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DEPARTMENT OF ENVIRONMENTAL PROTECTION.

THE NEW YORK CITY DEPARTMENT OF ENVIRONMENTAL PROTECTION (DEP) PROTECTS PUBLIC HEALTH AND THE ENVIRONMENT BY SUPPLYING CLEAN DRINKING WATER, COLLECTING AND TREATING WASTEWATER, AND REDUCING AIR, NOISE, AND HAZARDOUS MATERIALS POLLUTION.

DISTRIBUTES MORE THAN ONE BILLION GALLONS OF CLEAN DRINKING WATER EACH DAY TO NINE MILLION NEW YORKERS AND COLLECTS WASTEWATER THROUGH A VAST UNDERGROUND NETWORK OF PIPES, REGULATORS, AND PUMPING STATIONS; AND TREATS THE 1.3 BILLION GALLONS OF WASTEWATER THAT NEW YORKERS PRODUCE EACH DAY IN A WAY THAT PROTECTS THE QUALITY OF NEW YORK HARBOR.

EMBODIED ENERGY

WHAT IS EMBODIED ENERGY?

- **EMBODIED ENERGY IS THE SUM OF ALL THE ENERGY REQUIRED TO PRODUCE, TRANSPORT AND INSTALL MATERIALS.**

EMBODIED ENERGY CALCULATION.

Embodied energy quoted in MJ or GJ units of energy. Calculating embodied energy is complex and involves numerous sources of data that does not have exact formula and generally not available for the public use.

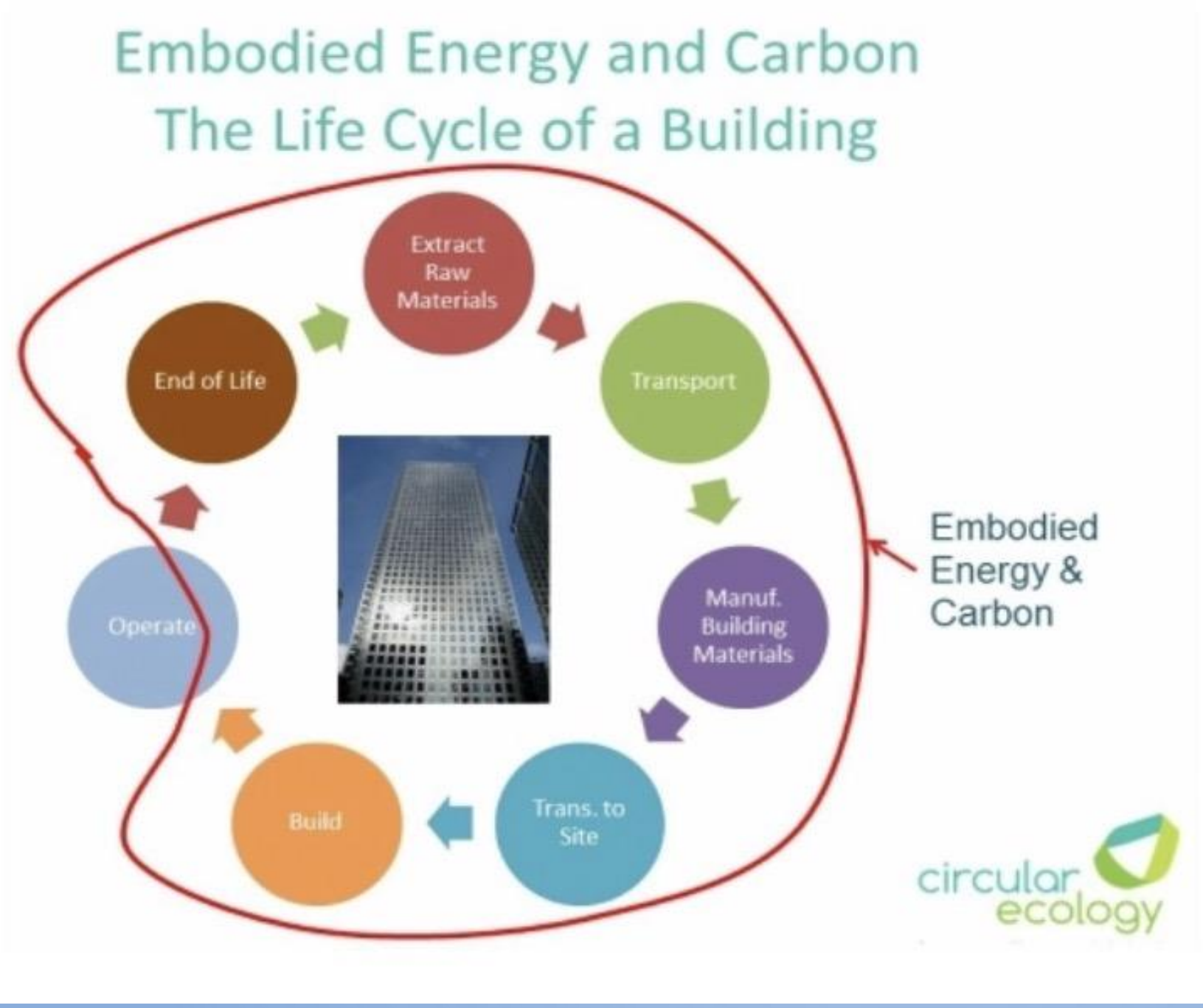
General information that needed for calculation.

- the energy that required to extract the raw materials that were chosen for new project,
- the energy required to transport these materials to the factory,
- the energy required to manufacture required building materials,
- the energy that will be spent on transportation of the made materials to the working sites,
- the energy that will be spent on putting the materials together at working sites. This energy also should include the energy that spent on transportation of workers to the site.
- the energy required to recycle the building component at the end of its life
- the energy needed for the maintaining and reconstruction of the building.

I CREATED A SIMPLE FORMULA THAT WOULD HELP TO EASILY UNDERSTAND AND CALCULATE EMBODIED ENERGY:

EE= EXT+T1+M+T2+B+O+R

EXT- EXTRACTION OF THE RAW MATERIALS
T1- TRANSPORTATION OF RAW MATERIALS TO THE MANUFACTURING
M- MANUFACTURING
T2- TRANSPORTATION TO THE SITES.
B – BUILDING CONSTRUCTION
O –OPERATION
R – ENERGY THAT SPENDS ON WASTE RECYCLING



Each step of the cycle releasing significant amount of CO2 in the air. One of the important step in reducing embodied energy and therefore CO2 emission is choosing local materials. Therefore, I decided to focus on the transportation aspect of EE. Also I will calculate how much CO2 emission releases.

It is possible to reduce the embodied energy and carbon of a building or construction project by 10-20% without adding to the build cost.

BUILDING MATERIALS

OPEN-GRADED AGGREGATE

- OPEN-GRADED AGGREGATE IS AN AGGREGATE IN WHICH A SKIP BETWEEN THE SIEVE GRADATIONS HAS BEEN DELIBERATELY ACHIEVED SO THAT THE VOIDS ARE NOT FILLED WITH INTERMEDIATE-SIZE PARTICLES

The material located 181 miles away from the DEP (Amsteam, NY)

RECYCLED GLASS AGGREGATE (RGA)

- RECYCLED GLASS AGGREGATE IS A MIX OF COLORS GLASS CRUSHED TO A SMALL SIZE. IT IS SUBSTITUTED FOR MANY CONSTRUCTION AND UTILITY PROJECTS IN PLACE OF PEA GRAVEL OR CRUSHED ROCK.

The material located 13 miles away from DEP (Brooklyn, NY)

EMBODIED ENERGY CALCULATION

THE AVERAGE FUEL CONSUMPTION OF GASOLINE CARS IS ABOUT 0.076 L/KM TRAVELLED. TO CONVERT THIS FIGURE TO ENERGY WE MULTIPLY BY THE ENERGY CONTENT OF GASOLINE: 32 MJ/L PER KM.

THEREFORE, THE ENERGY CONSUMPTION OF A GASOLINE CAR = (0.076 L/KM) (32 MJ/L) = 2.4 MJ FOR EACH KM TRAVELLED.

OPEN-GRADED AGGREGATE

- **OGA TRAVEL 181 MILES = ~290 KM**
- **ENERGY CONSUMPTION = 290*2,4**
- **= 696 MJ.**

RECYCLED GLASS AGGREGATE

- **RGA TRAVEL 13 MILES = ~ 21 KM**
- **ENERGY CONSUMPTION= 21KM*2,4**
- **= 50.4 MJ.**

This calculation shows that open graded stone required almost 14 times more energy use than RGA.

CO2 EMMISION CALCULATION

1 Gallon of gasoline produce 20 pound of CO_2 when burned.

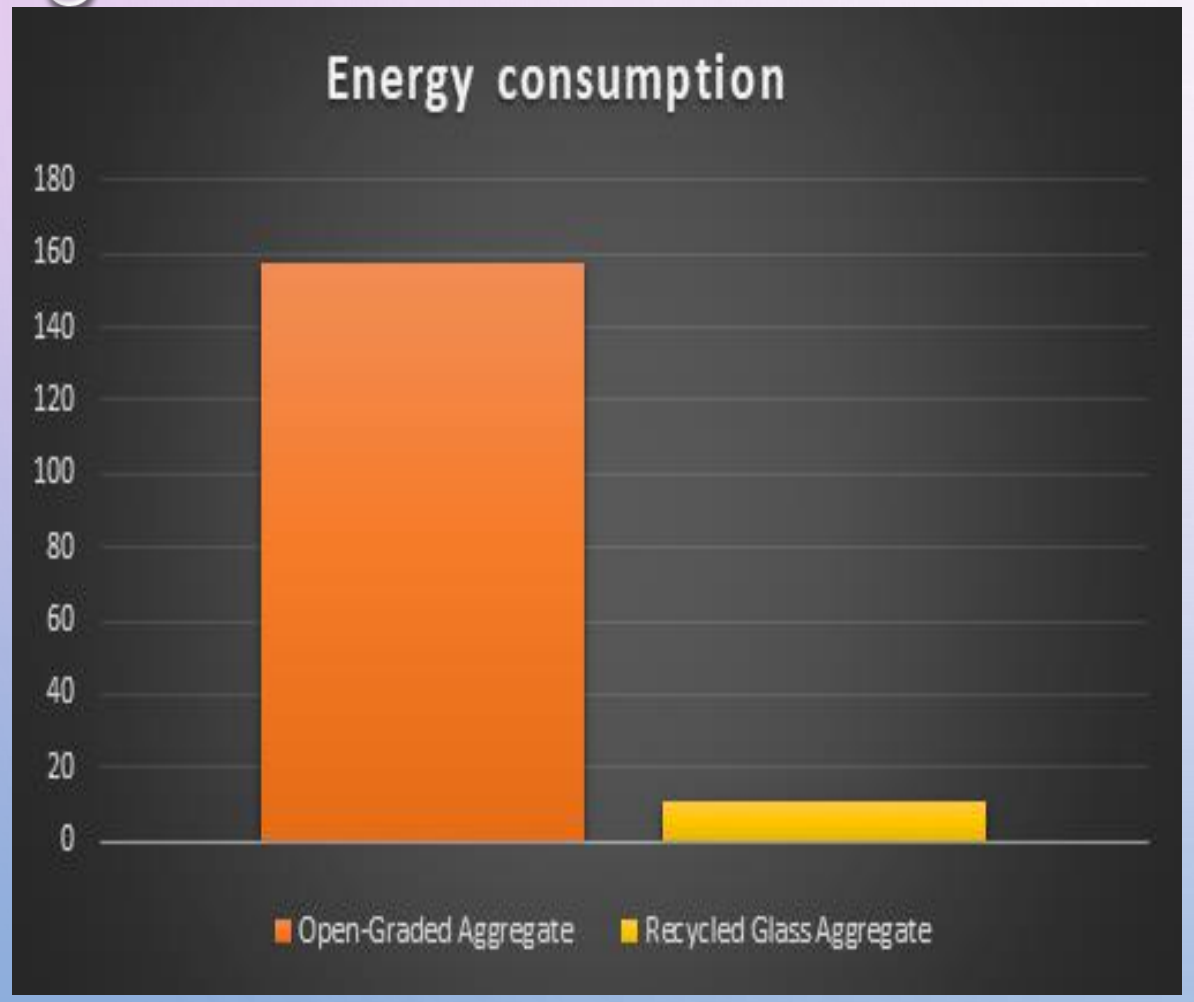
OGA

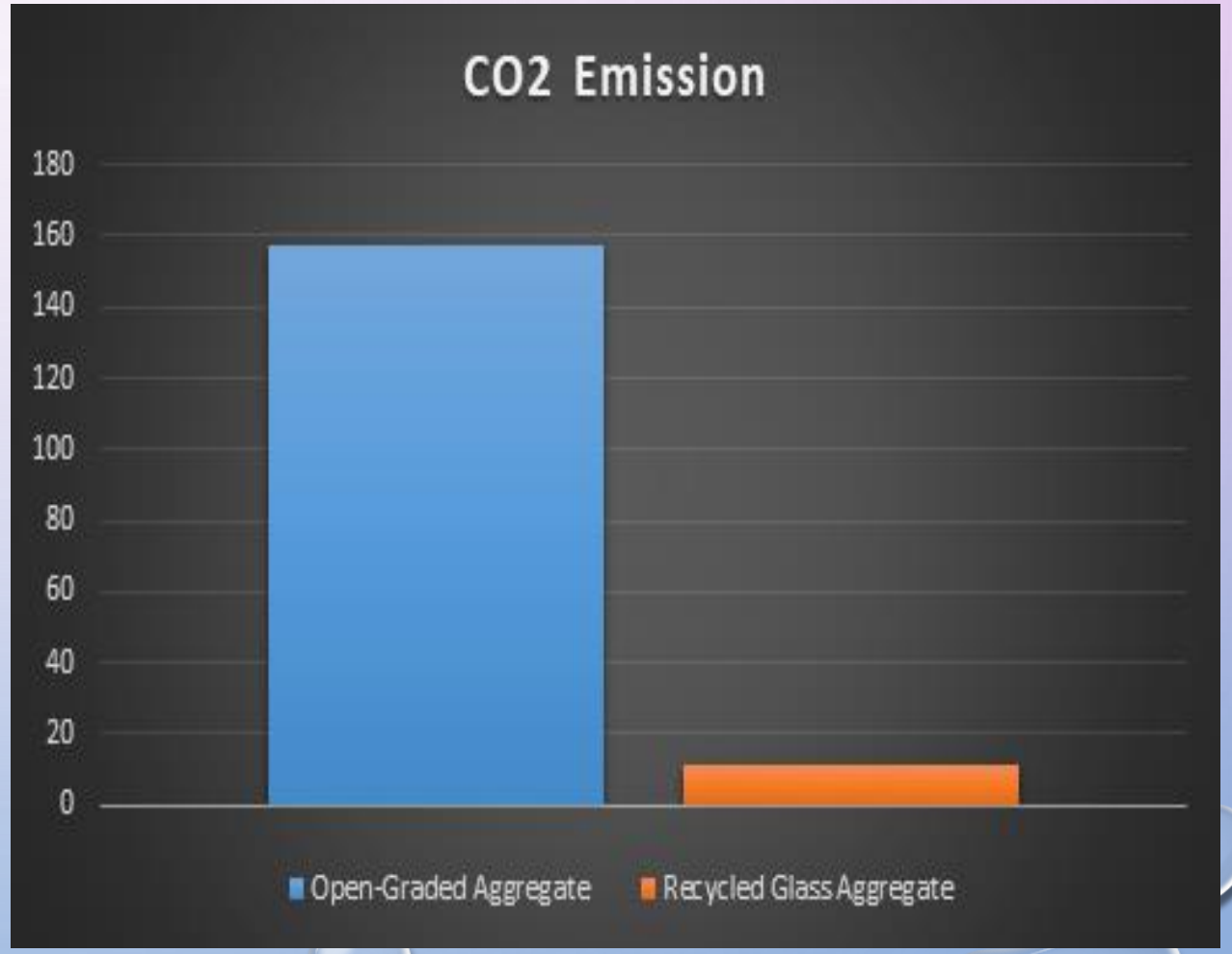
- THE TRANSPORTATION OF OPEN-GRADED STONE TO THE WORKING SITES RELEASING **157.2 POUNDS** OF CO2 (7.86 GALLONS X 20 POUND).

RGA

- WHEN RGA TRAVELS FROM THE MANUFACTURE IT SPENDS 0.56 GALLONS THAT IS EQUAL TO
- **11.2 POUNDS** OF CO2.

This calculation shows that open graded stone releasing 14 times more CO2 in the air than RGA.


Energy consumption
180
160
140
120
100
80
60
40
20
0
Open-Graded Aggregate
Recycled Glass Aggregate


CO2 Emission
180
160
140
120
100
80
60
40
20
0
Open-Graded Aggregate
Recycled Glass Aggregate

SUGGESTIONS THAT HELP TO REDUCE EMBODIED ENERGY.

THE BEST WAY TO FIND OUT HOW MUCH EMBODIED ENERGY WILL BE SPENT IS TO LOOK AT THE FOLLOWING FACTORS:

1. How far does the material need to travel? Using local materials will reduce transportation energy use and therefore CO2 emission.
2. How much raw materials is used? Reducing the number of raw materials that are used during construction will decrease energy that is spent on the production of the materials.
3. How difficult is it to manufacture the product? Some materials at the beginning involved more energy for their production then others.
4. How large is the facility? Right design with the right size of the building will save energy use, because building a large facility would require extra materials and more energy use to build and serve the building, therefore, would have higher embodied energy.
5. How much waste occurs during construction and during operation? The more waste produced the bigger amount of embodied energy would be spend on transporting this waste out of the facility.
6. Are the materials that used in the construction recycled or recyclable? The use of recycled or recyclable materials will decrease energy that spends on production of the materials
7. Reducing material needed for repair and maintenance.
8. Use materials that come from renewable sources wherever possible.

CONCLUSION

Proper embodied energy calculation is an important step to sustainable future. My research shows that there is a huge difference in the embodied energy and CO2 emission between open-graded aggregate and recycled glass aggregates due to travel distance.

Most important step DEP architects and engineers can take to reduce the embodied energy of building structures is to choose local products as much as they can. My recommendation is to use recycled glass aggregate instead of open-graded aggregate because it located closer to DEP and therefore will save energy and reduce CO2 emission. Reducing CO2 emission is one of the main solutions in fighting climate change. Therefore, using local materials that have lower embodied energy will lower energy use, while protecting our climate.