Comparative Assessment of Embodied Energy and CO_2 of Water Tanks

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Rain Tanks

Capture, storage and re-use of water using water tanks can reduce demand

- Particularly effective for non-potable uses such as
  - Showers
  - Toilets
  - Laundry
  - Dishwashers
  - Gardening
- These comprise ca 65% residential water consumption
- Most raintanks in NZ are made of plastic, concrete, steel or wood

Concrete Tanks

- Can be either rectangular or circular
- Strengthened with 3-5% reinforcing steel
- Will last 30-35 years, warranty usually 25 years
- Can raise the pH of the water and increase water hardness
- Not likely an issue unless water is stored for a long time
- Steel must be separated for recycling
- Concrete can be recycled as aggregate in roading

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Plastic Tanks

- Usually rotational moulded HDPE
- Economical
- Little waste of material
- Inherent design strength
- Warranty 20 years but manufacturers claim will last 50 years
- Can be recycled but some degradation of plastic does occur
- Can be heat fused if damaged

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Steel Tanks

- Constructed of hot-dipped, galvanized steel with joints lapped and bolted at 60cms
- Frame fabricated from hot rolled steel, dipped after fabrication
- Seams are rubber sealed (ethylene propylene)
- Prone to rusting at seams and welds
- Warranty usually 20 years
- Can be recycled if processing of galvanised steel is available

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Wood Tanks

Constructed in NZ of radiata pine treated with CCA

Consists of a top and bottom with staves held in place with stainless steel cables

Liner of food-grade PVC provides water integrity and protection from CCA

Warranty of 25-30 years but manufacturer claims up to 50 years

Can be refurbished for reuse

Objective

To compare the embodied energy and carbon dioxide of the four materials used for manufacturing rainwater tanks in New Zealand using life cycle analysis

Further research would be required to fully assess the life cycle impacts of the four materials

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Methodology

Construction diagrams for each of the four types of tanks were obtained through manufacturers

Used to identify the materials used for each tank and the mass of each material per tank

Alcorn (2003), Centre for Building Performance Research (2007) calculated embodied energy and embodied CO_2 of various materials for NZ

Embodied energy

- extraction of raw materials
- transportation of raw materials to the processing plant
- manufacturing processes
- presented in mega-joules per kg (MJ/kg).

Methodology

Embodied CO_2

- Quantities and types of various fuels used through the life cycle of a specific material
- Known carbon dioxide emission rates for various fuels used to calculate the embodied CO_2 for the material
- Presented in grams of carbon dioxide per kg (g carbon dioxide /kg)

Data used to calculate total embodied energy and CO_2 for each type of water tank based on the weight of the materials used

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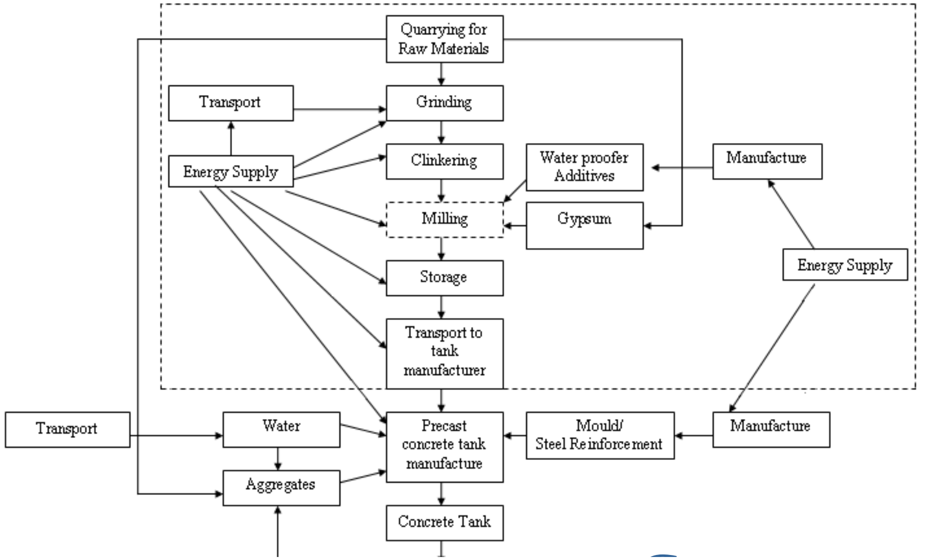
Life Cycle of Materials



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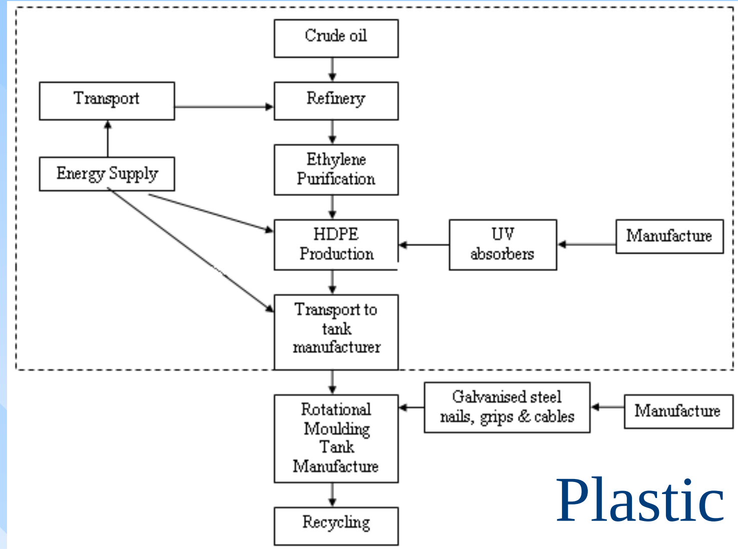
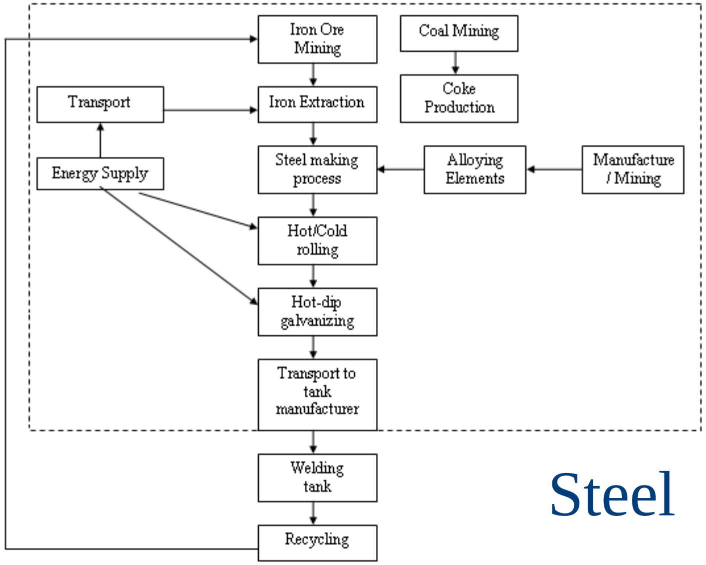


Plastic



Steel

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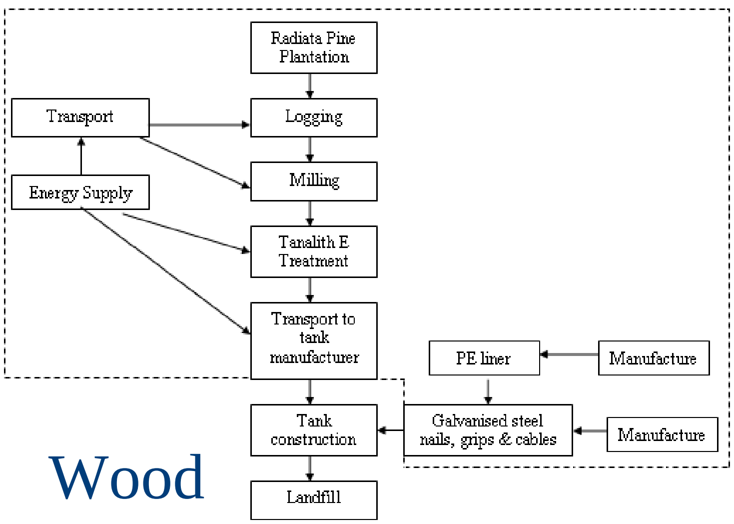


Wood

Assumptions

Tank size 25000 L

Transportation by land on rigid trucks

Materials were sourced from nearest producer

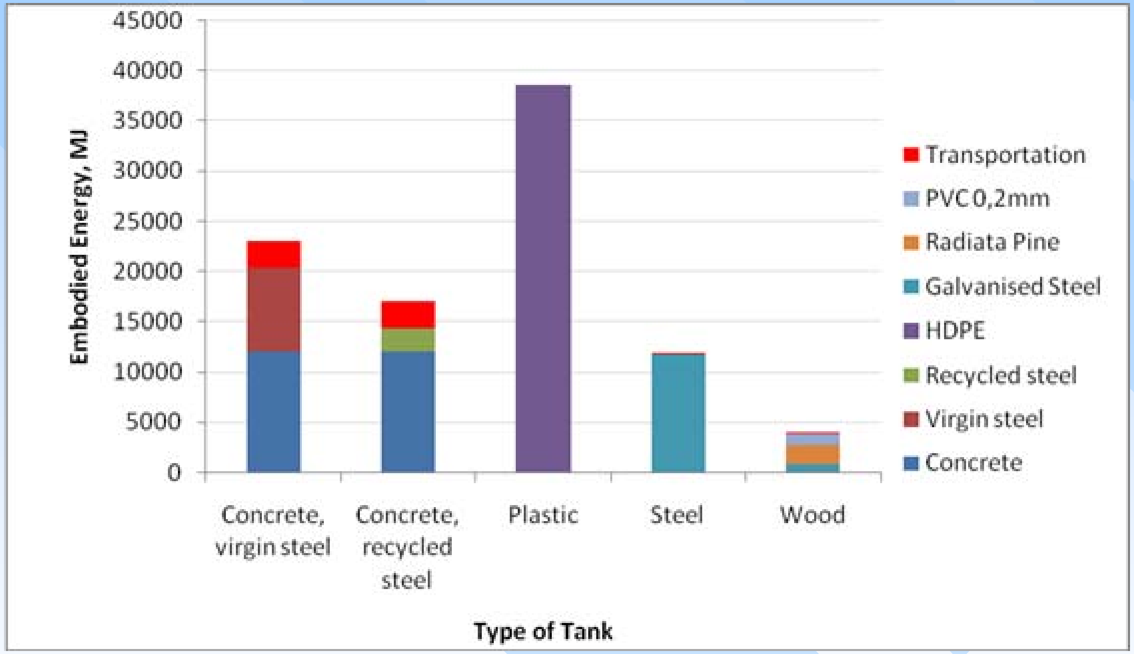
Embodied energy of each tank

- the sum of embodied energy of each component
- Plus energy for transportation

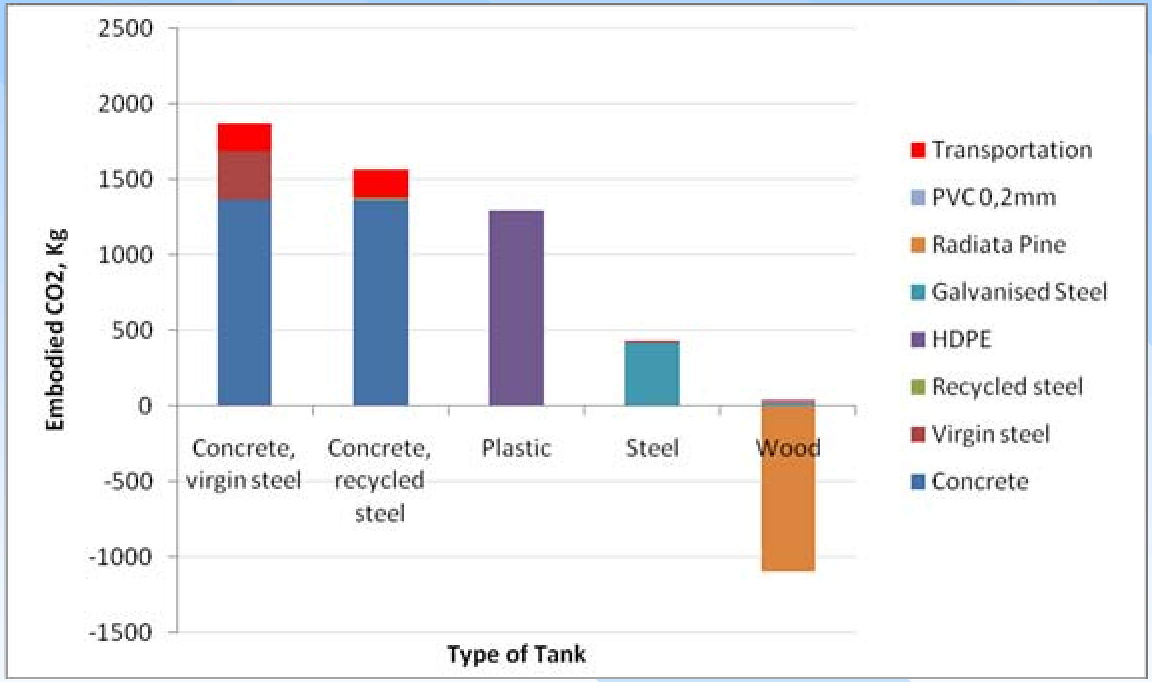
Normalised to 20 years

For the concrete tank, both virgin steel and recycled steel were assessed

Results – Embodied Energy



Results – Embodied CO_2



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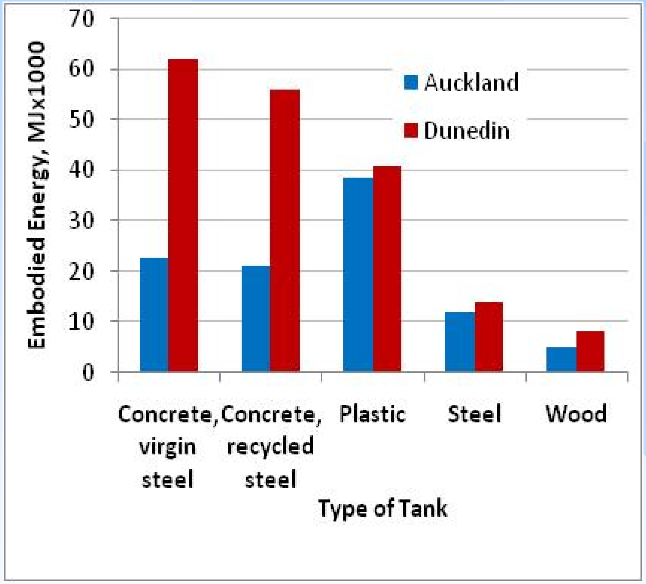
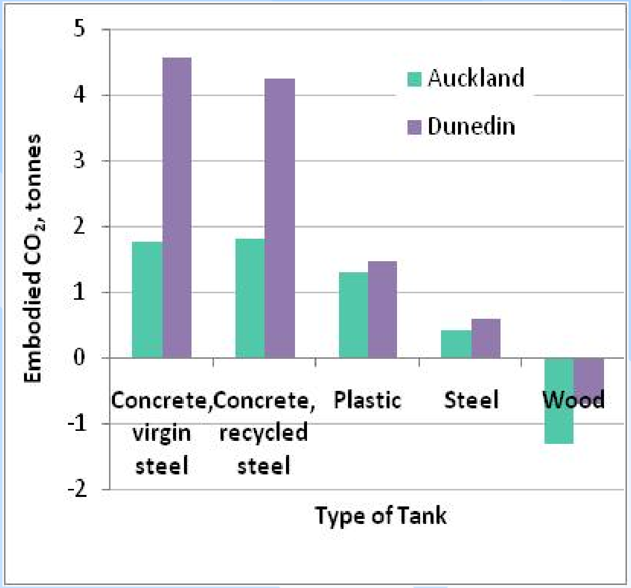
Increased transportation





Conclusions

- Wooden tank has the lowest embodied energy and CO_2
- Plastic tank has highest embodied energy
- Concrete tanks have second highest embodied energy and highest CO_2
- Due to weight, transportation has a major effect on energy and CO_2 for concrete tanks; minor effect on other tanks
- Manufacture on site would reduce this
- Use of recycled materials and lifespan of the tank is important
- Toxicity of CCA, pthalates must be considered