Essays on the Carbon Sources of Carbon-Recycle Fuels (3)
— Attribution of CO_2 Emission Reduction Effect—

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1. Key points of this paper

- There are two main schools of thought on the attribution of CO_2 emission reduction effect for carbon-recycle fuels that use CO_2 derived from fossil fuels.
- The first school of thought is that it is only attributable to the producers and users of carbon-recycle fuels. This stance is based on the following two lines of reasoning. (1) As CO_2 is only separated, captured, and re-emitted in the production and utilization of carbon-recycle fuels, and the CO_2 emission reduction effect is dependent solely on hydrogen, the utilization of carbon-recycle fuels is the same as the direct use of hydrogen. (2) Hypothetically, in order to attribute a part of the CO_2 emission reduction effect to CO_2 separation and capture facilities, it is necessary for "CO_2 reduction effect from the utilization of carbon-recycle fuels > CO_2 reduction effect from the direct use of hydrogen." However, due to the efficiency of the conversion process, CO_2 emission reduction effect is absolutely "Direct use of hydrogen > Utilization of carbon-recycle fuels." Consequently, it is considered that CO_2 emission reduction effects are not attributable to CO_2 separation and capture facilities.
- The second school of thought is that it should be allocated between the providers of CO_2 derived from fossil fuels (such as power plants and industrial plants), and the producers and users of carbon-recycle fuels. CO_2 providers and users have an interdependent relationship in carbon recycling. In short, for the CO_2 providers, CO_2 reduction cannot be achieved without any users; on the other hand, for the users, the provision of CO_2 is vital. From this perspective, it is important to have a structure that allows both sides to cooperate easily, and there is a need to allocate the CO_2 reduction effect to both parties. Hypothetically, if CO_2 reduction effect were not allocated to the carbon provider, power plants and industrial plants would have little motivation to participate in carbon recycling. In addition, as this would mean that power plants and industrial plants do not implement any CO_2 reduction measures, it would inevitably lead to the early closure of plants in the process of decarbonization. This signifies a reduction in carbon sources, which in turn, can also prove to be disadvantageous to CO_2 users.

2. Body text

In the first and second papers, we discussed the principles of carbon-recycle fuels and the carbon sources that are necessary in a decarbonized economy. In this paper, we offer two differing schools of thought on the attribution of CO_2 emission reduction effect of carbon-recycle fuels. With the aim of helping readers consider and discuss this subject, we have ventured to include a diverse range of opinions.

Attributing CO_2 emission reduction effect only to the users of carbon-recycle fuels

As explained in the first paper, hydrogen plays a leading role in carbon-recycle fuels, while CO_2 plays the supporting role (it is only offset in the processes of separation and capture, utilization, and re-emission). Hence, the decarbonization effect of carbon-recycle fuels is attributed to its main ingredient, hydrogen. In short, we can regard the utilization of carbon-recycle fuels as being equal to the utilization

of hydrogen. If we were to consider the direct use of hydrogen, based on the assumption that hydrogen replaces fossil fuels, such as the case where there is a thermal power plant nearby, the power plant only emits and discharges CO_2 into the atmosphere, and does not generate any CO_2 emission reduction effect in itself. In other words, while CO_2 is temporarily separated and captured from thermal power plants in the case of carbon-recycle fuels, it is only emitted in a dispersed manner at different times and locations, and is therefore no different from the direct utilization of hydrogen.

If a portion of the CO_2 emission reduction effect in the production and use of carbon-recycle fuels is attributed to CO_2 separation and capture at thermal power plants, there is a need to identify the effect that can be generated through that action (CO_2 separation and capture at thermal power plants). In this case, the following must be true: "CO_2 reduction effect through the utilization of carbon-recycle fuels > CO_2 reduction effect through the direct utilization of hydrogen." However, due to losses in the conversion process, CO_2 emission reduction effect must absolutely be "Direct utilization of hydrogen > Utilization of carbon-recycle fuels." Consequently, CO_2 separation and capture from thermal power plants do not contribute to reducing CO_2 emissions. In short, it is considered to be impossible to attribute any CO_2 emission reduction effects to CO_2 separation and capture from thermal power plants. The same can be said for biomass power plants.

If the CO_2 that is separated and captured from thermal power plants is not stored but is utilized in the production of carbon-recycle fuels, in spite of the intention of the thermal power plant to carry out CCS (interception of CO_2 for CCS use), then it would be possible to attribute the CO_2 emission reduction effect that should originally have been generated through the implementation of CCS, to the thermal power plants. However, if CO_2 that has no way but to be discharged into the atmosphere is used, it would be reasonable to attribute the CO_2 emission reduction effect to the manufacturers and users of carbon-recycle fuels, or in other words, to the hydrogen users.

Accordingly, of course, the costs related to CO_2 separation and capture are shouldered by the producers and users of carbon-recycle fuels.

In order to avoid the problem of allocating CO_2 emission reduction effect to the sources of CO_2 emissions (CO_2 providers), introduced in the next section, as well as the issue of CO_2 re-emission in the realization of a decarbonized economy by 2050 covered in the second paper, one possibility could be for the producers and users of carbon-recycle fuels to have their own biomass power plants or direct air capture (DAC) facilities and utilize the CO_2 from these facilities.

Allocating CO_2 emissions effect to both the carbon providers and the users of carbon-recycle fuels

On the other hand, another school of thought posits that emission reduction effect should also be allocated to the carbon provider (such as power plants and industrial plants) in cases where fossil fuel-derived CO_2 is reused. If CO_2 reduction effect were not allocated to the carbon providers, power plants and industrial plants would have little motivation to participate in carbon recycling, making it possibly difficult to reuse fossil fuel-derived CO_2 in the medium- to long-term.

Hypothetically, if the CO_2 reduction effect were not allocated to the carbon providers, they would not in effect be implementing any emission reduction measures, nor would they be contributing to CO_2 reductions in economy. If environmental measures such as carbon taxes and emissions trading were to be tightened in the future, the carbon providers would then be subjected to penalties (such as payment of carbon taxes or incurring expenses to purchase carbon offsetting credits) for the combustion of fossil fuels.[1] This may be acceptable in a short-term situation where environmental

[1] Even in the case where CO_2 reduction effect is not allocated to power stations and industrial plants, if CO_2 were passed on to users at a charge, it could be possible to ease the impact of the penalties imposed on fossil fuel combustion. However, this would be a situation in which a part of the penalties is shouldered by

regulations are lax. In contrast, if we were to consider the carbon neutral environment of 2050, it may be more rational for carbon providers to close their plants down at an early stage or put in place alternative measures such as fuel conversion and CCS, instead of maintaining fossil fuel power plants or industrial plants while being subjected to penalties. In short, in a situation where there are no advantages to the carbon provider from generating CO_2 reduction effects, they may become unable to sustain the "provision of fossil fuel-derived CO_2" in the medium- to long-term. This could place constraints on the quantitative expansion of carbon-recycle fuels, and could also be disadvantageous to CO_2 users.

In carbon recycling, the carbon providers and users of carbon-recycle fuels are considered to have an interdependent relationship. For the carbon providers, an absence of carbon-recycle fuel users would make it impossible to realize CO_2 emission reduction. At the same time, CO_2 is a vital resource for carbon-recycle fuel users, and the stable procurement of this resource holds the key to commercialization (without CO_2 supplies, it would become necessary to utilize hydrogen directly, making it impossible to enjoy the benefit of "compatibility with existing infrastructure" offered by carbon-recycle fuels). It is important to have a system that facilitates the cooperation and sustainability of both parties. From this perspective, there is a need to allocate the CO_2 reduction effect to both parties. In the CO_2 reduction effect is allocated, carbon-recycle fuels are also regarded as a source of CO_2 emissions.

Incidentally, in cases where reduction effect is not allocated to the carbon provider, as described above, issues may arise in relation to the sustainability of the carbon provider. As we have also discussed at the end of the second paper, it may be important for carbon-recycle fuel users to refine their carbon procurement strategy based on this point (for example, make plans in advance for alternative carbon sources and CO_2 procurement infrastructure).

Other issues

The discussion in this paper was based on the premise of the domestic production and utilization of carbon-recycle fuels. In the case where carbon-recycle fuels are produced overseas and imported in a cross-border scenario, there would be issues with the attribution of CO_2 emission reduction effect. In the case where Country A produces carbon-recycle fuels from hydrogen and CO_2, exports these fuels to Country B where the fuels are then utilized (combustion/CO_2 re-emission), CO_2 is captured in Country A and emitted in Country B, but only at a different time. Hence, from a global perspective, the volume of CO_2 emissions remains unchanged. However, as this is accompanied by cross-border activities, there is a need to establish international rules on the attribution of CO_2 emission reduction effect.

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the CO_2 users. From an economic point of view, we can say that the CO_2 reduction effect is, in effect, redistributed.