Impact of Promoting the Use of Wood in Buildings on CO2 Emissions in Japan

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Toward the realization of a decarbonized society, the use of wood, a material with lower environmental impact, is being promoted in buildings in Japan. A look at the floor area of construction starts in Japan shows that although the share of â€˜low-riseâ€™ residential construction starts made of wood is higher than that made of other materials such as concrete, the number of new housing starts is on a downward trend during the period between 2000 and 2020. On the other hand, it is important to note that the share of â€˜medium- and high-riseâ€™ residential construction starts made of wood is considerably lower than that made of other materials such as concrete due to engineering problems. The Japanese government has enforced the Law on the Promotion of the Use of Wood in Public Buildings since 2010 and promoted the use of wood to reduce CO2 emissions.

An important research question is to what extent CO2 emissions can be mitigated through the promotion of the use of wood in building construction? To the best of our knowledge, few studies addressed this research question, however they did not provide a comprehensive analysis framework to estimate the change in life-cycle CO2 emissions associated with expanding the use of wood in building construction instead of the use of other materials. To the best of our knowledge, this study is the first attempt to develop a new life-cycle analysis framework with a focus of detailed construction technologies and to estimate the life-cycle CO2 emissions under the construction technology change scenarios. Based on the Japanese Input-Output Tables in 2015 and the Embodied Energy and Emission Intensity Data (3EID) for Japan Using Input-Output Tables provided by the National Institute for Environmental Studies of Japan, we firstly calculated the amount of direct and indirect CO2 emissions (i.e., carbon footprint) induced by the final demand of residential construction (wooden), residential construction (non-wooden), non-residential construction (wooden), and non-residential construction (non-wooden) in Japan in 2015.

Secondly, we estimated the carbon footprint of buildings in 2030 based on the medium- to long-term construction investment in 2030 forecasted by the Research Institute of Construction and Economy, and analyzed the changes in the carbon footprint of buildings during the period between 2015 and 2030. The results show that construction investment level for different construction technologies will be 98% for residential construction (wooden), 100% for residential construction (non-wooden), 134% for non-residential construction (wooden), and 134% for non-residential construction (non-wooden) in 2030 compared to 2015. We found that if there are no technological changes in buildings, the total of the carbon footprint of buildings (i.e., residential construction (wooden), residential construction (non-wooden), non-residential construction (wooden), and non-residential construction (non-wooden)) is shown to be 116% in 2030 compared to 2015.

We further found that under the scenario for replacing non-wooden buildings with wooden buildings, the amount of direct and indirect CO2 emissions from the manufacture of buildings will be significantly reduced due to a rapid replacement of concrete with relatively higher CO2 emission intensity mainly used in reinforced concrete (RC) construction (the main construction method for nonresidential buildings) with lumber with relatively lower emission intensity. Finally, we suggest a demand-side policy (i.e., subsidy policy and/or ecolabeling policy) aiming at the promotion of â€˜medium- and high-riseâ€™ residential construction starts made of wood.