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# Environmental Impact Assessment on Korean Construction Industry

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**Abstract.** This study quantitatively assessed the effect of Korea's construction industry on environment after estimating the influence of various environmental loads on environment. According to the analysis, the effect of Korean construction industry on environment in 2010 was 8,368,112pe·yr. In particular, global warming accounted for 89.3%.

**Keywords:** Life Cycle Assessment, Life Cycle Inventory Analysis, Environmental Impact, Construction Industry,

## 1 Introduction

Recently, environmental problems have been observed in various forms in addition to global warming. In Korea, however, carbon footprint-based global warming has been concentrated. In fact, there has been a lack of studies which considered various environmental loads.

Therefore, this study attempted to estimate overall environmental effects by carrying out an environmental impact by environmental load and quantitatively assess the effect of Korea's construction industry on environment.

## 2 Analysis Outline

This study estimated the overall effect of various environmental loads on environment using the Life Cycle Impact Assessment (LCIA) [1] proposed by Life Cycle Assessment (LCA, ISO14040). then, their environmental effects on Korea's construction industry were quantitatively assessed as follows: First, environmental loads produced in construction industry are selected, and the influence category by environmental load is classified. For the relative comparison of environmental impact among the classified impact categories, characterization, normalization and weighted values are applied to estimate the overall effect on environment. Second, the input cost in Korea's construction industry is investigated, and environmental load by energy consumption is estimated using input-output analysis. Third, the effects of

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Korea's construction industry on environment through environmental evaluation on the estimated environmental load.

# 3 Analysis Results

## 3.1 Results of environmental impact assessment by environmental load

The environmental load used in this study includes nine (9) different energy sources consumed in construction industry and 6 different atmospheric loads which occur with energy consumption. The related environmental load factors [2][3] are stated in Table 1 below:

**Table 1.** Environmental Load Factor Output

| Environmental Load | Anthracite (kg) | Bituminous (kg) | LNG (kg) | Gasoline (ℓ) | Jet fuel (ℓ) | Kerosene (ℓ) | Diesel (ℓ) | Fuel Oil (ℓ) | LPG (ℓ) |
|---|---|---|---|---|---|---|---|---|---|
| CO (g-CO) | 3.00E-01 | 2.50E-01 | 1.34E+00 | - | - | 6.00E-01 | 6.00E-01 | 6.00E-01 | 3.84E-01 |
| $CO_2$ (g-$CO_2$) | 2.42E+03 | 2.31E+03 | 2.75E+03 | 2.13E+03 | 2.43E+03 | 2.45E+03 | 2.60E+03 | 2.98E+03 | 2.87E+03 |
| $NO_X$ (g-$NO_X$) | 5.83E+00 | 5.55E+00 | 3.70E+00 | - | - | 2.40E+00 | 2.40E+00 | 6.32E+00 | 1.16E+00 |
| $SO_X$ (g-$SO_X$) | 1.37E+01 | 9.50E+00 | 1.00E-02 | - | - | 1.70E+00 | 1.70E+00 | 7.27E+00 | 5.00E-03 |
| $NH_3$ (g-$NH_3$) | 2.80E-04 | 2.80E-04 | 5.10E-02 | - | - | 9.60E-02 | 9.60E-02 | 9.60E-02 | 1.30E-02 |

In terms of characterization for each environmental load, the yield rate of production [5] by energy source was applied to the characterization factors of crude oil [4]. In terms of normalization, the amount by population was stated [6] by setting the world as geographical boundary in pan-global impact category and country as geographical boundary in local impact category just like EDIP. Lastly, in terms of a weighted factor, the coefficient estimated for environmental impact assessment [7] was applied. The table below reveals the results of environmental impact assessment by environmental load:

**Table 2.** Environmental Assessment Output by Environmental Load

| Impact category | List | environmental load (a) | Characterization coefficient (b) | Characterization value (a)×(b)=(c) | Normalization coefficient (d) | Normalization value (PE·yr) (c)/(d)=(e) | Weight (f) | environmental impact (PE·yr) (e)×(f)=(g) |
|---|---|---|---|---|---|---|---|---|
| Inanimate resource depletion | Anthracite | 1.00E+00 (g-E) | 4.61E-03 (/yr) | 4.61E-03 (g-E/yr) | 2.49E+04 (g-E/PE.yr$^2$) | 1.85E-07 | 2.31E-01 | 4.28E-08 |
| | Bituminous | 1.00E+00 (g-E) | 4.61E-03 (/yr) | 4.61E-03 (g-E/yr) | 2.49E+04 (g-E/PE.yr$^2$) | 1.85E-07 | 2.31E-01 | 4.28E-08 |
| | LNG | 1.00E+00 (g-E) | 1.67E-02 (/yr) | 1.67E-02 (g-E/yr) | 2.49E+04 (g-E/PE.yr$^2$) | 6.71E-07 | 2.31E-01 | 1.55E-07 |
| | Gasoline | 1.00E+00 (g-E) | 2.04E-03 (/yr) | 2.04E-03 (g-E/yr) | 2.49E+04 (g-E/PE.yr$^2$) | 8.19E-08 | 2.31E-01 | 1.89E-08 |
| | Jet fuel | 1.00E+00 (g-E) | 1.61E-03 (/yr) | 1.61E-03 (g-E/yr) | 2.49E+04 (g-E/PE.yr$^2$) | 6.47E-08 | 2.31E-01 | 1.49E-08 |

 

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Kerosene | 1.00E+00 (g-E) | 2.36E-03 (/yr) | 2.36E-03 (g-E/yr) | 2.49E+04 (g-E/PE.yr$^2$) | 9.48E-08 | 2.31E-01 | 2.19E-08 |
| | Diesel | 1.00E+00 (g-E) | 6.11E-03 (/yr) | 6.11E-03 (g-E/yr) | 2.49E+04 (g-E/PE.yr$^2$) | 2.45E-07 | 2.31E-01 | 5.67E-08 |
| | Fuel Oil | 1.00E+00 (g-E) | 6.03E-03 (/yr) | 6.03E-03 (g-E/yr) | 2.49E+04 (g-E/PE.yr$^2$) | 2.42E-07 | 2.31E-01 | 5.59E-08 |
| | LPG | 1.00E+00 (g-E) | 9.19E-04 (/yr) | 9.19E-04 (g-E/yr) | 2.49E+04 (g-E/PE.yr$^2$) | 3.69E-08 | 2.31E-01 | 8.53E-09 |
| Global Warming | $CO_2$ | 1.00E+00 (g-$CO_2$) | 1.00E+00 (g$CO_2$-eq/g-$CO_2$) | 1.00E+00 (g$CO_2$-eq) | 5.53E+06 (g-$CO_2$-eq/PE.yr) | 1.81E-07 | 2.88E-01 | 5.21E-08 |
| Photochemistry Oxide Generation | CO | 1.00E+00 (g-CO) | 2.70E-02 (g$C_2H_4$-eq/g-CO) | 2.70E-02 (g$C_2H_4$-eq) | 1.03E+04 (g-$C_2H_4$-eq/PE.yr) | 2.62E-06 | 6.50E-02 | 1.70E-07 |
| | $NO_X$ | 1.00E+00 (g-$NO_X$) | 2.80E-02 (g$C_2H_4$-eq/g-$NO_X$) | 2.80E-02 (g$C_2H_4$-eq) | 1.03E+04 (g-$C_2H_4$-eq/PE.yr) | 2.72E-06 | 6.50E-02 | 1.77E-07 |
| | $SO_X$ | 1.00E+00 (g-$SO_X$) | 4.80E-02 (g$C_2H_4$-eq/g-$SO_X$) | 4.80E-02 (g$C_2H_4$-eq) | 1.03E+04 (g-$C_2H_4$-eq/PE.yr) | 4.66E-06 | 6.50E-02 | 3.03E-07 |
| Acidification | $NO_X$ | 1.00E+00 (g-$NO_X$) | 7.00E-01 (g$SO_2$-eq/g-$NO_X$) | 7.00E-01 (g$SO_2$-eq) | 3.98E+04 (g-$SO_2$-eq/PE.yr) | 1.76E-05 | 3.60E-02 | 6.34E-07 |
| | $SO_X$ | 1.00E+00 (g-$SO_X$) | 1.00E+00 (g$SO_2$-eq/g-$SO_X$) | 1.00E+00 (g$SO_2$-eq) | 3.98E+04 (g-$SO_2$-eq/PE.yr) | 2.51E-05 | 3.60E-02 | 9.04E-07 |
| | $NH_3$ | 1.00E+00 (g-$NH_3$) | 1.88E+00 (g$SO_2$-eq/g-$NH_3$) | 1.88E+00 (g$SO_2$-eq) | 3.98E+04 (g-$SO_2$-eq/PE.yr) | 4.72E-04 | 3.60E-02 | 1.70E-06 |
| Eutrophication | $NO_X$ | 1.00E+00 (g-$NO_X$) | 1.30E-01 (g$PO_4^{-3}$-eq/g-$NO_X$) | 1.30E-01 (g$PO_4^{-3}$-eq) | 1.31E+04 (g-$PO_4^{-3}$-eq/PE.yr) | 9.92E-06 | 3.80E-02 | 3.77E-07 |
| | $NH_3$ | 1.00E+00 (g-$NH_3$) | 3.50E-01 (g$PO_4^{-3}$-eq/g-$NH_3$) | 3.50E-01 (g$PO_4^{-3}$-eq) | 1.31E+04 (g-$PO_4^{-3}$-eq/PE.yr) | 2.67E-05 | 3.80E-02 | 1.02E-06 |
| Human Toxicity | $NO_X$ | 1.00E+00 (g-$NO_X$) | 1.20E+00 (g1.4DCB-eq/g-$NO_X$) | 1.20E+00 (g1.4DCB-eq) | 1.48E+06 (g-DCB-eq/PE.yr) | 8.11E-07 | 1.05E-01 | 8.51E-08 |
| | $SO_X$ | 1.00E+00 (g-$SO_X$) | 9.60E-02 (g1.4DCB-eq/g-$SO_X$) | 9.60E-02 (g1.4DCB-eq) | 1.48E+06 (g-DCB-eq/PE.yr) | 6.49E-08 | 1.05E-01 | 6.81E-09 |

### 3.2 Environmental impact assessment in construction industry

To assess environmental impact in domestic construction industry, the amount of energy consumption by energy source according to input cost in 15 construction sectors suggested in the 2010 Input-Output Table [8] and results of environmental impact assessment by category are shown in Figure 1:

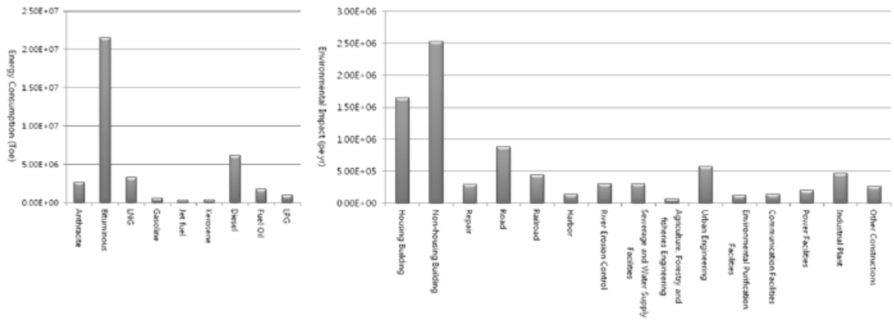


**Fig 1.** Consumption (left side) and Environmental Impact Assessment (right side) by Energy Source

According to the analysis on Korea's construction industry in 2010, building construction such as housing and non-housing buildings was greater than civil engineering in terms of effect on environment. In addition, the effect of Korea's construction industry on environment was 8,368,112pe·yr. Specifically, 'global warming' was the highest with 89.3%, followed by 'acidification (9.0%)', 'photochemistry oxide generation (0.9%)', 'eutrophication (0.6%)', 'human toxicity (0.1%)' and 'inanimate resource depletion (0.0%)'.

## 4 Conclusion

This study estimated the effects on energy consumption on environment, considering diverse environmental loads. Then, it quantitatively assessed the influence of Korea's construction industry on environment as follows:

1) A total of nine (9) energy sources and six (6) atmospheric loads were selected as environmental loads. Then, they were classified into six (6) different impact categories. After that, the results of environmental impact assessment by environmental load factor and environmental load were suggested as database.

2) The effect of Korea's construction industry on environment in 2010 was 8,368,112pe·yr. Specifically, 'global warming' was the highest with 89.3%, followed by 'acidification (9.0%)', 'photochemistry oxide generation (0.9%)', 'eutrophication (0.6%)', 'human toxicity (0.1%)' and 'inanimate resource depletion (0.0%)'.

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