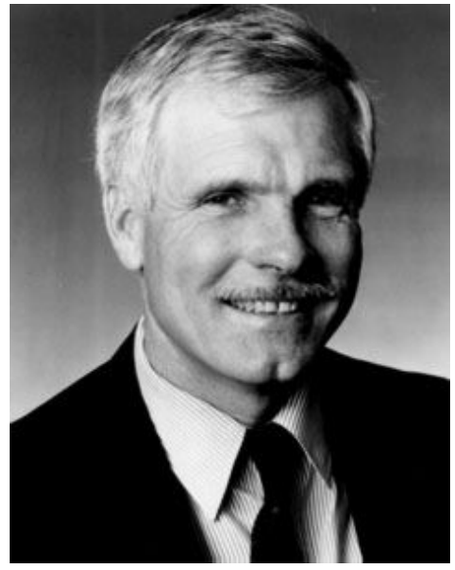
It's going to take trillions of dollars to rework the energy sources all over the world. We're going to have to move away from fossil fuels.

Ted Turner



Arizona State University
SES 194

Energy in Everyday Life

Order of Magnitude Estimate

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What’s the total mass of rubber left on US roads each year by tire-wear?

Our guidelines for making an order-of-magnitude estimate:

* *Guess*
* *Talk to your gut*
* *Divide and conquer*
* *Lie skillfully*
* *Punt*
* *Use guerrilla warfare*
* *Lower your standards*
* *Cross-check*

I'll guess that with ~200 million cars in the US, maybe 2 billion lbs/year ~ 1 billion kg/yr ~ 1 million tons/yr are left on the roads each year.

I'll estimate a tire loses a 1 lb of rubber per year.
4 tires per vehicle means 4 lbs/year.
250 million adults = 250 million vehicles.
So, 1 billion lbs/year or 0.5 billion kg/year.

This is about a factor of two from my wild initial guess.

This estimation path depends on the mass of rubber lost per year. Let’s do a more refined estimate of that mass.

A tire get replaced when its lost ~ 1 inch of tread.
A tire width is about the length of my hand, so ~ 6 inch.
A tire radius is ~ 1 foot, so 12 inch.

Volume of cylinder is
$\pi \times \text{radius}^2 \times \text{width}$

The volume of rubber lost is
$\text{Volume}_{new} - \text{Volume}_{replace}$
$\sim (3 \times 12^2 \times 6) - (3 \times 11^2 \times 6)$
$\sim 18 \times (144 - 121)$
$\sim 18 \times 20$
$\sim 400\ \text{inch}^3$

Converting to metric,
$400\ in^3 \sim 400\ in^3 \times (2.5\ cm/in)^3 \sim 400 \times 20 \sim 8000\ cm^3 \sim 10^4\ cm^3$.

I know water has a density of ~ 1 g/cm^3.
Rubber kinda floats so rubber has ~ 1 g/cm^3.

The mass of rubber lost by one tire before replacement is
~ $10^4\ cm^3 \times 1\ g/cm^3$
~ 10^4 g ~ 10 kg ~ 20 lbs.

So far this makes some gut level sense.

Common Knowledge

Share what you know.

I know the average driver puts on ~ 12,000 miles/year and tires need replacing every ~ 40,000 miles.
On average then, one tire gets replaces every year.

Assuming every adult has one car and that motorcycles balances commercial semis, 250 million adults = 250 million vehicles = 250 million tires replaced every year.

Since each tire has lost 10 kg upon being replaced, this means a total mass per year on US roads of 250 million x 10 ~ 2 x 10^9 kg , or 4 million tons.

Our three estimates, although similar in approach taken, yield consistent answers.