Take a minute and think about how many things you've used today that need a

battery. We're surrounded by them. The one in your car represents a fifty-three billion-dollar market. The kind in your phone twenty-three billion dollars. Plus, in under ten years those markets are expected to grow to eighty-one and ninety-three billion dollars

respectively. But how much do you know about how batteries actually work. A battery is a device inside of which a chemical reaction happens that generates electricity.

It's an electrochemical device and for it to work you need two different metals and a substance called an electrolyte. A standard double-a battery, for example, uses zinc and manganese dioxide. This all started in 1799, when an Italian scientist named Alessandro Volta invented what would become known as the voltaic pile, the first modern battery.

The initial invention by Volta was basically a stack of coins silver and

zinc separated by cardboard soaked in

brine. it would deliver electric current

on demand. and that's the way things were

for about 60 years. And already during

that time within ten years of the

publication of Voltas invention people

were pulling it out into

commerce.

So, the metals Volta used was

zinc and silver and the electrolyte was

just salt water. And you'll notice that

as we talk about later battery tech the

innovations happen when scientists

figure out how to swap out one of those

two things the metals for the

electrolyte.

Things changed again in 1831

when a British scientist named Michael

Faraday invented the Dynamo a generator

and we were finally able to get

electricity on demand.

When electricity

generation was invented as a result of

the Dynamo then people started to

think about rechargeable batteries and

that was when the lead acid battery was

first rolled out.

Most of us are familiar

with car batteries so this our lead acid

battery, these are very low in energy

density but operate for about a decade.

they're extremely robust but they're

very large.

And then after World War two

nickel cadmium battery

showed up and we're used to power things

like early camera flashes. after that

nickel metal hydride batteries came onto

the scene and improved on nickel cadmium

batteries in most every way. Both of

these batteries are still used in

certain things today and were at one

point both used in electric vehicles. but

then in 1991 Sony introduced the first

commercial lithium ion battery. And once

again everything changed.

Sony was able to produce the

lithium-ion battery in there today. This

technology allowed another doubling of

energy density and allowed for now these

small consumer devices to be on a scale

that one can hold and put in your pocket.

Today's looking Li-ion battery has

enabled the revolution of electric cars.

They have enabled the revolution of

consumer electronics like laptops and

cell phones.

blue Theo Mayan is here to

stay for the foreseeable future. It's a

proven technology. It's the the best

we've got and it's the right technology

for mobile handheld devices whether it's

phones and computers tablets and so

on. Lithium ion batteries have had a

transformative effect on electronics. And

the industry has exploded. The lithium

ion battery market was worth twenty

three billion dollars in 2016 but that's

expected to jump to 93 billion by 2025.

electric cars are a huge reason why.

Tesla for example is betting big on

lithium-ion. It's cars whose battery

packs made up from thousands of

lithium-ion battery cells. Individually

they look like slightly larger double-a

batteries, but together they generate

enough power to move a car. these cells

are made by Panasonic for Tesla at its

massive Giga factory one battery factory

outside we know Nevada. The factory works

around the clock and cranks out about

two of these huge battery packs every

minute.

The battery remains the dustiest

part of the vehicle. So, it's really

really important that we improve our

efficiency and the designs that will

make them more affordable. The more

electric vehicles out there the better.

Any new battery technology has to

compete with lithium-ion batteries, If

the battery technology is to be viable

for the huge market of electric

vehicles. Unfortunately it is very

challenging to design a battery that can

decrease in cost faster than the looking

lithium-ion battery and this is largely

being the reason why lithium-ion battery

is and will be the dominating and

technology for electric vehicles in the

next 10 to 20 years.

But nonetheless this

current generation of lithium-ion

batteries is not the end of the road for

battery tech.

We've been working a

lithium-ion per say since the

early 90s but that is evolved from

cobalt oxide to nickel oxide to

manganese oxide. To now we have some

combination of all three metals to give

sort of the best value we know

of today. And while American scientists

have invented their fair share of

battery technology lately other

countries like South Korea China and

Japan have been leaders in improving

batteries Continuously making them more

powerful and more efficient. with

millions upon millions of battery

powered devices being produced where we

get the elements that go into them and

what happens to them at their

end-of-life are both big concerns.

Elements like cobalt for example a known

conflict mineral are currently needed to

produce most lithium-ion batteries. a

battery is a closed device it doesn't

output any carbon dioxide, it doesn't

release any harmful chemicals. So, in that

sense it is very environmental friendly.

However that is not a complete view of a

battery life cycle.

and we're talking about many billions of batteries that

are now reaching their end-of-life.

Researchers are working on two main

solutions- how to best recycle the

component materials and how these

batteries can be reused in other

applications. One of the other biggest

things that material scientists are

working on right now is developing

large-scale energy storage technologies.

it's these types of huge batteries that

are going to link intermittent

renewables like solar or wind power with

the grid.

I think that people don't

realize that the grid operates such that

the electricity powering this

conversation was generated just moments

ago. It's all just in time.

The grid is the world's largest supply

chain with zero inventory. If for example

it's a beautiful sunny day and we've got

a super abundance of electricity we

can't use it.

Supply must be in balance with demand everywhere at

all times. So, batteries is everything. The

takeaway here is that if we had really

really big battery systems that could

store renewable energy and then inject

that energy into the grid when and where

we want them to. It could transform the

world's electricity systems for the

better.

Tesla powerwall does this at the home

level but the hope is to do it on a city

level. Tesla is one of the companies

working on that too though and last year

it opened the world's largest lithium

ion battery facility on a wind farm in

Australia. but right now systems like

this are few and far between. To be able

to store the electricity generated by

wind and solar

you need a technology that is perhaps 10

or 20(twony) times less expensive than today's

lithium-ion battery technology. So, you

don't have to worry about temperature of

operation because it's not going to be

put on your lap or next to your face. You

don't have to worry about energy density,

because you're not going to be moving it.

What you really care about is safety a

service life time. And if you can give me

something that's big, cheap, safe, then I

don't care about things like watt hours

per kilogram and there are a number of

contenders out there. But the future is

not going to be a mirror of the past. If

we want to get 5x better we've got to do

something that's radically different

from everything that's been done up

until now and I'm really excited about that.