

LESO-PB

Life-Cycle Assessment of the New Wooden Facade of the LESO Building

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LIFE-CYCLE ASSESSMENT OF THE NEW WOODEN FACADE OF THE LESO BUILDING

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ABSTRACT

The former experimental south façade of the LESO building on the EPFL campus at Lausanne, has recently been replaced by a new one. The bearing structure as well as the cladding and the windows are made of larch, cedar or fir wood. Sustainable development was the determining factor for choosing the materials.

The building-in of large openings in the façade including anidolic elements was the second purpose of this architectural conception, allowing for a better use of daylight and consequently less artificial lighting.

The results of the life-cycle assessment confirmed the design. A comparison between two other hypothetical facades allowed further conclusions, drawing attention to some recommendations for the building industry.

RÉSUMÉ

Le bâtiment abritant le Laboratoire d'énergie solaire et de Physique du bâtiment sur le site de l'EPFL à Lausanne, est depuis peu dotée d'une nouvelle façade sud en bois. La structure porteuse ainsi que l'habillage et les fenêtres ont été exécutés en mélèze, en cèdre et en sapin. Lors des choix des matériaux, le principe du développement durable était déterminant.

L'intégration de grandes ouvertures équipées d'éléments anidoliques était une deuxième décision ayant comme but une augmentation de la pénétration de la lumière naturelle, et par conséquent une diminution des besoins en éclairage artificiel.

L'écobilan dressé en cours de travaux a permis de statuer sur l'efficacité des options prises, et les comparaisons avec deux autres façades hypothétiques, ont permis de tirer un certain nombre de conclusions sous forme de recommandations pour les professionnels de la branche.

INTRODUCTION

The Solar Energy and Building Physics Laboratory on the EPFL campus was built in 1981-82. At that time, the main purpose was notably experimentation of passive solar concepts and industrial products on the south facade: the building design was carried out to suit this goal. Also, the offices towards south have different behaviour in between them, due to thermally insulated heavy separation walls. Thus prepared, the building offered the opportunity to test a range of solar modules under good scientific conditions.

During this period, a large amount of experiences, widely published, has been made on 15 different solar facade units. While we are preparing our moving into the new architect's building on the site, the LESO building got a final wooden south facade. Better day lighting was part of the main targets of this project, as well as sustainable development, according to the Swiss government's strategy.

Works were finished by mid spring 1999. The massive use of wood as a bearing structure, as well as cladding and windows, together with the architectural demands, respond to the announced criteria.

OBJECTIVES

The scope and goal of this research was to establish an Impact Assessment allowing conclusions to be drawn regarding a minor object. The calculations were carried out exclusively with the building materials being used, including as well the pulling down of the ancient parts of the building, the numerous transports and the energy used on site by the contractors. The following impacts were taken into account :

NRE Non Renewable Energy, in [GJ]

GWP Global Warming Potential, in [kg CO₂ equ]

AP Acidification Potential, in [kg SO₂ equ]

Several working hypothesis were expressed and the effective energy need was calculated by means of the computerised program LESOSAI.

METHODOLOGY

Our key procedures were identifying units and collecting input and output data at two levels:

Building materials used and their transports

Primary energy necessary for operating the building

The basis for the inventory of the materials was transmitted by the architect and the contractors, but due to lack of information, hypothesis were expressed in particular regarding transports. We even applied the "insignificant item rules", i.e. minor quantities were overlooked. Some data available about "losses, waste and crushes" were furthermore interpreted and rounded up. The appropriate boundaries decided at the outset of the project were iteratively reviewed while computing.

ANALYSIS PROCEDURES

The scope of the study allowed exploration of various confrontations between different items :

1. A typical section of the facade, which is not an ordinary prefabricated wooden one, is featured (cf. *Figure 1*), showing its important thickness. Due to this particular expression, the weight and volume relationship (cf. *figure 2*) is underlined. Then the impact expressed in [GJ], [t CO₂ equ] and [kg SO₂ equ], re the construction was computed (cf. *figure 3*) and compared to those resulting from the pulling down of the old facade, the transports as well as the site energy (cf. *figure 4*).

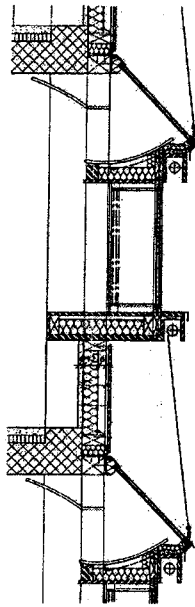


Figure 1 : Section of the wooden facade on the LESO building

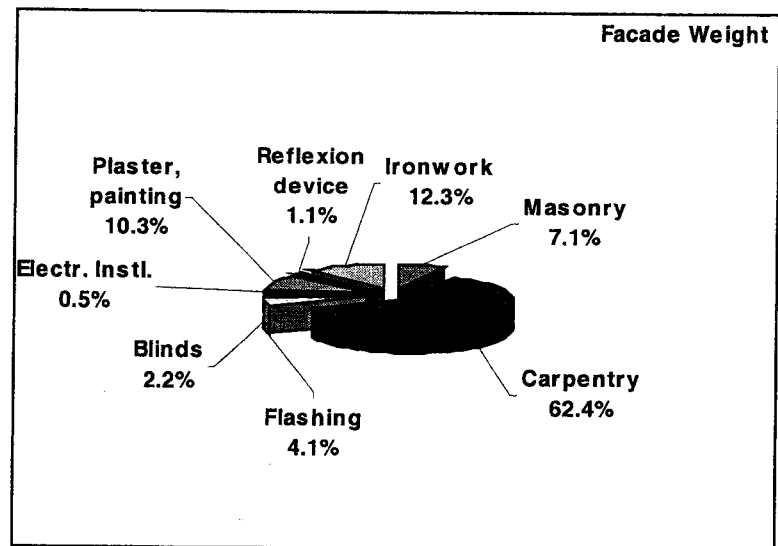
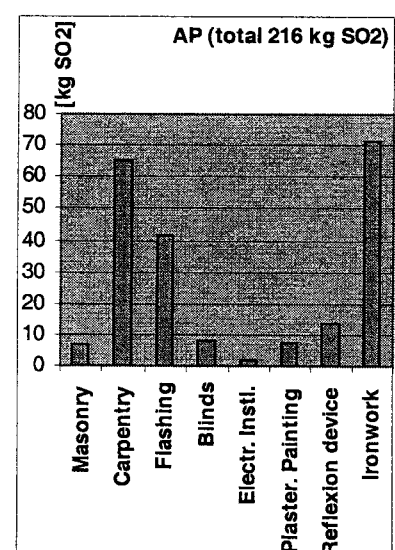
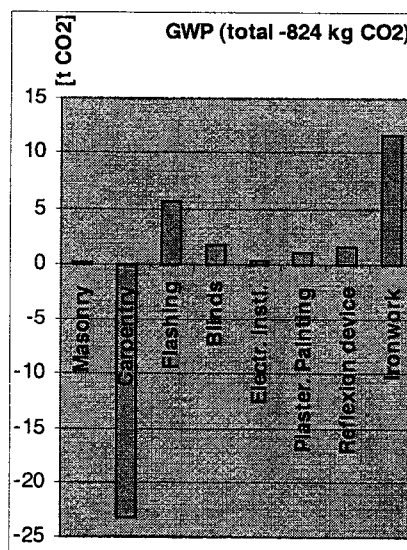
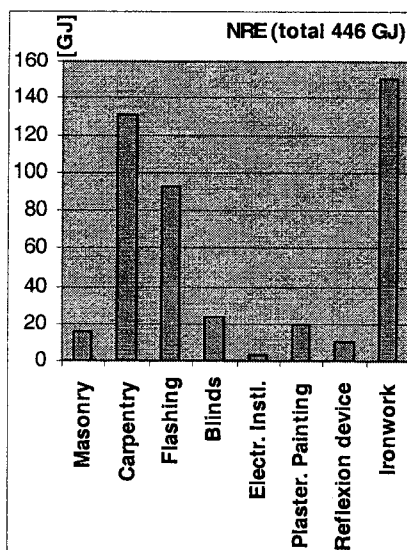


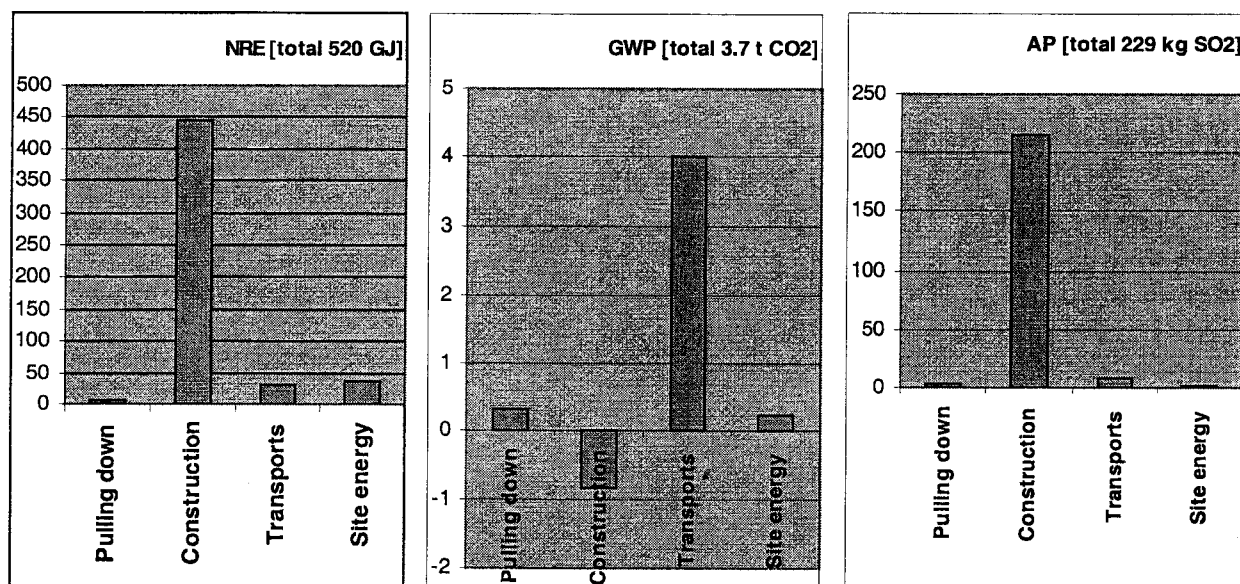
Figure 2: Contractor's influence on facade weight (total weight is 30 t; 142 kg/m² facade and 561 kg/m³ material)

As the bearing structure, the cladding as well as the windows are made of wood, the carpentry works represent logically 62.4 % of total weight (cf. Figure 2). The ironwork represents 12.3 %, due to the framing of the anidolic system including glazing, the metal sheets cladding of the facade and the suspension devices. As plaster was used as interior cladding, it represents 10.3 % together with the painting, in spite of the untreated wooden surfaces outside and the already prelacquered metal sheets.



Figures 3 : NRE, GWP and AP impacts re the construction

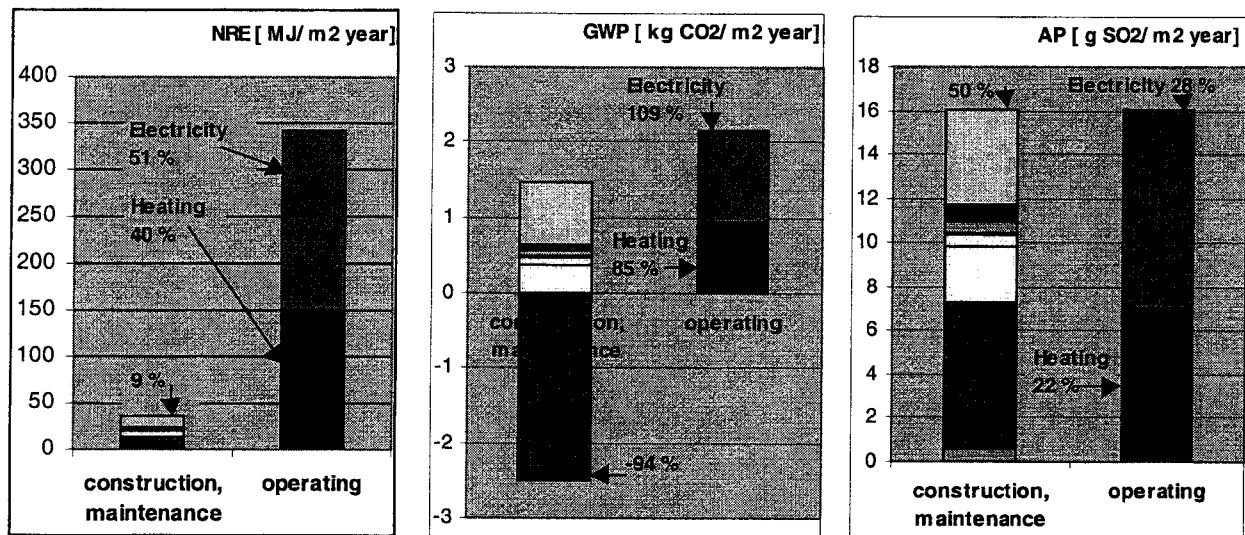
The heavy non renewable energy impacts (cf. *Figure 3*) from ironwork and flashing stands out (high values of metal parts), particularly considering their weight. The NRE value of the carpentry works, including glazing, reveals the important amount of wood. The negative value of the global warming potential of the wooden parts is well known, a performance particularly used for promoting wooden constructions. The relatively high values of ironwork/ flashing, non weight related, shows their importance on the CO₂ emissions. As for the acidification potential, the same three items differ from the others, the carpentry (some parts are glued laminated) due to its massive use, and the ironwork/ flashing again shows important non weight related impacts.



Figures 4 : NRE, GWP and AP impacts re the pulling down, the construction, the transports and the site energy

The importance of the intervening actions (cf. *Figure 4*) must be stated in this case; the pulling down only demanded a couple of days, local awarding means less transports and a large amount of goods prepared and pre assembled reduce site energy needs. Thus, the significant parts of total embodied energy consumption (86%) as well as the acidification potential (95%) underlines the importance of the building materials. As a rule, the transports reach 10 to 12 % of the non renewable energy. In this case, the amount is only 6 %, due to local awards. On the contrary, the construction reveals the expected negative value for the global warming, due to the wooden items. Subsequently, in spite of their local conditions, the transports climbs to 116 %, underlining the fact that the largest source of CO₂ is the burning of fossil fuels.

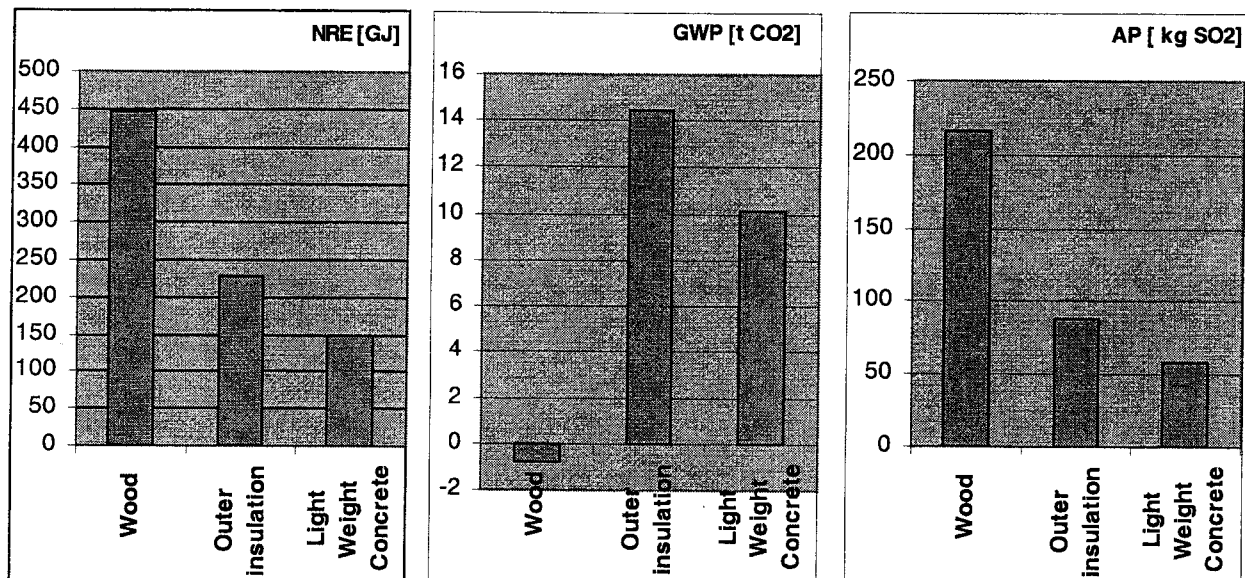
2. We assumed the service life of the new facade to be 50 years. The embodied energy consumption together with the CO₂ and SO₂ emissions were computed yearly during this life cycle (cf. *Figure 5*). The maintenance and replacement of items with a shorter service life was included, as well as operating the building, i.e. (electric) heating and electricity. The surface referred to was assumed to be 380 m², including the offices looking onto the south. The all over surface of the LESO building is 785 m².



Figures 5 : Building and operating, comparison of annual environmental impacts : NRE, GWP and AP

Considering the three environmental impacts (cf. Figure 5), the construction clearly embodies less energy (9 %), than when operating the building (91 %). The CO₂ emission again has a negative value for the construction (-94 %), while the operating reveals important impacts (194 %), although, as for the NRE, the values are computed with the lower Swiss hydroelectric power data. The acidification potential has a more balanced score, due to the relatively high values for carpentry, ironwork and flashing (cf. Figure 3) in comparison to electricity. Total amounts, year and pro m², are 379 MJ, 1,112 kg CO₂ and 0,032 kg SO₂.

3. The environmental impacts shown previously do not admit easily other parallels to be drawn, depending on the object. To compensate this, two other hypothetical facades were imagined on the same experimental building. The first one features an outer insulation glued on a concrete wall, with cement rendering finishes. The second light weight concrete facade is massive with rendering finishes (cf. Figure 6). The three cases show similar U-values and identical window openings. However, only the wooden construction is equipped with the anidolic system and the two other facades have more usual sections, overall thickness about 30 cm. Thus, we are dealing with facades not offering the same day lighting performance as the one existing on the site.



Figures 6: Three facades, comparisons of environmental impacts NRE, GWP and AP

In spite of the sought-after similar performances, it is obvious that the complex shape of the wooden facade burdens its results, above all the NRE and AP (cf. *Figure 6*). The ironwork and flashing together with the carpentry, as already explained, are to blame for this. The ironwork and flashing are mainly to be found in the anidolic system, the suspension device and the aluminium cladding on parts of the facade. Although, again in this case, the CO₂ emissions shows a negative value, due to massive use of wood, but have heavy impacts on the two other facades, depending of their materials. It is interesting to take note of the lowest environmental impacts (NRE and AP) of the third case, the light weight concrete.

4. In the previous models, we dealt with performances related to different contractor's works, mixing the materials being used. Furthermore, in order to emphasize their importance, the ones of the wooden facade were strictly divided into groups as follows: wood, metal, glass, insulation, plaster, painting and miscellaneous (cf. *Figure 7*).

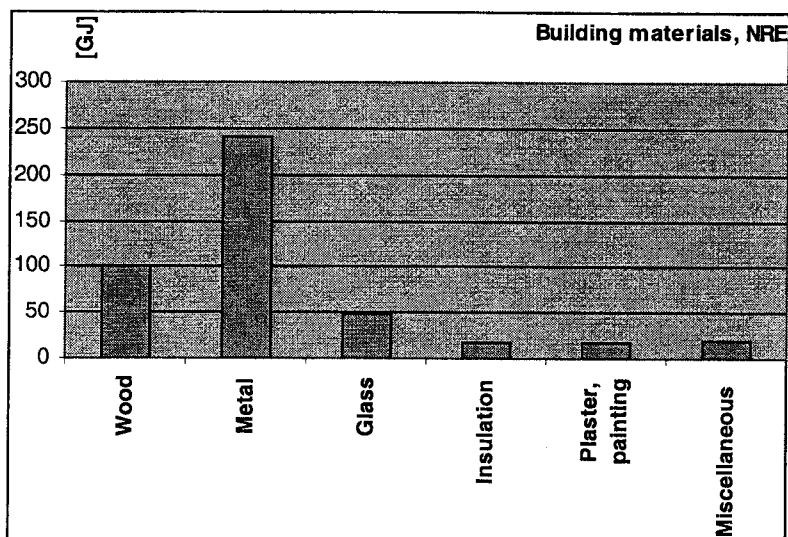


Figure7 : Building materials, wooden facade, NRE necessary for the construction

The contribution of metal, 54% of the embodied energy consumption [total 446 GJ], contrasts with the importance of its weight, only 13 % of overall weight [30t], not to mention the volume. Wood, on the contrary, seeded second with 23 % of the embodied energy, represent 58 % of the overall weight (cf. Figure 7).

- Following the Marrakech signature in 1994 of the WTO agreement on trade, a Swiss law and its ruling apply since january 1996. Clause n° 21 of the law offers the possibility to call for tenders, while favouring the environment. In order to evaluate differences, we put up the hypothesis to award to Bern contractors all the works of the wooden facade.

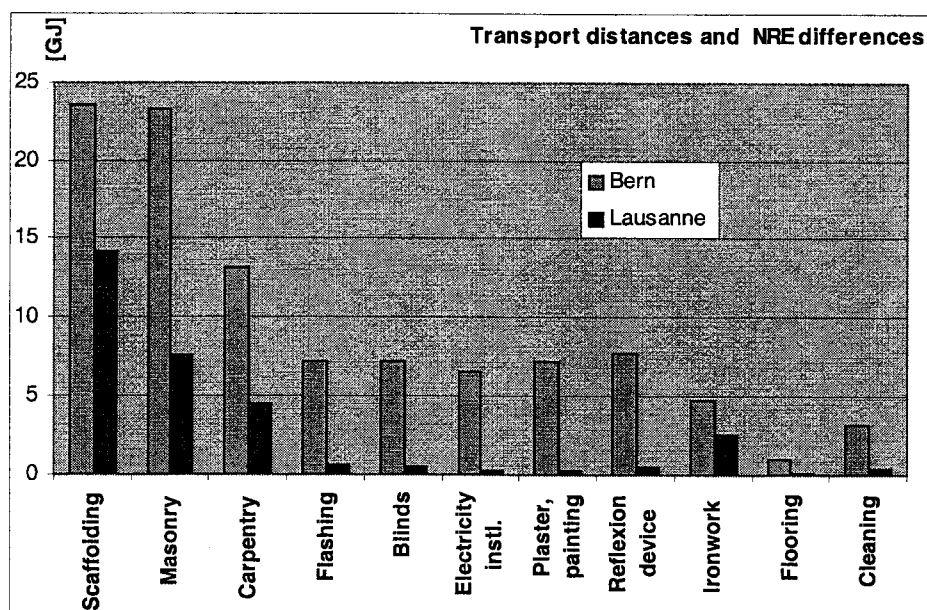


Figure 8 : Awarding locally (Lausanne, total 31 [GJ]) or at 100 km (Bern, total 104 [GJ]), transports comparison of embodied energy consumption

When interpreting the *Figure 8*, « Think globally, act locally », could be the motto, which is the opposite to the globalisation advocated by WTO and the already mentioned Swiss law. Earlier, we notified the part of the transports to be 6% of total NRE (cf. *Figure 4*). If ever Bern contractors would have won the tendering, the increase of the environmental impact would have been multiplied by more than 3. Furthermore, the part of the transports would have been 18 % of the entire embodied energy instead of effective 6 %.

CONCLUSIONS

We experienced some difficulties in managing the data gaps as well as receiving reliable information. By an unconditional use of ISO 14'041, the computing methods being stipulated, the opportunity for interpretations should diminish in the future.

The different results obtained, show important impacts in general for the Ironwork and the Flashing, in particular compared to their weight. The non renewable energy as well as the acidification potential are also fairly important for the carpentry, due to the amount of wood on this facade. Expectedly for the carpentry, its CO₂ emissions are negative.

When considering the construction as an entirety, the building materials are the determining factor for the NRE and AP. As for the global warming, the transports receives the far highest value due to the fuel.

The annual environmental results reveals the important impact of the operating system, in particular as for the NRE and GWP. The metal parts of the building, however, diminishes the operation supremacy as for the acidification potential.

The max/ min environmental impact data available, reveals gaps up to seventeen times the initial value between sources and convenient materials. Aluminium showed the most important differences due to its rate of recycling and origin.

We do underline the contracting authority's responsibility, in particular when stating priority of criteria. As for the Swiss law, ecological criteria is depending on the economic situation. The question is, how to manage consequently environmental strategy and economic laws ?

In the light of this experience, we stated that many replacement materials, less heavy for the environment, could easily do without interfering with important architectural choices. Information seems to be a basic problem, the message must be brought to and clearly understood by the builders. The importance of our environment and nature should be seriously considered in accordance with the government's strategy, it is worth it.

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