



WAIT BUT WHY

How Tesla Will Change the World



T E S L A

By Tim Urban

INTRODUCTION

This is Part 2 of a four-part series on Elon Musk's companies. For an explanation of why this series is happening and how Musk is involved, [start with Part 1](#).

A Wait But Why post can be a few different things. One type of WBW post is the “let’s just take this whole topic and really actually get to the bottom of it so we can all completely get it from here forward.” The ideal topic for that kind of post is one that’s really important to our lives, and that tends to come up a lot, but that’s also hugely complex and confusing, often controversial with differing information coming out of different mouths, and that ends up leaving a lot of people feeling like they don’t totally get it as well as they “should.”

The way I approach a post like that is I’ll start with the surface of the topic and ask myself what I don’t fully get—I look for those foggy spots in the story where when someone mentions it or it comes up in an article I’m reading, my mind kind of glazes over with a combination of “ugh it’s that icky term again nah go away” and “ew the adults are saying that adult thing again and I’m seven so I don’t actually understand what they’re talking about.” Then I’ll get reading about those foggy spots—but as I clear away fog from the surface, I often find more fog underneath. So then I research that new fog, and again, often come across other fog even further down. My perfectionism kicks in and I end up refusing to stop going down the rabbit hole until I hit the floor.

For example, I kind of got the Iraq situation, but there was a lot of fog there too—so when I wrote [a post](#) about it, one fog-clearing rabbit hole took me all the way back to Muhammad in 570AD. That was the floor. Digging into another part of the story brought me to the end of World War I. Another brought me to the founding of ISIS.

Hitting the floor is a great feeling and makes me realize that the adults weren’t actually saying anything that complicated or icky after all. And when I come across that topic again, it’s *fun* now, because I *get* it and I can nod with a serious face on and be like, “Yes, interest rates are problematic” like a real person.

I’ve heard people compare knowledge of a topic to a tree. If you don’t fully get it, it’s like a tree in your head with no trunk—and without a trunk, when you learn something new about the topic—a new branch or leaf of the tree—there’s nothing for it to hang onto, so it just falls away. By clearing out fog all the way to the bottom, I build a tree trunk in my head, and from then on, all new information can hold on, which makes that topic forever more

interesting and productive to learn about. And what I usually find is that so many of the topics I've pegged as "boring" in my head are actually just foggy to me—like watching episode 17 of a great show, which would be boring if you didn't have the tree trunk of the back story and characters in place.

So when it was time to start what I had labeled in my head as "the Tesla post," I knew this was going to be one of those posts. To understand if and why Tesla Motors matters, you have to understand both the story of cars and the story of energy—two worlds I somehow am simultaneously confused by and tremendously sick of. Just hearing someone say "climate change" or "energy crisis" or "tailpipe emissions" makes me kind of gag at this point—just too much politics, too many annoying people, too much misinformation on all sides, and it's just hard to know how much I actually care and if there can be a solution to all of it anyway. So I did what I do when my tortoise shits when I'm out of the apartment and then spends hours walking through it and tracking it across everything, including the walls somehow—I rolled up my sleeves, took a deep breath, whispered, "Be a man, Tim," and started scraping through layers of shit. If I have to live in a world with people arguing constantly about energy and oil and greenhouse gases and incentive programs, I might as well build myself a proper tree trunk.

After weeks of reading and asking questions and writing, I've emerged from the tortoise sewage with something that toes the line between a long blog post and a short book. I could have broken this into multiple posts, but it's all one story and I wanted to keep it all together. It'll be a bit of a time investment, but I think you'll come out of it with a sturdier tree trunk about all of this than you have now. And as it turns out, when it comes to this topic, we may be witnessing a very awesome moment in history without quite realizing it yet.

Two disclaimers before we start:

1) This is a highly politicized issue, but this post has no political agenda. I'm not political because nothing could ever possibly be more annoying than American politics. I think both parties have good points, both also have a bunch of dumb people saying dumb things, and I want nothing to do with it. So I approached this post—like I try to with every post—from a standpoint of rationality and what I think makes sense.

2) Spoiler: The post is very pro-Tesla. Which might seem suspicious since A) Elon Musk asked me to write about this and B) I just wrote a post calling him the raddest possible man. But two things to keep in mind:

First, this isn't commissioned by Musk, and I'm being paid \$0.00 for doing it. He suggested I take the issue on because I think he thinks there's a lack of full tree trunks in people's heads about it—but he never suggested that I say good things about Tesla, electric cars, or anything else.

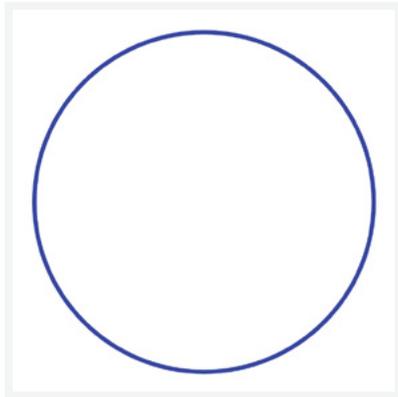
Second, the currency Wait But Why lives on is integrity. Without it, WBW loses its ability to make an impact. And integrity came first here, even at the expense of Musk potentially hating me at the end of it, if that's what was necessary. If I didn't think this would have made a great WBW topic, I wouldn't have taken it on, and I'm pro-Tesla in the post because after a ton of learning and thinking—including as many counterarguments to Tesla and its worldview as I could find—that's how I feel.

And with that, let's dive in.

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Part 1: The Story of Energy



Energy is important. Without energy, we'd all be like this:



But what really is energy? The dictionary says it's "the property of matter and radiation that is manifest as a capacity to perform work." And it says "work" is "the exertion of force overcoming resistance or producing molecular change." Putting that together, we get energy being "the property of matter and radiation that is manifest as a capacity to perform the exertion of force overcoming resistance or producing molecular change."

That was pretty unfun, so for our purposes, let's call energy "the thing that lets something do stuff."

But the tricky thing about energy is the law of conservation of energy, which says that energy can't be created or destroyed, only transferred or transformed from one form to another. And since every living thing needs energy in order to do stuff—and you can't make your own energy—we're all awkwardly left with no choice but to steal the energy we need from someone else. ¹

1

I come across much more in my research than I have room to fit in these posts, so I'll tuck extra tidbits and related thoughts into these blue footnotes throughout the post. Read these if you have time.

¹ Orange footnotes are as boring as you'd think an orange footnote would be. Just sources—only bother with these if you want to see the source of a quote or fact or find out where you can read more about the topic.

Almost all of the energy used by the Earth's living things got to us in the first place from the sun. ② The sun's energy is what makes the wind blow and the rain fall and it's what powers the Earth's living things—the biosphere.

The joule is a common unit of energy—defined as the amount of energy it takes to apply a force of one newton through a distance of one meter. ③ While the sun's joules can provide any animal with heat and light, the joules that *power* all of us from the inside enter the biosphere in the first place when the sun gives them to plants.



That's how food is invented—plants know how to take the sun's joules and turn them into food.

At that point, all hell breaks loose as everyone starts murdering everyone else so they can steal their joules.

We use “the food chain” as a cute euphemism for this murder/theft cycle, and we use the word “eating” to refer to “stealing someone else's joules and also murdering them too.” A “predator” is a dick who always seems to want your *joules* over everyone else's, and “prey” is just some sniveling nerd you particularly like to bully and steal lunch money from. Plants are the only innocent ones who actually follow the Golden Rule, but that's just because they have the privilege of having the sun as their sugar daddy—and humans are the biosphere's upsetting mafia boss who just takes what he wants from anyone he wants, whenever he wants. It's not a great system, but it works.

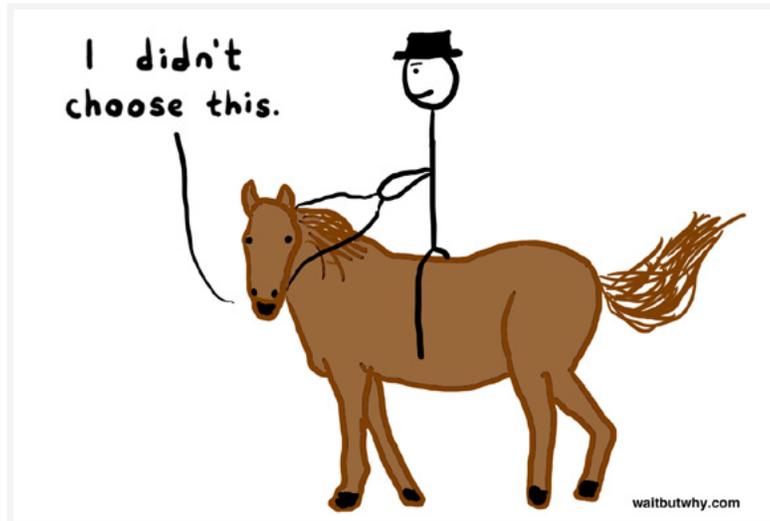
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As for how the sun got its energy in the first place, it's a very physics-y explanation. The sun is full of particles that have mass. Mass has gravitational potential energy. When so many particles are gathered in one place like they are in the sun, they squish together unpleasantly until they combine with each other, which is called nuclear fusion, and it's an intense process that releases a ton of energy. So to say it boringly, the gravitational potential energy of the sun's particles ignites fusion, which generates radiation energy, and that's the energy we receive from the sun on Earth. I'm regretful that this was the first footnote, because people are likely to click on the first one to see whether footnotes are actually interesting or not and then plan accordingly from there—and this was a kind of dull first footnote.

3

A calorie is about 4 joules.

And that all went on normally for a while, but in the last few hundred thousand years, humans started to realize something: while it was enjoyable to put new joules into your body, actually *using* those joules sucked. It's much less fun to use a bunch of joules running fast or lifting something heavy than it is to just sit on a log pleasantly and hold onto those joules instead. So humans got clever and started to figure out ways to get joules *outside* their bodies to do work for them—by doing that, humans could have their joules and eat them too. Sometimes the methods would be dickish:



But joules aren't only in living things. There are joules floating and swirling and zooming all around us, and by inventing the concept of *technology*, humans figured out ways to get use out of them. They made windmills that could steal some of the wind's joules as it went by and convert them into mechanical energy to grind food. They built sailboats that would convert wind joules into kinetic boat energy they could control. Water absorbs the sun's radiation joules and turns them into gravitational potential energy joules when it evaporates and then kinetic energy joules when it rains and slides down land, and humans saw the opportunity to snatch some of those up by creating water wheels or dams.

But the most exciting joule-stealing technology humans came up with was figuring out how to burn something. With wind or water, you can only capture moving joules as they go by—but when you *burn* something, you can take an object that has been soaking up joules for years and release them *all at once*. A joule explosion.

They called this explosion fire, and because the joules that emerged were in the useful-to-humans formats of heat energy and light energy, burning things became a popular activity.