According to the Table 4, wood creates less pollution and negative impact, when it manufactures and uses. Except than land use and global warming potential items in Table 4, others are not considerable. It confirms the definition of wood as an environmental-friendly material. All data are available in eTOOLLCD open source.

DISCUSSION AND RESULT ANALYSIS

Step 2: Evaluation

Life Cycle Energy Assessment (LCEA)

Ramesh et al. (2017) and Cabeza et al. (2014) define LCEA as an approach that accounts for all energy inputs to a building in its life cycle.

LCEA illustrates the energy consumption during the life cycle and environmental impact.

Life Cycle Energy Analysis focuses on energy as the only measure of the environmental impact of buildings and products. The purpose of LCEA is to present a more detailed analysis of energy attributable to products, systems or buildings, to compare and evaluate the embodied energy and operational energy in materials and components (Ramasamy et al, 2017). (Figure 4)

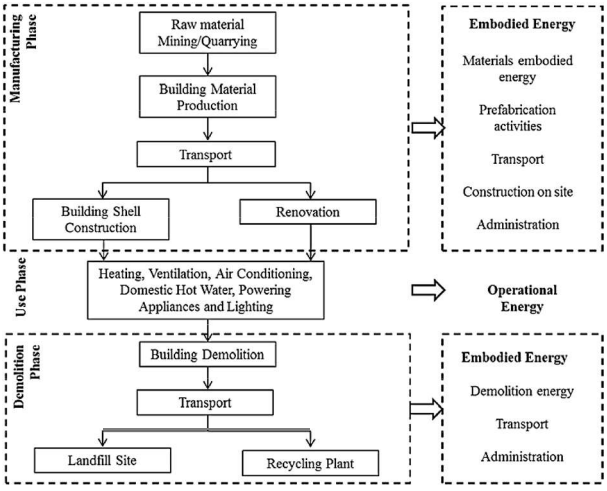

Figure 4. LCEA frame. (Ramesh et al, 2010), (Cabeza et al, 2014)

Then LCEA contains all energy that is consumed for EE and OE as (3) proves.

$$\textbf{LCEA} = EE + OE \quad (3)$$

Where, EE= embodied energy, the expanded cumulative energy consumption due to building construction (manufacturing phase).

OE= Operation energy, that is, the expanded cumulative energy consumption due to building operation (using phase).

LCEA definition is the numerical sum of OE and EE. (1kwh= 3.6 MJ)

Step 3: output, results analysis

Selecting model with Min (LCEA)

Figure 5 illustrates LCEA of building in case of containing external shading in the southern elevation or not. It confirms that although wood-based shading system in Tehran located building causes more EE, that it is not noticeable in comparison with OE over the building life cycle.

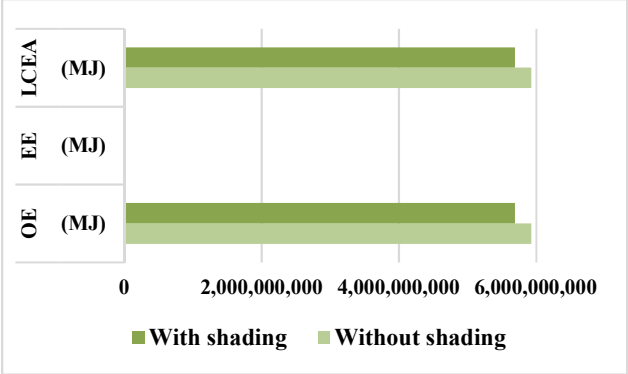

Figure 5. The comparison of models' LCEA.

CONCLUSION

The method of study and results provide a process that helps to make the decision in selecting an energy efficient system for enhancing building energy performance without causing the more negative environmental impact. Energy performances achievable by applying external solar shading for the residential building would reduce the total energy consumption for buildings over the life cycle. Saving energy will overcome the amount of fossil fuel depleted, pollution of energy consumption and emissions.

Not only equipping the building with details to slowdown consumed energy lead to the saving energy in building sector in the concept of OE, but also selecting materials that have less emission and polluted is a method for respecting to the environment, that means LCEA concept too.

At the essence, the wood made external shading causes about 4% less LCEA, the total of OE and EE energy consumption over the Tehran summer weeks over the building lifespan and simultaneous this type shading is an economic-environmental friendly alternative too.

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