Evaluation of Environmental Contribution in R&D Themes

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Global movement toward carbon neutrality is accelerating. In the field of information and communication technology (ICT), efforts are being made not only to reduce the power consumption of individual devices, but also to improve the energy efficiency of the ICT society as a whole.

OKI is working to realize a sustainable society with the key message "Delivering OK! to your life." This article evaluates the environmental contribution potential (future possibility) in R&D themes to examine the directionality of R&D for increasing the contribution value. In the evaluation, the usage scenario of a technology was considered, and the reduction effect for each usage was calculated. Furthermore, the avoided emission was calculated by multiplying the reduction effect with market size to estimate the potential for the entire society. Based on the analysis of the results, the directionality of R&D that considers environmental contributions is presented.

Ripple Effect of Environmental Contributions

ICT is used in a variety of far-reaching scenarios and reducing its environmental impact will have large effect on society. However, accurately evaluating its environmental contributions is difficult.

ICT's contributions to the environment are broadly divided into direct and indirect contributions. Direct contribution is when an ICT equipment or device directly reduces environmental impact through lower power consumption, whereas indirect contribution is when ICT plays a part in reducing the movement of people and goods, and indirectly reduces environmental impact by optimizing and improving the efficiency of energy use.

In an actual ICT usage scenario, there are both direct and indirect contributions. For example, when considering the environmental contribution of updating an old video conferencing system, there is a direct contribution from the reduced power consumption of the new system, but there is also an indirect contribution in that there will be less need for people to travel and the use of cars and public transportations are reduced.

As can be seen, the impact of ICT is extensive both temporally and spatially thus it is necessary to consider the effects of a system from various angles.

Environmental Contributions of R&D

In order to provide products with high environmental contribution value, it is most effective to take the environment into consideration at the R&D stage. If the elemental technology is used in a variety of scenarios, it can be expected to expand the range of applicable products and, as a result, have a large impact on society. Furthermore, by including environmental considerations in the initial stage of value verification, it may lead to the discovery of new values and other possible uses.

This article presents the attempt that was made to evaluate the environmental contribution potential of current R&D themes to examine the directionality in R&D that will increase the value of environmental contribution. It is OKI's belief that this evaluation will deepen the understanding of each technology and will be useful to examine the directionality in its R&D efforts for environmental contribution.

Method of Evaluating Potential Avoided Emissions

For the evaluation, a manual[1] published by the IT/IoT Green Contribution Technical Committee under the Green IT Promotion Committee of the Japan Electronics and Information Technology Industries Association (JEITA) was referenced. The manual provides quantitative evaluation examples of environmental contributions specific to ICT.

Avoided emission, which assumes the potential reduction contribution to the society as a whole, was defined as the product of the reduction effect and the market size, and the yearly amount of CO_2 emissions was calculated. The calculation steps were (1) assumption of usage scenario, (2) calculation of reduction effect, and (3) calculation of market size. Each calculation step is described in detail below.

(1) Assumption of Usage Scenario

One typical and effective scenario in which the technology under examination would be used was selected.

(2) Calculation of Reduction Effect

Reduction effect was defined as active mass multiplied by emission intensity. Active mass represents the amount of change in activities that affects society from the environmental perspective due to the use of ICT. Active mass was calculated by listing the activities that change before and after the introduction of the assumed scenario, and calculating the increases or decreases from those activities. Furthermore, each activity was classified and organized according to its positive effect (CO_2 emissions decrease) or negative effect (CO_2 emissions increase) on the environment. Emission intensities were mainly based on values taken from the emission intensity database[2] published by the Ministry of the Environment. Then, net amounts of CO_2 emissions expected to be reduced due to positive effects and increased due to negative effects were calculated, and in turn the reduction effect was determined.

(3) Calculation of Market Size

The market size was calculated using publicly available market reports and the Fermi estimate (rough estimation of unknown data from known data) to determine the number of usage scenarios, assumed in (1), that exists in Japan.

Examples of Actual Evaluation

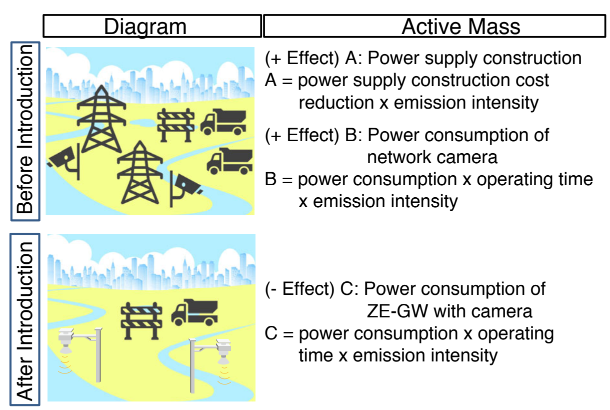
The method described above was applied to actual R&D themes in progress, and two specific examples are presented below.

(1) AI Model Compression Technology "PCAS"

"PCAS"[3] is a technology developed by OKI that reduces the number of operations in a deep learning model to compress its weight. This technology is registered in the "Challenge Zero" initiative promoted by Keidanren (Japan Business Federation)[4]. The scenario envisioned with this technology is the compression of the AI recognition model for detecting people and abnormalities with cameras that cover a wide surveillance area. The reduced power consumption was considered the activity that provides positive effect from an environmental viewpoint. Additionally, it was assumed that the power consumption of the surveillance cameras operating 24/7 will be reduced by 80%. The market size was based on the value from a market report[5]. As a result, the reduction effect was 0.96 [tCO_2 [*1)]/unit], and assuming a market size of 1.3 million units, the amount of avoided emission was calculated as 1.2M [tCO_2].

(2) Zero Energy Gateway Technology

Zero Energy Gateway (ZE-GW) is a solar cell driven sensor for social infrastructures and requires no external power source[6]. It enables remote monitoring of infrastructure conditions when installed on such structures as bridges, slopes, and steel towers. **Figure 1** shows an image of a usage scenario in which a river is remotely monitored by a ZE-GW equipped with a high-sensitivity camera. Activities that provide positive effects from an environmental viewpoint are the elimination of work required for power supply construction and the reduction in power the surveillance camera consumed from the power supply. For the negative effect, it was the increase in power consumption due to the ZE-GW's high-sensitivity camera. As positive effects, the elimination of power supply construction was 6.9 [tCO_2/unit], and the reduction in the power consumption of the surveillance camera was 0.04 [tCO_2/unit]. The negative effect was the increased power consumption of the ZE-GW, which was 0.11 [kCO_2/unit]. The market size was based on the assumption that the ZE-GW cameras are installed at equal intervals along the entire river distance publicized by the Ministry of Land, Infrastructure, Transport and Tourism. As a result, the reduction effect was 6.93 [tCO_2/unit], and assuming that the market size is 27,000 units, the avoided emission was calculated to be 0.18M [tCO_2].



$$\text{Reduction effect} = (A + B) - C = 6.93\ [tCO_2]$$

Figure 1. Avoided Emission Calculation of ZE-GW Technology

Evaluation Results

Assuming a usage scenario for each technology, the avoided emissions for other R&D themes were calculated. A plot of the evaluation results is shown in **Figure 2**. The

*1) Unit expressing the amount of emissions, absorption, and storage of various greenhouse gases converted to an equivalent weight of carbon dioxide.

vertical axis indicates the market size (number of units), and the horizontal axis indicates the avoided emission. As you go to the upper right, the technology has a higher potential for avoided emission. After plotting the results, it was found that the pattern can be broadly divided into the following two types.

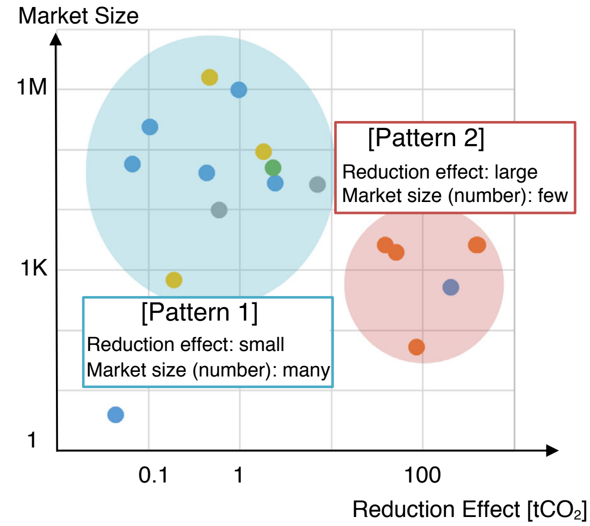


Figure 2. Evaluation of OKI R&D Themes from an Environmental Perspective

(1) Pattern 1

Pattern 1 corresponds to the group on the upper left. The reduction effect is small, but there are many markets. Many of the R&D themes in this group are focused on improving the efficiency of individual devices, such as edge devices, and primarily targets people and movements. The impact tends to be localized to the surrounding area.

(2) Pattern 2

Pattern 2 corresponds to the group on the lower right. The reduction effect is large for this group, but the markets are few in number. Many of the technologies in the group are for traffic and logistics optimization targeting highways and tunnels. The range of impact tended to reach a wide area.

Issues with Potential Evaluations

In the potential evaluations, the avoided emissions were calculated based on the typical usage scenario assumed for each technology. With this method, there are four issues that need to be addressed in the future.

(1) Divergence from Actual Usage Scenario

In the usage scenarios selected, it was assumed that the technologies are utilized effectively, and the calculated avoided emissions are only indications of the possibilities. Since the technologies are in the R&D stage, the scenarios themselves are hypothetical. Hence, it is unavoidable for the reliability in the reduction of active mass to be lower than expected. However, at the planning and R&D stages, it is possible to use the evaluation results as reference values for desk study. In order to make a more precise evaluation, it will be necessary to set a realistic scenario and recalculate at the commercialization stage.

(2) Scope of Contribution and Handling of Ripple Effects

As shown in the example of the video conference system, even a single system can have a variety of effects. Therefore, it is important to fully consider the temporal and spatial effects during evaluation. Especially in the case of indirect contributions, it is necessary to list the active mass after considering the fundamental value of the technology and examining the various possible effects. For this evaluation, only the engineers associated with the technology targeted for evaluation was included when the main contribution activities were summarized. As a result, there is a possibility that the temporal/spatial effects were not sufficiently examined. In order to perform an evaluation that includes all possible the contribution effects, it is necessary to hold discussions with people who know the site well, examine more multifaceted effects, and make appropriate corrections.

(3) Consideration of Contribution Rate

ICT solutions are generally composed of multiple technologies, such as sensing and communication technologies. However, in this potential evaluation, it was assumed that a single technology contributed entirely to the reduction even if the solution consisted of multiple technologies. This raises a concern that the avoided emission associated with a technology may be overestimated. It would be more appropriate to clarify the overall composition of the solution that brings about an effect and proportionally set a contribution rate for each component technology according to the extent of the technology's contribution to the reduction. Then, multiplying the total avoided emission by the contribution rate enables the avoided emission of an individual technology to be determined.

(4) Diversification of Usage Scenarios

The direction of contribution for technologies used in multiple scenarios, such as optimization technology utilizing AI, completely differs depending on the target and area. This potential evaluation was limited in that it assumed only one usage scenario for each R&D theme.

For a highly versatile technology, it is necessary to envision use cases and usage scenarios from multiple angles.

Directionality of R&D

The results of this potential evaluation suggested that several approaches can be considered to increase avoided emissions. Specifically, there are three methods: (1) further reduce each active mass, (2) switch to a unit with lower emission intensity, and (3) expand market size.

Since there are limits to market size and optimization range depending on the technology, it is necessary to ascertain which approach to take. Considering these three approaches and the two contribution patterns of OKI's R&D themes obtained from the evaluation results, study is underway on the directionality of R&D that enhances environmental value.

The first direction is increasing the technologies' versatility. For technologies that mainly improve and reduce the power consumption of edge devices or handle local information such as human movements, patterns will expand if they can be used in scenarios other than those currently assumed, thus increase the overall avoided emissions. Ideas to increase versatility include improving environmental resistance and increasing the number of compatible sensors.

The second is to expand the applicable target range. Mainly in the areas of traffic/logistics and infrastructures such as highways and tunnels, the target range can be expanded and the expected reduction of active mass can be increased if technologies can be promoted to provide optimization for a wide area. Ideas for expanding the range of applications include increasing the number of parameters to be considered to improve optimization capabilities, enabling a single sensor to monitor a wider area, and further developing the technologies to handle more information and perform advanced optimization.

In developing such technologies, it is considered effective to have a highly versatile group of sensors and an information platform that acquires and collectively manages the information obtained from the various sensors. To that end, further efforts are required to enable flexible interactive control even with a wide mixture of edge devices, easy integration of internal/external data and systems, and flexible system expansion.

To raise environmental awareness from the initial stage of R&D, it is believed to be effective to conduct periodic evaluations from an environmental perspective at each stage. For example, it is ideal to conduct regular evaluations at a time when potential customers or market pivots, or when technological enhancements are made.

In order to perform this systematically, incorporation of a mechanism is being considered to appropriately evaluate from an environmental perspective at each stage of technology development and business promotion.

Conclusion

This article explained a method of evaluating the potential avoided emissions of R&D themes and presented results of specific examples. Four issues that were not taken into consideration in the evaluation were also mentioned. Based on the results of the evaluations, the approach to increase the environmental contribution and the directionality of future R&D themes were discussed.

Taking into consideration the contents examined in the evaluations, awareness of environmental contributions will be further raised from the R&D stage, and initiatives to "Delivering OK! to your life." from an environmental perspective will be promoted. ◆◆

References

1) JEITA Green IT Promotion Committee: Energy Contribution for Society as a Whole through IT Solutions (in Japanese) https://home.jeita.or.jp/greenit-pc/contribution/index.html
2) Ministry of the Environment: Emission Intensity Database for Calculating Greenhouse Gas Emissions of an Organization through Its Supply Chain (in Japanese) https://www.env.go.jp/earth/ondanka/supply_chain/gvc/estimate.html
3) NEDO News Release: Development of a New Lightweight Technology for Deep Learning Models, September 9, 2019 (in Japanese) https://www.nedo.go.jp/news/press/AA5_101191.html
4) Challenge Zero: Improvement of power consumption efficiency for advanced AI processing using deep learning compression technology https://www.challenge-zero.jp/en/casestudy/350
5) Yano Research Institute Ltd.: Network cameras / VCA image analysis systems market (2021) (in Japanese)
6) Hiroshi Hashizume, Yuki Kubo, Atsushi Yoda: Zero Energy High-Sensitivity Camera -Take Clear Pictures of Remote Sites Day and Night with Easy Installation-, OKI Technical Review, Issue 239, Vol.89 No.1, May 2022 https://www.oki.com/en/otr/2022/n239/pdf/otr-239-R13.pdf

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