017	• Modify logic trees to ensure consistency between a vision and potential policy options • Discuss policy instruments in five years • Entitle the vision
3rd WS Sep. 2017	• Make storylines based on the vision to explain the objective and concepts of the vision • Simulate CO_2 emissions with a simple model using a spreadsheet
4th WS Dec. 2017	• Create a pathway to connect the present condition with the future vision (i.e., a roadmap) • Prioritize policy instruments/options

WS: workshop.

Prior to the start of the first workshop, experts established the workshop agenda and prepared the information that was later provided to the workshop participants as the background knowledge. The experts considered in this study were scholars and researchers from universities and policy-makers from the city hall. Specifically, the first workshop included an information session in which information on GHG emission reductions and energy-saving targets for 2050 was disseminated, along with details on the current trends in GHG emissions and energy consumption. Further, the lecture clarified the potential of renewable energy sources in Suita city, as well as the available technologies and specific initiatives toward a low-carbon society promoted by Japanese municipalities. Experts also served as facilitators for each group during the discussions. The main role of facilitators included, but was not limited to, providing a discursive framework, setting an appropriate tone for the discussion, and ensuring the participation of all members in the discussion [36].

After obtaining the consent of all workshop participants, all the group discussions were recorded. Specifically, after the first workshop, the group conversations were analyzed and a logic tree was constructed for each group to structure the conversation. The logic tree revealed the causes and effects of the key terms (nodes) that came up in the discussion, and all the key terms eventually contributed to the realization of the final vision in the logic tree (Figure 4) [35]. In the second workshop, the participants analyzed their group's logic tree and attempted to identify logical jumps between nodes and add relevant key terms (nodes) to bridge these logical gaps. This reinforcement of the logic tree helped the participants discuss the policy instruments and countermeasures that would become necessary in the coming five years [37].

Subsequently, the experts introduced a simple calculator for estimation of the emissions of Suita city. The workshop participants were non-experts, and had limited time to participate in the workshop; hence, parameter inputs were minimized to photovoltaic (PV) diffusion rates and energy consumption in individual sectors. In the third workshop, participants used this calculator to demonstrate a CO_2-emission simulation. Using the simulator, participants could understand how the selection of individual technologies and policies would affect the city's CO_2 emissions. In addition, experts prepared for the roadmap framework by classifying important domains into goals, policy, market, lifestyle, and technology [38]. This framework indeed helped participants draw a roadmap by expressing the policies and countermeasures necessary in specific sectors for the realization of their vision.

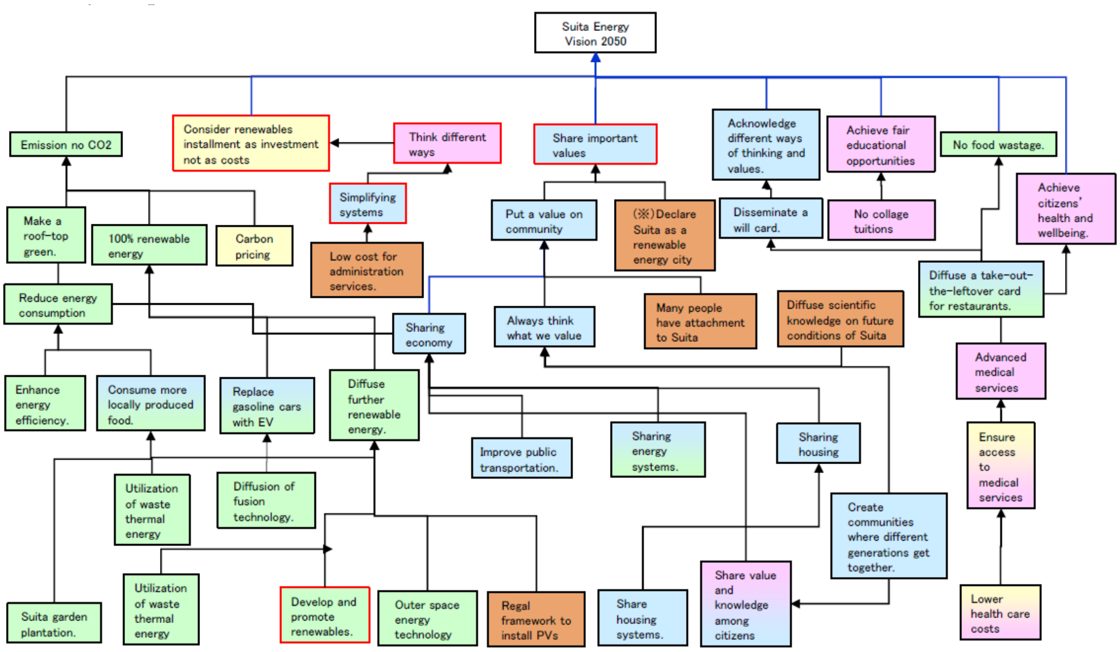

Figure 4. Schematic of a logic tree: Example of part of a logic tree for Group B.

5. Proposed Scenarios as Workshop Outcomes

In this section, the scenarios proposed by the four groups are discussed. A scenario consisted of an energy vision and a pathway oriented toward the vision, with a quantified emission reduction target set in accordance with the various sectors, instruments, and necessary policies.

5.1. Energy Visions of the Four Groups

Table 2 depicts the storylines of the four groups' energy visions. Each vision describes a way to achieve a 75% reduction in CO_2 emissions, but the emphasis of the vision differed between groups.

Groups A and C focused on renewable energy (i.e., PV panels/sheets), whereas Groups B and D focused more on social aspects. Group B paid significant attention to diversified social values and investments for future generations. The vision of Group D was characterized by lifestyle changes which promote energy savings.

A comparison between the groups comprised of an imaginary future generation (Groups A and B) and those representing the current generation (Groups C and D) revealed seemingly unclear generational differences. Nevertheless, Group B was obviously aware of the existence of future generations since the members assumed that the current generation would bear high costs to ensure benefits for future generations.

Table 2. Storylines of the four groups' energy visions for Suita.

Title	Storyline
Group A. Eco-roof Suita	The ownership rate of PV (photovoltaic) panels/sheets is 90% or higher, and are installed on both rooftops and walls. A local electricity company (Suita Electric Power Company) starts its business to manage the local electricity system.
Group B. Environmental city Suita—investment is not cost	In pursuit of new and diversified social values, environmental technologies are actively introduced as investments for future generations. The city's electricity consumption is decreased by passing legislation to increase electricity prices.
Group C. Citizens construct 100 renewables in Suita	Citizens prefer renewable energy sources over other energy forms, aiming to achieve 100% self-sufficiency in energy production. Some factories are relocated to outside of the city limits to reduce the city's industrial CO_2 emissions.
Group D. Stars are twinkling in Suita	Residential districts with green areas and active business streets coexist in the city. The city promotes energy savings via the adoption of cutting-edge technologies and the promotion of lifestyle changes.

Note: Groups A and B represent the imaginary future generations, and Groups C and D represent the current generation.

5.2. Quantification of Visions

To further discuss the details of each vision, the workshop participants quantified their visions in accordance with the storylines depicted in Table 2. As mentioned in Section 4, we developed a simplified simulation tool for calculating the city's CO_2 emissions, with which the participants could understand how energy savings in each sector (e.g., residential and industrial sectors) and PV installation would affect CO_2 emission volumes.

According to Figure 5, all of the energy visions achieved 75% reductions in CO_2 emissions by 2050. Group A achieved negative CO_2 emissions (a 106% reduction, i.e., the generation of more electricity than the demand) since their strategy was to promote the large-scale dissemination of PV panels/sheets. Group B aimed to achieve high energy savings in all three sectors by 2050 through substantial increases in energy prices in Suita city (e.g., the implementation of a local carbon tax), aiming to achieve the minimum target requirement of a 75% reduction in emissions. The uniqueness of the strategy of Group C was the large emission reduction in the industrial sector through the relocation of energy-intensive plants to outside of the city limits. Finally, the vision of Group D exhibited balanced reductions between the various sectors along with the installment of PV panels/sheets.

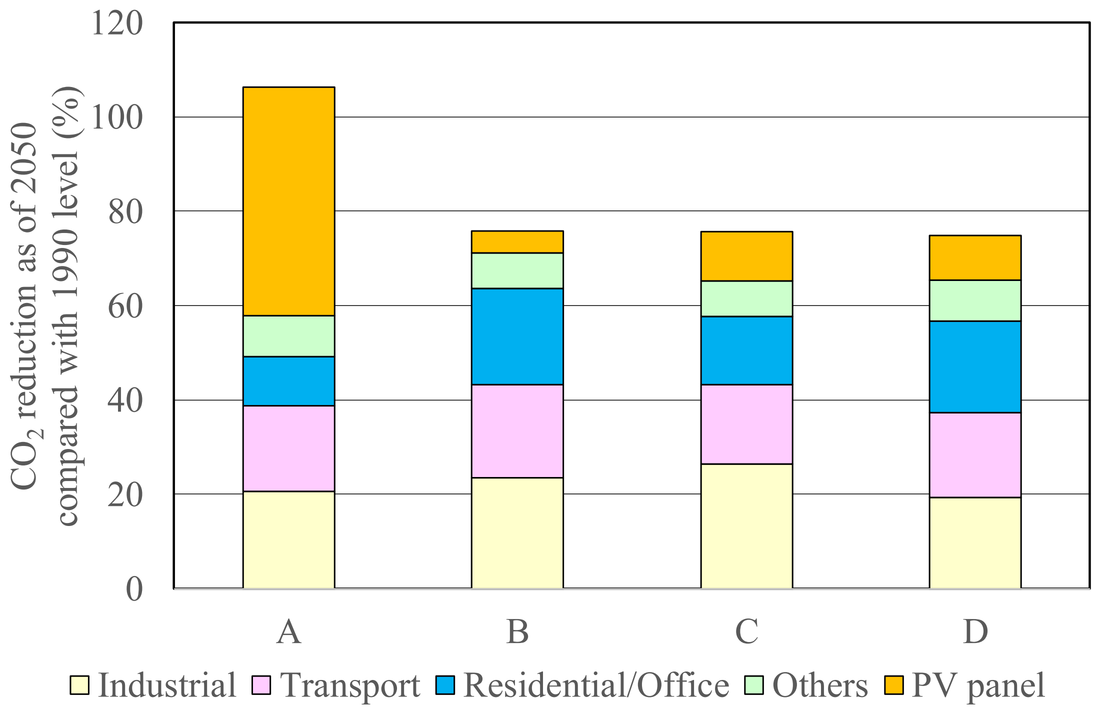

Figure 5. Breakdown of CO_2 reductions for 2050 among various sectors in the visions of the four groups.

5.3. Roadmaps to Realize the Visions

Workshop participants developed a roadmap to clarify the policies and other actions that would need to be realized to achieve each vision, along with the relevant timelines. Figure 6, the format of which refers to the literature [24], demonstrates the roadmap developed by Group A, in which several policy options were generated (e.g., launching a local electric power company and enacting legislation) to achieve 100% self-sufficiency in electricity production through PV installation. In this manner, various policy options, including taxes and subsidies to promote energy savings, were suggested as part of the city's environmental policy planning.

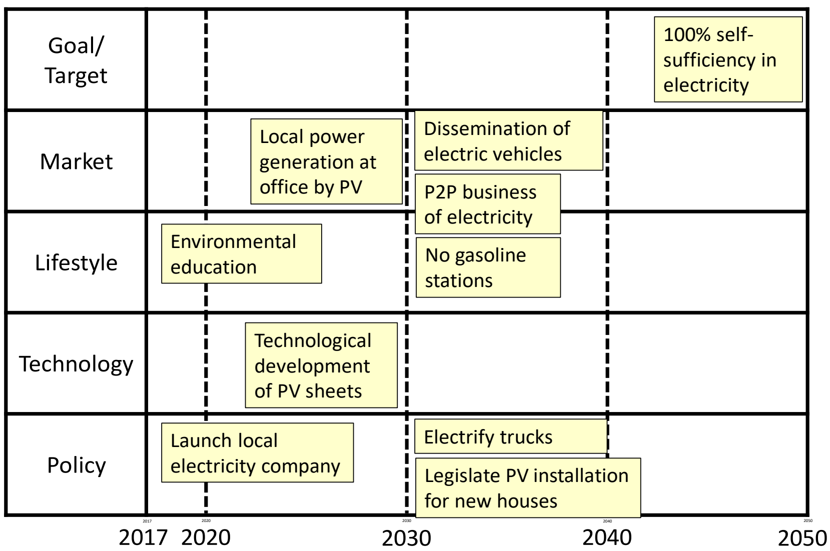

Figure 6. An example of a roadmap (for Group A). PV, photovoltaic; P2P, peer-to-peer.

6. Scenario Assessment

In this section, we first examine how the elements of the visions created by future generations differed from those created by the current generation. Second, we examine how the inclusion of future generations influences the public's evaluation of the energy visions created by the four groups.

6.1. Scenario Assessment: Future Generations Versus Current Generation

The first step of the scenario assessment aimed to confirm whether the inclusion of imaginary future generations affected the process and results of the deliberation. From the conversation recorded during the energy-visioning workshop (the first workshop), we transcribed the recording in Japanese, and subsequently performed text mining and statistical analyses. The text data consisted of individual terms that came up in discussion, which revealed the characteristics of the conversations within the four groups.

In particular, in our analysis we focused on the combinations of some particular terms in a single sentence of the conversation. Using the quantified text data, we first conducted principal component analysis to identify the combinations of terms that appeared in a single sentence. Subsequently, we calculated the frequency at which each combination of words arose in the discussion, and computed connectedness statistics, which are the sums of squared component loads (i.e., contribution rates). The word combinations appearing at high frequency and with high values of connectedness indicated important opinions in the deliberations [39].

Table 3 depicts the selected combinations of terms appearing at high frequency and with strong connectedness for the four groups. These combinations of terms were interpreted by reading the neighboring sentences.

Table 3. Selected combinations of terms appearing frequently and with high connectedness values.

Group A	Frequency	Connectedness	Combination of Terms
1	22	1.75	Future, Generation, Important, Construction
2	19	1.53	Society, Renewable energy, Electricity, Dissemination, Build
3	16	1.83	Everyone, Institution, Cost, Build, Participate
Group B	**Frequency**	**Connectedness**	**Combinations of Terms**
1	25	2.03	Value, Diversity, Community, Accept
2	24	1.47	Energy, Utilize, Environment, Build, Increase, Livelihood
3	19	1.33	Something that we can do, Difference, Use
Group C	**Frequency**	**Connectedness**	**Combinations of Terms**
1	32	1.38	Interest, Absent, Nuclear Power, Many, Toward
2	24	1.83	Power generation, Electricity, Generate, In city, Citizen
3	18	2.02	Households, Public facility, Rooftop rent, Installment, PV
Group D	**Frequency**	**Connectedness**	**Combinations of Terms**
1	26	1.39	Change, Important, Citizens, Viewpoint, Absent, Natural
2	21	1.54	Transport, Move, Many, Can do, Automobile, Bicycle
3	18	1.85	Use, Power generation, Gasoline, Electricity, PV, Advance

For Group A, the first combination of terms addresses the importance of including imaginary future generations in the deliberation process. The second combination highlights renewable energy and its dissemination, whereas the third emphasizes the importance of institutions, whereby everyone is involved and pays relevant costs. On the other hand, Group B seemingly emphasized the social value of accepting diversity among people. The other two combinations propose that residents should reconsider methods of using energy and find new methods themselves. Group C focused on promoting PV installation in houses and public facilities. Hence, they frequently discussed how to get people involved who do not show any apparent interest. Finally, Group D particularly addressed the changes in current energy and transportation practices, and further discussed the importance of changing citizens' consciousness regarding the environment.

This discussion revealed two important findings. First, the results show that the future generation groups used more proactive phrases while referring to renewable energy, for example, "we citizens participate in and pay the incurred cost," or "we seek what we can do." However, the present generation groups focused on renewable energy education/campaigns, as well as the involvement of the local government. Second, the future generation groups seemed to maintain a backcasting perspective. For example, Group B stressed the values regarding diversity that would characterize the future society, and this social value affected their discussion of countermeasures, which included a community-based approach and the promotion of education.

6.2. Evaluation by Public

We attempted to clarify whether the proposals made by future generations would receive the support of the current generation. Specifically, we conducted an online survey for residents of Suita (N = 418) in October 2018. This survey had two purposes, and employed the questionnaire shown in Table 4. First, we assessed whether ordinary people would support the opinions of future generations. In the survey, questionnaires were used to collect data on the respondents' individual attributes and demographic information. Further, they were requested in order of importance to rank the following energy planning criteria [40]: energy security, economy, safety, environment, feasibility, and locality. Energy security refers to the stable supply of energy resources, and safety focuses on the risks posed by power generation, which emerged as an important consideration after the Fukushima nuclear power plant accident. Economy refers to the costs of energy, where cheaper energy is considered better for the economy. Feasibility and locality are not explicitly mentioned in Japan's basic energy plan. However, these two elements represent important considerations in local energy visioning and are mutually interconnected. For example, ignoring local conditions can increase the installment and operation costs of proposed energy systems. Finally, the questionnaires asked the survey participants to rank the four visions according to their perceived importance (Figure 7). To facilitate an intuitive understanding of the visions, we provided pictorial representations of each of the four visions. In the survey, the participants were required to consider both the storylines and the pictures of the four visions.

Table 4. Questionnaire for scenario assessment.

Individual Attributes	
1. Gender	
2. Age	
3. Having children or not	
4. Marriage status	
5. Household income level	
6. Occupation	
7. Years of living in Suita	
Individual Preferences	
8. Lifestyle preference A	Choose one: living in a rural area or living in an urban area
9. Lifestyle preference B	Choose one: individual orientation or large-family orientation
10. Consumption style preference	Choose one: shorter consumption cycle or longer consumption cycle
11. Housing style preference	Choose one: housing complex or detached house
12. Preference between the 4 energy scenarios	Rank the scenarios proposed by the four groups

Figure 7. Visualized energy visions of the four groups: (**A**) Eco-roof Suita; (**B**) environmental city Suita—investment is not cost; (**C**) Citizens construct 100 renewables in Suita; (**D**) stars are twinkling in Suita [35].

Table 5 presents the number of votes for each vision obtained from the questionnaire. The two visions created by future generations (Eco-roof Suita and Environmental city Suita) received the most votes for highest importance (1st-place ranking; 132 and 133 votes, respectively), and the vision Environmental city Suita received the most votes for the 4th-place ranking (least perceived importance). It seems that the visions created by future generations generated a divided reception, between individuals supporting them and those appearing not to like them.

Table 5. Number of votes obtained for each ranking.

Vision/Ranking	1st	2nd	3rd	4th
Eco-roof Suita (Future generation)	132	55	50	180
Environmental city Suita (Future generation)	133	81	114	89
Citizens construct 100 renewables in Suita (Current generation)	108	101	144	64
Suita where stars are twinkling (Current generation)	44	180	109	84

Subsequently, we examined how individual attributes affected an individual's choice between the visions. However, as depicted in Table 6, individual attributes did not seem to correspond to preference between the visions. Although we do not report these results in further detail, it is worth noting that they were confirmed using regression analysis.

Table 6. Attributes of those who chose different visions.

	Female	Income Level *	Preference for Urban Lifestyle	Preference for Family-Oriented Lifestyle	Preference for Decentralization	Support for Recycling
Eco-roof Suita	49.24	3.9	80.3	13.64	65.15	76.52
Environmental city Suita	56.39	3.8	80.4	9	59.4	76.69
Citizens construct 100 renewables in Suita	48.15	4.3	81.5	10.2	59.2	70.73
Stars are twinkling in Suita	50	4.4	88.6	2.2	56.8	70.45

Note. Numbers are all given as percentages; * Income levels were grouped as follows: 1 = less than JPY 2 million; 2 = more than or equal to 2 million and less than 4 million; 3 = more than or equal to 4 million and less than 6 million; 4 = more than or equal to 6 million and less than 8 million; 5 = more than or equal to 8 million and less than 10 million; 6 = more than or equal to 10 million and less than 12 million; 7 = more than or equal to 12 million and less than 15 million; 8 = more than or equal to 15 million and 20 million; and 9 = more than or equal to JPY 20 million.

To further understand the factors that determined the preferences between the visions, we clustered the respondents according to their preferences regarding energy criteria, i.e., how values were assigned to different elements of the energy system. Table 7 depicts the results of the clustered analysis. Four clusters were obtained, which are described as follows: Cluster 1, respondents who valued security and economy (120 people); Cluster 2, those who valued safety and feasibility (93 people); Cluster 3, those who valued environment and security (112 people); and Cluster 4, those who valued economy and the environment (92 people).

Table 7. Number of votes for energy visions, clustered by energy preferences of respondents.

Energy Vision	Cluster 1: Security and Economy	Cluster 2: Safety and Feasibility	Cluster 3: Environment and Security	Cluster 4: Economy and Environment
Eco-roof Suita (Future generation)	43	25	30	34
Environmental city Suita (Future generation)	37	25	39	32
Citizens construct renewables 100 Suita (Current generation)	31	31	29	17
Suita where stars are twinkling (Current generation)	9	12	14	9

We now discuss the number of first-ranking votes obtained for each energy vision according to these clusters (Table 6). In this respect, distinct differences were observed. The clusters of respondents who valued the environment and resource security (Clusters 1 and 3) were more likely to choose the visions proposed by future generations. Contrarily, people who valued feasibility (Cluster 2) were more likely to choose a vision proposed by the current generation. The energy visions of future generations considered a balance between environment, resource security, and economic feasibility, whereas the major considerations of the current generations were feasibility and safety. Moreover, residents (who comprise the current generation) supported the energy visions proposed by future generations even though these proposals implied costs for the current generation. Finally, respondents' preferences for social and environmental elements affected their energy vision preferences (i.e., indicated which were more likely to support future generations, who among the current generation were more like future generations in that they defy present costs, etc.).

7. Discussion

The results of the analyses of the proposed visions and pathways for Suita city can be summarized as follows. First, the comparison between the controlled groups (current generation) and treatment groups (future generations) revealed significant differences in the topics and attitudes reflected in the discussion stage of the visioning process. For example, the imaginary future generations proposed visions and corresponding pathways that explicitly incurred substantial costs for the current generation, which were not implied in the current generations' proposals. Second, our scenario design methodology employed a logic tree and CO_2 emission calculator to facilitate the understanding of the proposals by each participant. The roadmaps constructed also specified necessary policy instruments and countermeasures. This understanding indeed enhanced the logicality and feasibility of the proposed scenarios. Third, despite containing aspects that could be considered disadvantageous for the current generation, the energy scenarios proposed by future generations were well supported by the current public. This last finding has important implications in decision-making by policy-makers and corporate leaders because it would help them make decisions that incur costs for current generations, with the knowledge that people are willing to bear these costs for the benefit of future generations. Therefore, we conclude that a combined future design and scenario design methodology is plausible and effective for visioning and in efforts to mitigate climate change.

There are certain limitations of this study, which remain as future research challenges. First, it is known that some factors, such as the clear existence of opposing opinions in discussion, can trigger or reinforce group polarization in deliberation [41,42]. In particular, this study focused on a local energy vision for Suita city, where the tertiary sector represents the local economy, so participants could freely assume the non-use of nuclear power and/or emigration of manufacturing plants, which received support from both future and current generations. However, when dealing with a national-level energy-visioning process, for instance, the inclusion of future generations may potentially worsen polarization in deliberation because more factors, such as nuclear power, globalization, and industrialization, should be taken into consideration in deliberation as endogenous variables. It is clear that opposing opinions exist over topics like nuclear power and globalization (immigration, free trade, etc.). Therefore, further research is needed to identify factors that can create and prevent polarization.

Another question that remains to be addressed is who should best represent which aspect in consideration. While we demonstrated the importance of including future generations in mini-publics in a particular context, limited knowledge is available regarding the optimal composition of these mini-publics. Regarding the issue of polarization, it is unclear whether the presence of future generations is always appropriate, particularly when deliberation involves a critical situation for the current generations, such as extreme poverty or fatal infectious disease. This problem becomes more serious when dealing with topics relevant to a larger geographic area, because a greater variety of stakeholders as well as more polarization factors will be involved. Only a few studies have explored the scenario design methodology at a national level [43].

Finally, it is important that participants understand how their deliberation results are used. In other words, it is of critical importance to seek ways to legitimize the proposals made by future generations. Similarly, deliberation enhances the perception of legitimacy by the public because stakeholders participate in the discussion process [6,24–26], but scenario design itself does not implicitly assume its design and implementation. Even though we observe and understand the positive effects of the inclusion of future generations in deliberation, we should further examine how judicial, administrative, and legislative systems such as education could be revised to account for the concerns of future generations. The literature on future design describes mechanisms that can potentially prevent future failures [44–47], and some studies have attempted to identify methods for their institutionalization [48,49]. It is necessary to accumulate and analyze successful cases to understand which conditions and factors make scenarios ready for implementation in the real world.

8. Conclusions

In this study, a new scenario design methodology was proposed by combining a participatory scenario approach and a future design approach. As a case study, four workshops in Suita city were conducted for energy visioning based on the scenario design methodology. The scenario assessment showed that the proposed methodology is effective in constructing energy visions in the local context. The scenarios created by imaginary future generations explicitly included policy options incurring costs to the current generation, but still received support from the current stakeholders. Future research should assess the scenario design methodology in the context of larger-scale topics and the practical implementation of scenarios.

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