

The Energy Transformation & The EV Resource



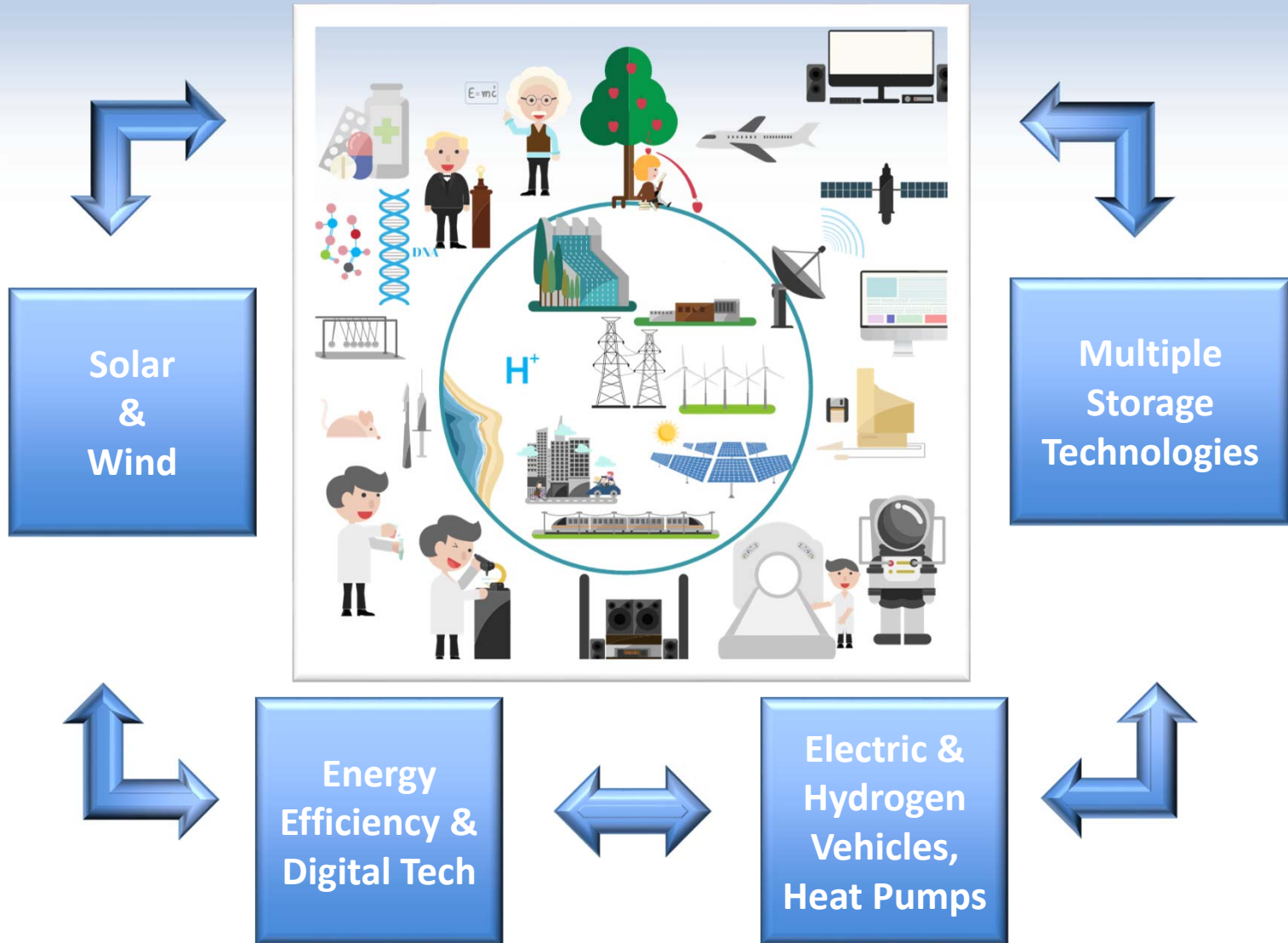
An All-Electric
All-Renewable
Infrastructure is
Possible by 2050

**Leah Y Parks
Co-Author**

**All-Electric America:
A Climate Solution and the Hopeful Future**



Modern Day Edisons Have Done Their Job





Renewable All-Electric Transformation

Electricity

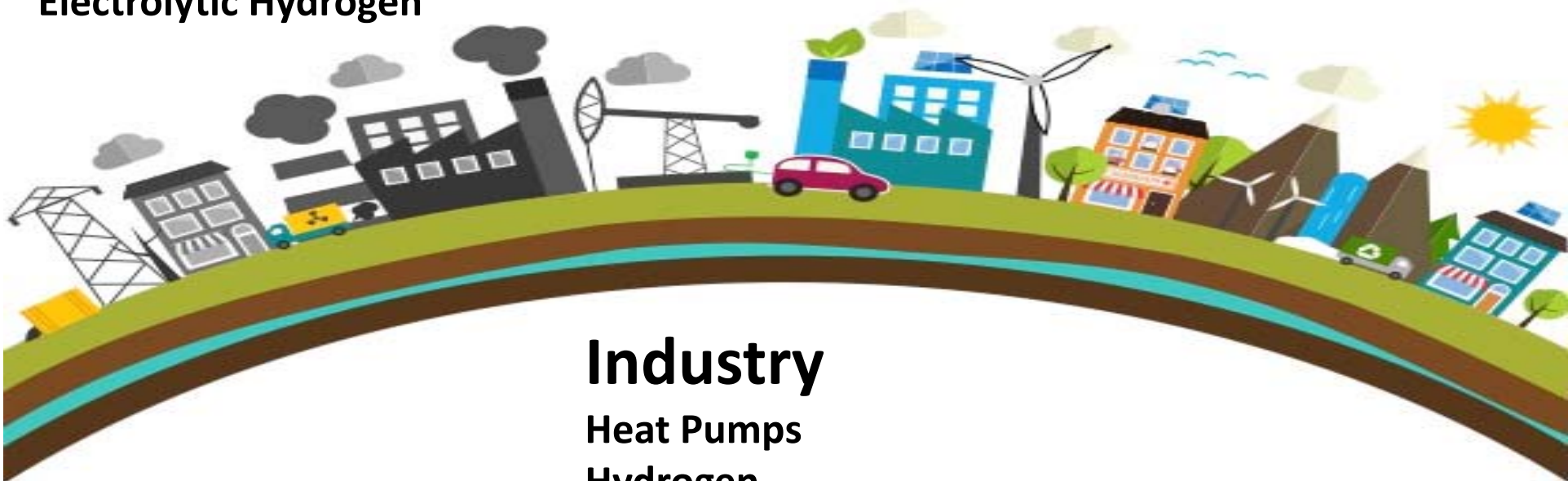
Solar, Wind, Hydro
Energy Storage
Distributed in Nature
Microgrids
Electrolytic Hydrogen

Transportation

H⁺ + Electric Cars/Trucks
Hydrogen Ships
Hydrogen Airplanes
Electric Trains

Heating/Cooling

Heat Pumps
• Air & Ground Source
Solar Hot Water Heaters



Industry

Heat Pumps
Hydrogen



Digital Transformation

Cloud Computing



Manage the electricity infrastructure and balance demand/supply

Internet of Things



Connect and control smart devices in homes and on the grid

Personal Devices



Connect to the digital world and manage our energy use

The digital revolution will facilitate an All-Electric, All-Renewable energy infrastructure



Resources Abound



150 TW Solar PV
Rural Capacity
~18X's the
2050
Requirement

0.42% US Land
needed w/out
spacing
1.6% US Land
with spacing



15.2 TW of Wind
~2.5 X's The
2050
Requirement



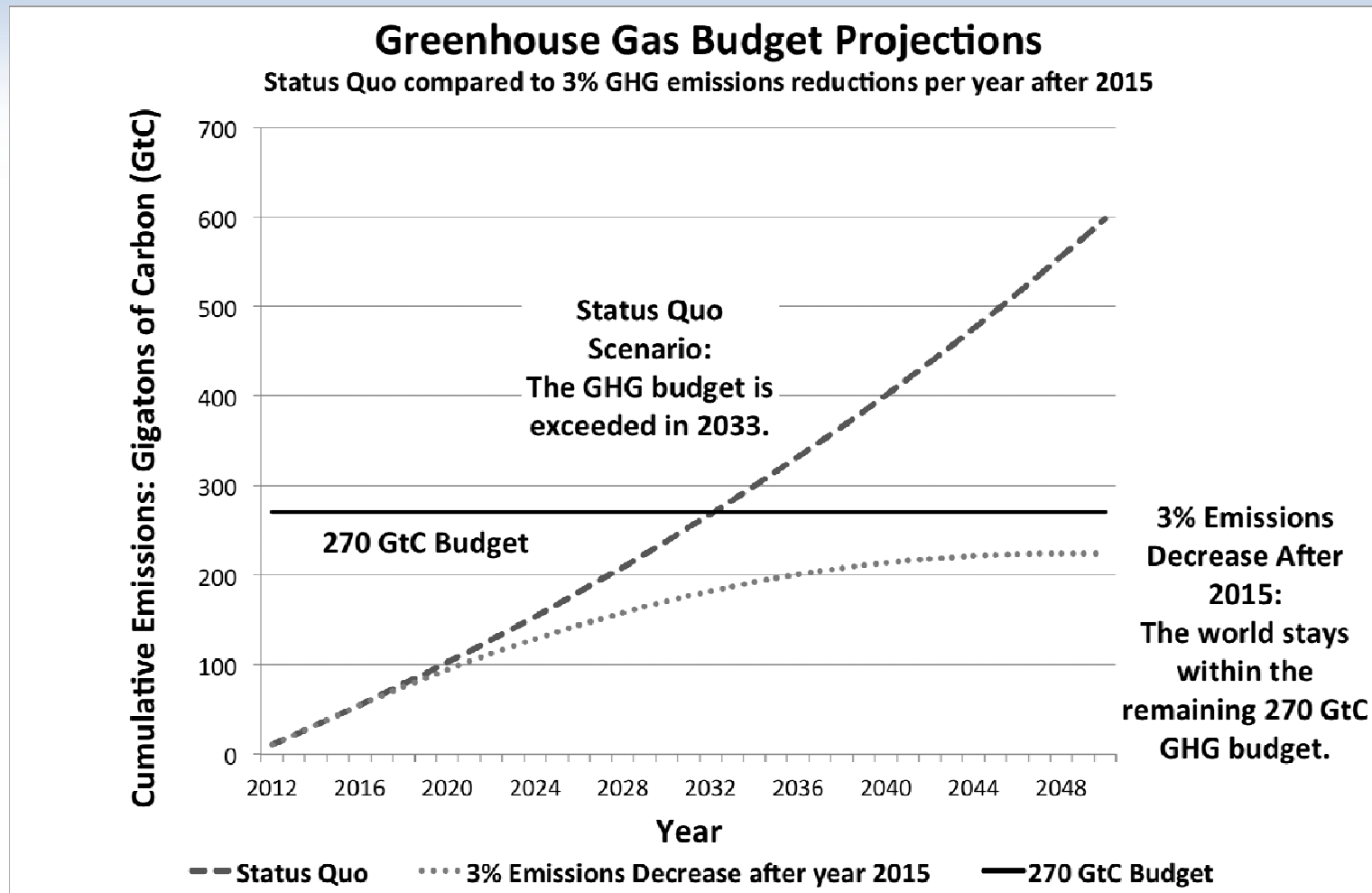
0.03 acres
for 2050
energy
needs per
person



1 acre
to feed
one person



Green House Gas (GHG) BUDGET

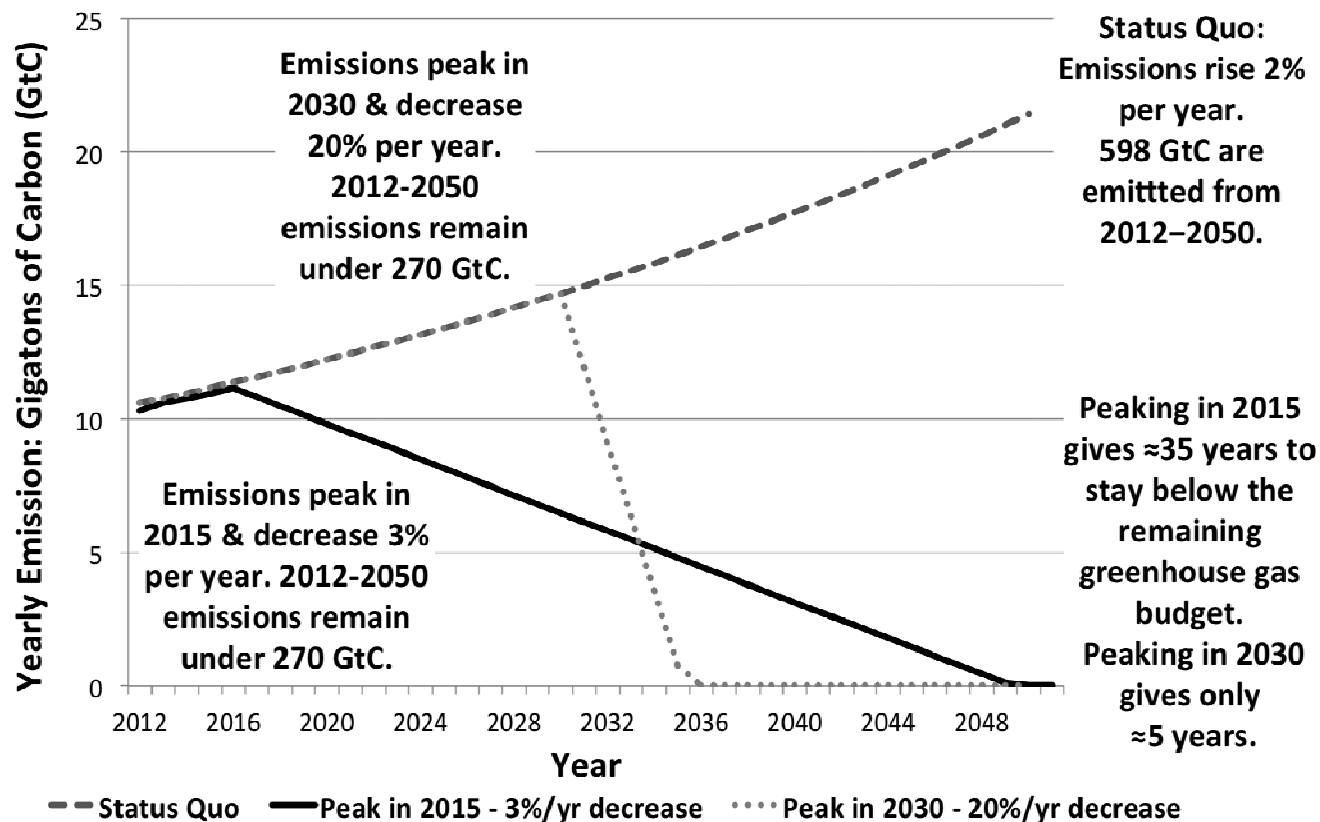




Green House Gas Peak Emissions

Peak Emissions & The Remaining 270 GtC Budget

Status Quo Compared to Peaking in 2015 and 2030





We Have the Means



180,000 MW per year to achieve **100% clean energy by midcentury**

- ~2% of US GDP per year (4% of GDP currently used for military)
- Money for fossil fuels, drilling, exploration, wars, fracking goes to RE



China plans ~1 million MW GHG Free Energy by 2030 (total US electricity capacity)

- 67,000 MW per year, ~3% of China's GDP



We have done this type of effort in the past

- WWII, transformed industrial infrastructure in 4 years, 40% of US GDP
- Build highway infrastructure after WWII
- Send humans to space and to the moon

100% OREGON

Transition to 100% wind, water, and solar (WWS) for all purposes
(electricity, transportation, heating/cooling, industry)



40-Year Jobs Created

Number of jobs where a person is employed for 40 consecutive years



Using WWS electricity for everything, instead of burning fuel, and improving energy efficiency means you need much less energy.



Mark Z. Jacobson & Team
Research and Plans for
running the US, States &
149 countries on
100% Renewable Energy.

E.G.,
Wind, Water & Solar
WWS
www.thesolutionsproject.org

M.Z. Jacobson: Professor of
Civil and Environmental
Engineering at Stanford
University

THE
SOLUTIONS
PROJECT

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100isNow



SolutionsProj

Data from Stanford University - For more information, visit
<http://go100.me/50StateTargets>



Cost & Trends



Cheaper Cleaner Safer

Like Hydroelectric Dams

- Fuel for Solar and Wind Energy is **FREE**.
- Once it is installed it will be cheap energy

Solar, Wind, & Storage Prices are Plummeting

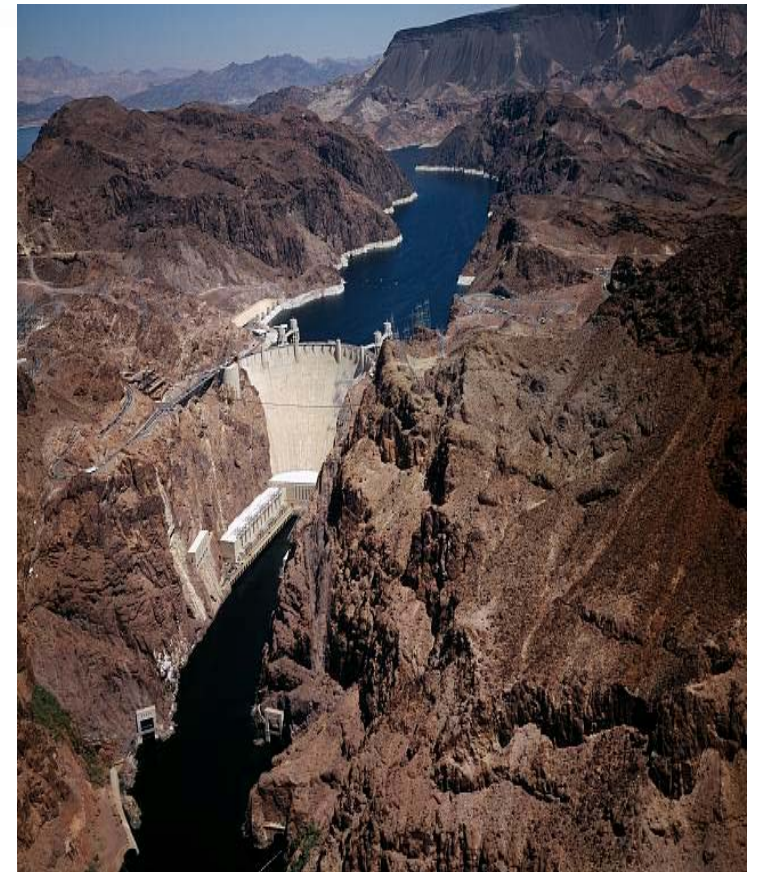
- Solar and Wind have become **CHEAPER** than **NEW** Gas, Coal or Nuclear
- Some Storage is already economical, prices are expected to drop further in next 5 years
- Storage is not needed until 50%-70% penetration

Electric Vehicles

- Electricity is cheaper, ~ \$1 per gallon equiv.
- Less maintenance will also be needed

Drain on Society is Relieved

- No spending money on wars for oil & spills
- Reduced energy & health costs \$1800/person
- Reduced climate costs \$8,300/person in 2050





New Solar & Wind Prices Plummeting & Cheaper than New Gas, Coal and Nuclear

(EIA 2020 LCOE)

- New Nat. Gas:
7-14 cents per Kwh
- New Coal:
9-14 cents kWh
- New Advanced Nuclear:
9.4 cents per kWh

- Renewable Energy accounted for 60% of all new added capacity in 2015
- Natural Gas accounted for 35% of all new added capacity 2015
- 1st 3 months 2016 RE = ~90% installed Capacity

New Utility Scale Solar
3.87-6 cents per kWh Low in TX, NV,
CA & CO

(unsubsidized price falling ~4.5-6 cents kWh)

New Wind
2.5-3 cents per Kwh
nationally

Rooftop PV
Grid Parity
2016 -
Deutsche Bank

Solar + Storage
grid parity in
many states by
2020-2030
(RMI).

Dubai Solar
3 cents per Kwh

Res. Solar
Grid Parity
in 20 States
GTM Research



EVs Moving to a Take-Off Point ~2022

Tony Seba Predictions

All new cars will be EVs 2030

400K Tesla Model 3 Pre-Orders

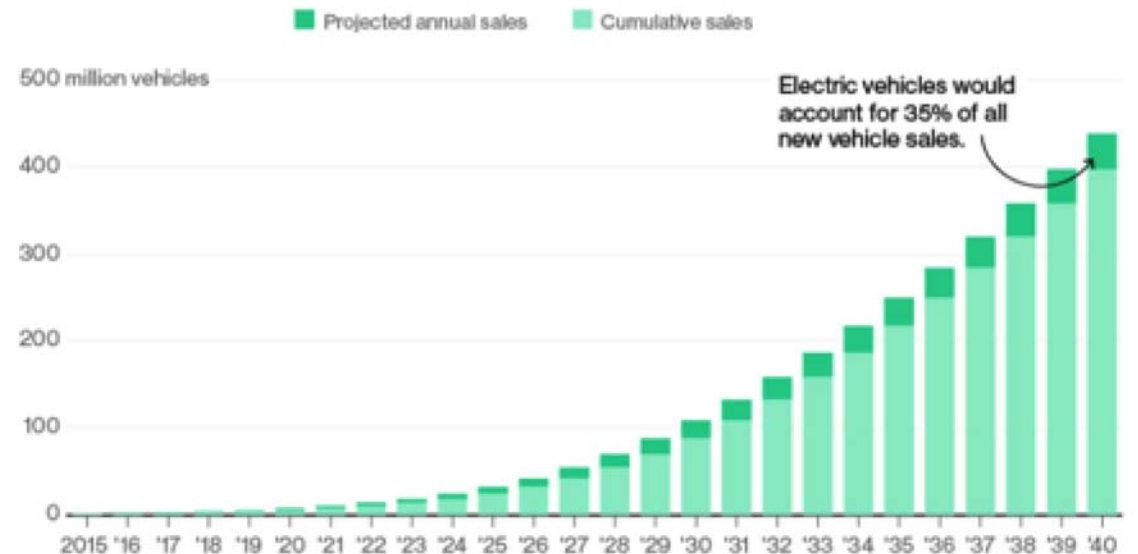
Goal 500,000/yr. 2018 & 1 million/yr. by 2020

Country Initiatives

- Norway all new cars and trucks EV in 2025
- China 5 million EVs on the road by 2020
- Dutch parliament passed a motion all new cars EV in 2025

The Rise of Electric Cars

By 2022 electric vehicles will cost the same as their internal-combustion counterparts. That's the point of liftoff for sales.



Sources: Data compiled by Bloomberg New Energy Finance, Marklines



BYD, Nissan, Chevy, German manufacturers, Faraday Future (20% more battery life and faster?).



EVs Price Trends



Battery Prices Dropping

EVs cost parity to be when battery costs hit \$250-300 per kWh. (IEA & investment Bank UBS)
Predicted Paradigm shift at \$150/kWh

- Chevy Bolt: batteries \$145 (215)/kWh & \$37,500 (Tax credits not included)
- Tesla's all-in pack < \$190/kWh (Model 3 will be ~145/kWh ?) & \$35,000 (Tax Credits not included)
- Used Batteries currently at 100/kWh or less (80% storage capacity still usable)
 - Repurposing could bring EV car prices down faster than expected



How to Make it Happen & Drivers



How Do We Fund The Transformation

- Private Industry
- Green Banks
 - loan guarantees
 - financing
- Incentives
- Utilities
 - Green Mountain Power
 - Financing and selling solar, storage and heat pumps.
 - TVA is financing HP's



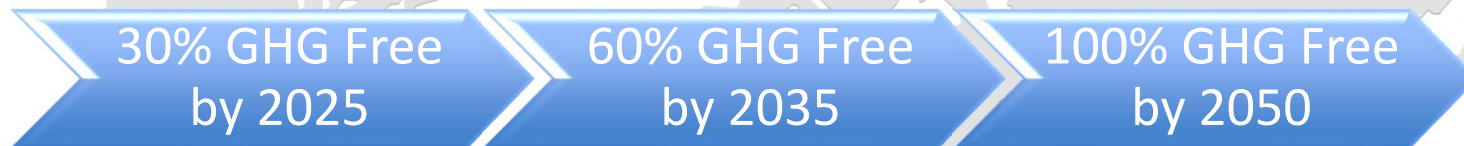


Timeframe

3% per year – 100% by midcentury
Electricity Infrastructure
Transportation
Heating & Cooling
Industrial uses

Ideally pass mandates and laws
Fuel efficiency standards
Carbon Tax is good, but not a sure thing

Must know where need to go – Keep Eyes on the Ball



What to do until get mandates passed?

We Start Working Now
Become Leaders in Business, Academics, & Government
Once the Ball is Rolling: Transformations Happen Fast



Disruptive Forces

- **Technology**
 - Solar + Storage
 - Energy Efficiency, Demand Response
 - Heat Pumps
 - EV's
- **Business Models**
 - Solar City as a Utility
 - Change In a Blink of an Eye => UBER & Netflix
- **Grass Roots Movements**
 - 100% cities
- **Political Process**
 - Elections
 - Laws & taxes passed





The EV: Driver of the Energy Transformation

Technological innovation &
Entrepreneurial spirit

Gives a
Tangible
Experience
with the
transformation



Young men enjoy a joyride: Early 1900's

Source: *PositiveBoost.com*

Disruptive:
Tesla Model 3
Awakens
Germany

Smooth Ride
Fun
Convenient

An Important
Resource



The EV Resource



The Amazing Electric Vehicle Resource

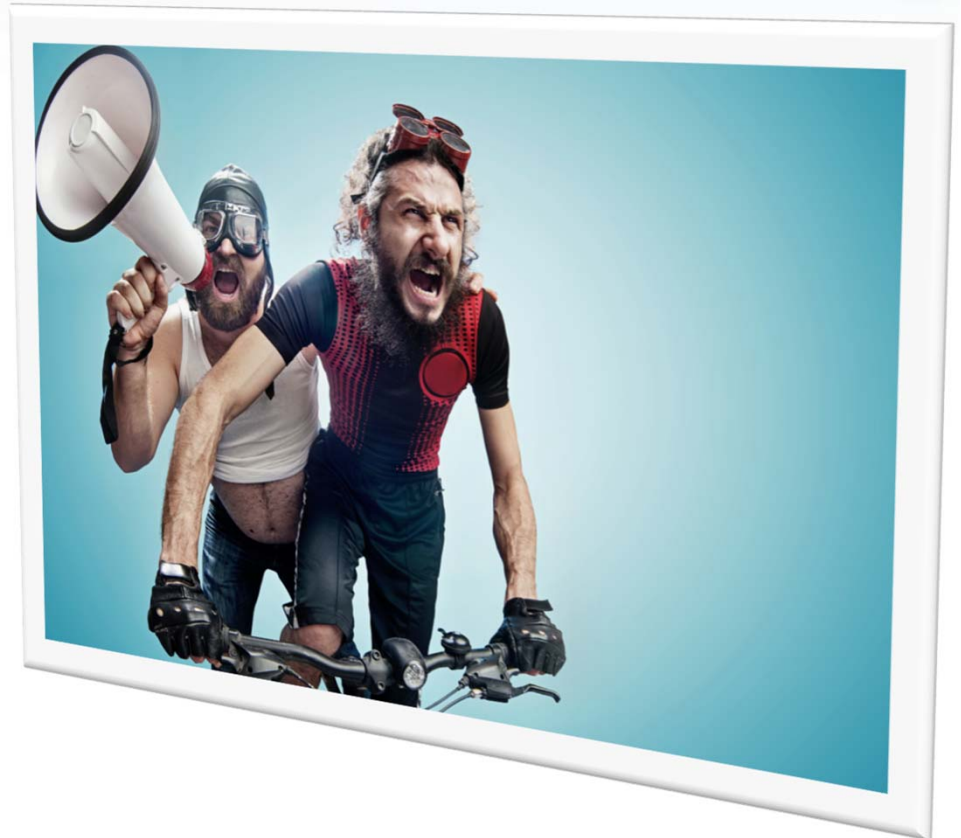
How we talk about EVs is important

General Public

- Awesome + Fun
- Convenient
- Cheaper
- Less Maintenance & Backup Storage

Utility, Planners, Lawmakers

- Utility Resource
 - Grid Balancing & Storage & Load
 - Revenue
- Defunds Dependence on Foreign Oil
- Technology for solving climate change crisis
 - 30% GHG can be eliminated





Consumer Resource

Convenient

Charging done while sleep/work

Fun-Fun-Fun

Torque, acceleration, noise, smooth

Maintenance

- Low maintenance, few moving parts

Backup Storage

- Vehicle-to-home

Peter Hoeckel: Better than the Powerwall

- Model 3 – 60 kWh Battery Pack
- Powerwall – 6.4 kWh and Battery Pack



*The infectious Tesla Smile is spreading!
Congratulations Ning, Lila, & David from
Boulder, CO!*

[Source: Hybridcars.com](http://Hybridcars.com)

Cheaper

- \$1 per gallon equivalent
- At \$25,000-\$37,000 (tax)
- New Cheaper Cars on the Way
- Cheaper with Solar



NREL



Utility Grid Resource

Vehicle to Grid Integration (V2G)

Facilitated by Charging Location: ~35% at work & ~60% at home

Emergency Power Backup

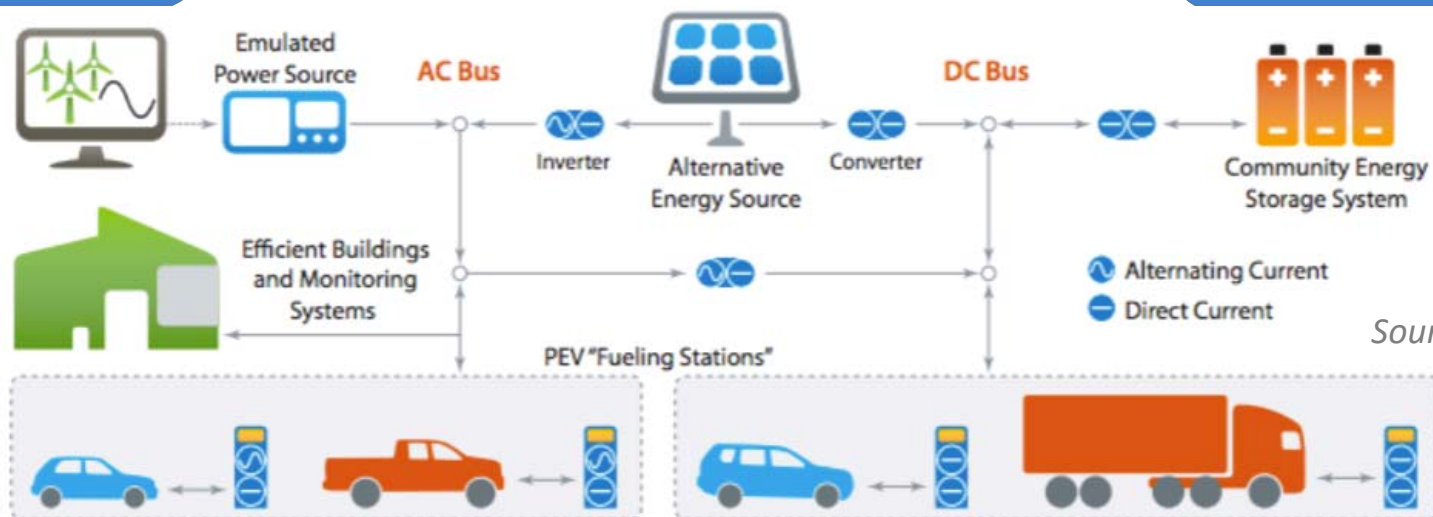
Assist in grid outages and disaster-recovery efforts

Bi-Directional Power Flow

Reduce local peak-power demands + Facilitate load management

Local Power Quality

Balancing & Grid Stabilization with high renewable penetration





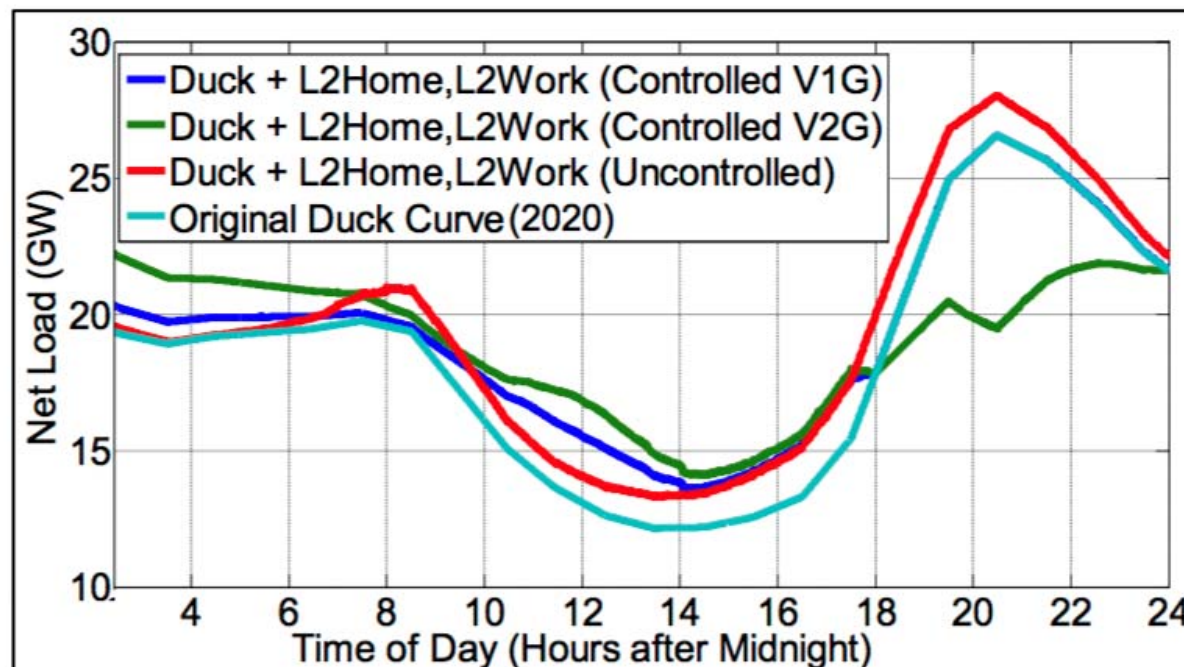
Utility Load Resource

PEVs, properly integrated as a grid resource

Enable greater deployment and integration of intermittent renewable generation.

- Uncontrolled charging - Helps over-generation & exacerbates Duck Curve when return home
- V1G smart charging
- V2G smart bidirectional charging

Impact of 3 million PEVs on California net load curve (Duck Curve)



Source: NREL



Utility Revenue Resource



Source: DOE



Source: Dept. of Commerce

Transfer \$\$\$ from Fossil Fuel Industry → High Tech & Electricity Industry

Energy in transportation sector ~1/3 total primary energy used in USA

Revenue for Utility (NREL)

Energy by light-duty vehicles = 61% of all transportation energy (2012)

– The equivalent of 8.4 million barrels oil/day (NREL)

– At \$44/barrel (2016-2017)

– **\$370 million/day or \$135 billion/year for Light-Duty Vehicles**



Batteries: Utility & Business Revenue Resource

Concern about Impact on Batteries

Second-Life Game-Changer Repurposed Batteries

BMW, GM, Nissan, Toyota

Exploring value EV battery has for use in the electricity storage market after battery can no longer be used for car.

- Possibly much cheaper electricity storage for renewables
- With additional value, EV makers can charge less for their cars
- Possibly \$100/kWh vs \$150 to \$250/kWh for batteries



Used Chevy Volt Batteries Help New GM IT Building Use Solar And Wind Power. Via GM and Joe Romm

Utility Opportunity

Utility to Own Car Batteries

- Can use for additional storage
- Justify because can use EV batteries before & after in car for a large variety of uses on grid



Buildings Resource

Value for Vehicle-to-Building (V2B) & Vehicles-to-Grid (V2G) Options

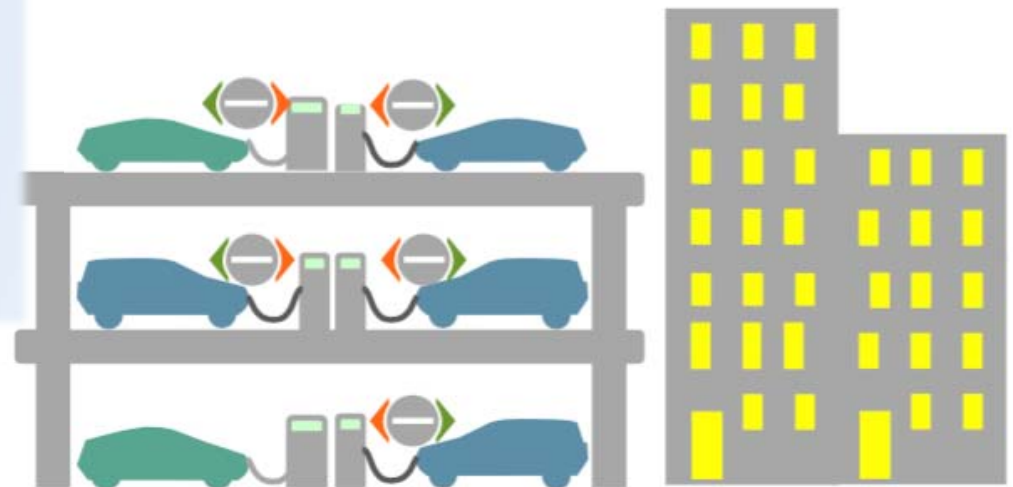
20%-40% Demand Charges are from electricity

- “Demand charges are based on peak load during 15-min window, a few events per month”
- “\$132B/yr. in commercial electricity expenditures.”
- “1% demand charge market ~\$420M/yr.”

Source: NREL

V2B operates “beneath the meter”

- Reduces the interaction with utilities & markets.
- Can use distributed assets (e.g., renewables, refrigeration & more)



Source: Much Information for this slide is from NREL:
Tony Markel PEV Grid Integration Research Talk 2014



National Security Resource

Tesla VP
\$75B/year of U.S. national defense budget goes towards securing access to foreign oil and the supply routes.



(Source: InsideEVs via Evannex)

“... Every time you fill up your car, you are sending a check to foreign countries to pay for their oil. Why not send your money to the local electric utility or your neighborhood solar installer instead?” –former CIA chief James Woolsey



Climate & Health Resource

Transportation sector contributes 28% of U.S.
GHG emissions annually

2013 MIT Study:
Air pollution causes
200,000 early U.S.
deaths/yr.

Equal to
Alzheimer's/Pneumonia

Road transportation causes
53,000 premature U.S.
deaths/yr.
Power generation
52,000 premature
deaths/yr.

**Duke University
Paris Treaty
Scenarios**

By 2030 clean
transportation could
prevent ~120,000 U.S.
premature deaths by
2030 & ~14,000/yr.
after

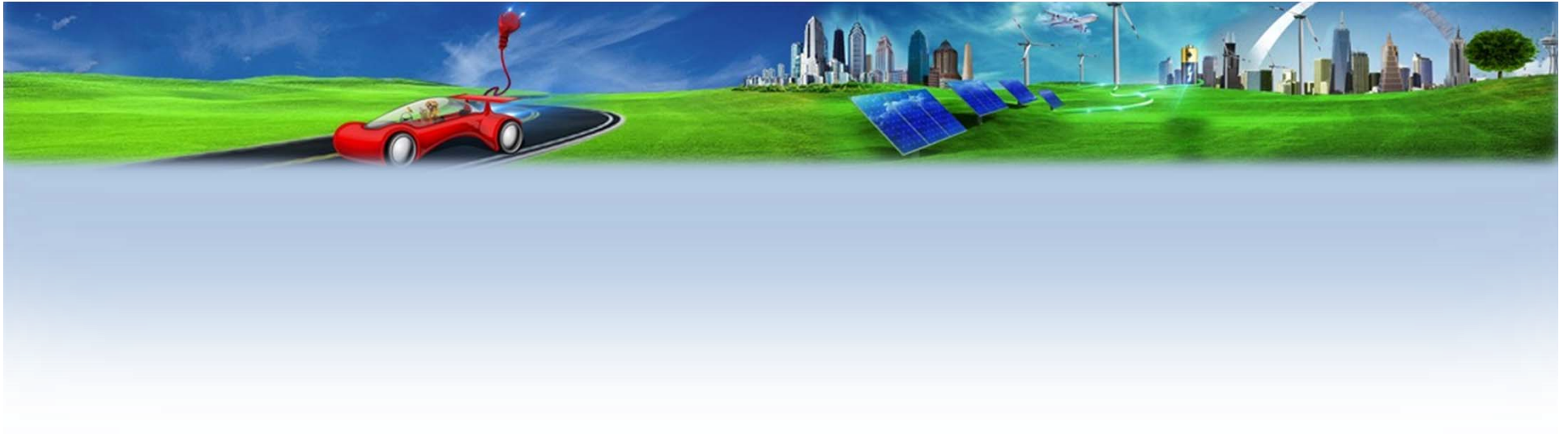
Stanford Study

By 2050 U.S. saves ~\$850
Billion/yr. in health/climate costs
& avoids ~46,000 deaths/year.
(5%/yr. 2014 US GDP vs.
2%/yr. GDP for RE
Transformation)

~\$10,000 health, climate &
energy savings/year/person
in 2050

\$17.42 trillion U.S. 2014 GDP

Image Source: CDC



Getting Ready for the Model 3 Wave



Are We Ready for the Model 3 Wave?

Businesses, cities and utilities need to evaluate if they are ready

Conflict

- Who owns charging stations? Utility, Private, Some Combination
- Will utility investment in charging stations increase rates? Is this fair?
- Equity, Access to charging in apartment buildings
- Requirements for business parking lots to have charging?



Are We Ready for the Model 3 Wave?

Businesses, cities and utilities need to evaluate if they are ready

Tesla plans to double its Supercharging network may not be enough to support the load of Model 3 preordered

Load of Plugging in at 6:00 PM: It is thought that the grid will handle this, but TOU incentives will help to encourage charging at night.

New York City lawmakers held a hearing in April 2016 to invest in charging infrastructure. Other Cities are planning too.

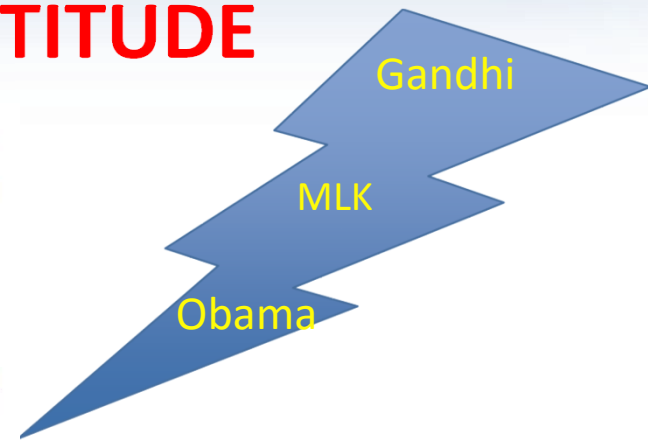
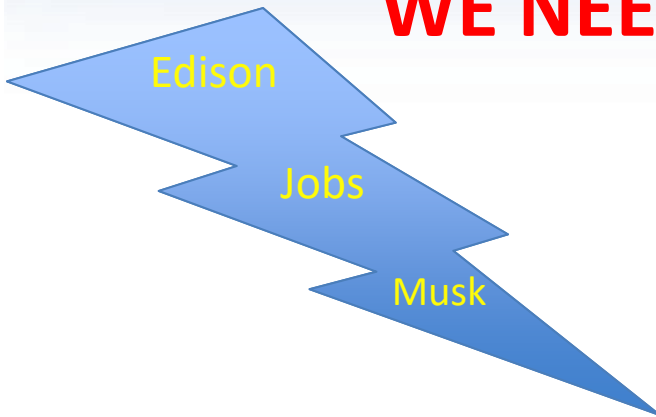
Cities need Streamline permitting processes for charging stations, smart grid communication protocols, coordinate w/local utilities, include business in their planning, and continue to provide monetary and non-monetary incentives



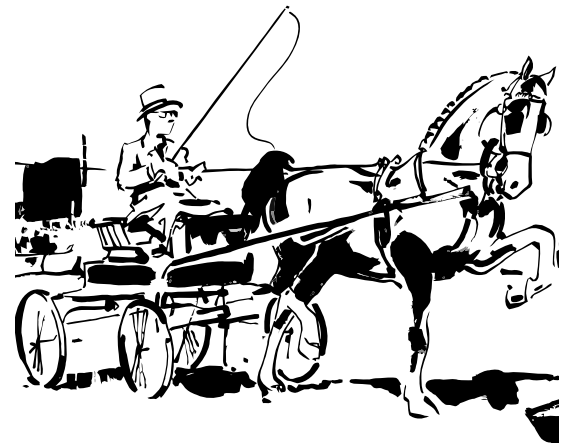
The Future is in our Drive to Innovate

Electric Vehicles are a Resource

WE NEED A "CAN-DO" ATTITUDE



**Don't be the last
one holding the Buggy Whip!**





Thanks

Peter Hoeckel:

OEVA Member

Gary Graunke:

OEVA Chair

Zachary Shahan:

Director/Editor of CleanTechnica, EV Obsession & More

Matt Pressman:

Evanx Aftermarket Tesla Accessories

(www.Evanx.com)

Robert Marritz:

Founder & Executive Editor of ElectricityPolicy.com & Electricity Daily

Yannis Schoinas:

Partner/Reviewer/Digital Tech Advisor

S. David Freeman:

Former Utility CEO & Co-author All-Electric America

Lucy Pond:

For coming to my talk on her birthday



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All-Electric America

A Climate Solution and the Hopeful Future

**Associate Editor ElectricityPolicy.com & Electricity Daily
Board President: Oregonians for Renewable Energy Progress (OREP)**

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Zachary Shahan References

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Slide 9: The Solutions Project

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Slide 12 New Solar & Wind Prices Plummeting

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Slide 13: EVs Moving to a Take-Off Point

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Slide 14: EV Price Trends

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Slide 19: The EV: Driver of the Energy Transformation

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Slide 22: Consumer Resource

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Slide 23: Utility Grid Resource + Slide 24: Utility Load Resource +

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Slide 26: Utility & Business Revenue Resource

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Slide 27: Buildings Resource

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Slide 31: Are We Ready for the Tesla Model 3 Wave

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