



The Dark Side of Renewable Energy

Joe Jenkins, PG, CHMM, CPESC
October 2019, Pikes Peak Environmental Forum

First, I must say that I am not is a renewable energy expert. I am an environmental manager who's business model is to assist companies to develop environmental management systems that clearly identify their environmental impacts, develop programs that reduce or eliminate their environmental risks and to become more efficient, cost effective and sustainable.

In 1980, I started my career in the oil and gas industry as an exploration and production geologist. I ended my career as an environmental manager in the oil and gas industry. I was laid off both times. The second time I was laid off, **Black Hills Energy, my employer at that time, was urged to divest of its oil and gas holdings by Wall Street.**

In 2001, I stood in a field just outside of Montezuma, Kansas surrounded by the unconstructed blades and towers of the first windfarm to be built in Kansas. It was being built by Florida Power and Light and would be owned and operated by my employer Aquila Inc. This was truly a revelatory moment – I was seeing the future of energy.

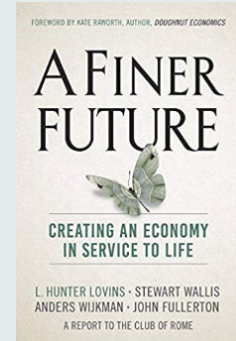
The Dark Side of Renewable Energy

- The future looks bright for renewables
- But there is a dark side
- Aspects and impacts of renewable energy
- Hidden environmental and social impacts of the renewable energy supply chain
- Disruptive technologies

During and after developing this presentation in May, I began to see articles and studies that support all of the information provided. Many of these articles are identified throughout the presentation. A list of additional references are provided at the end of the presentation.

Sources Used in This Presentation

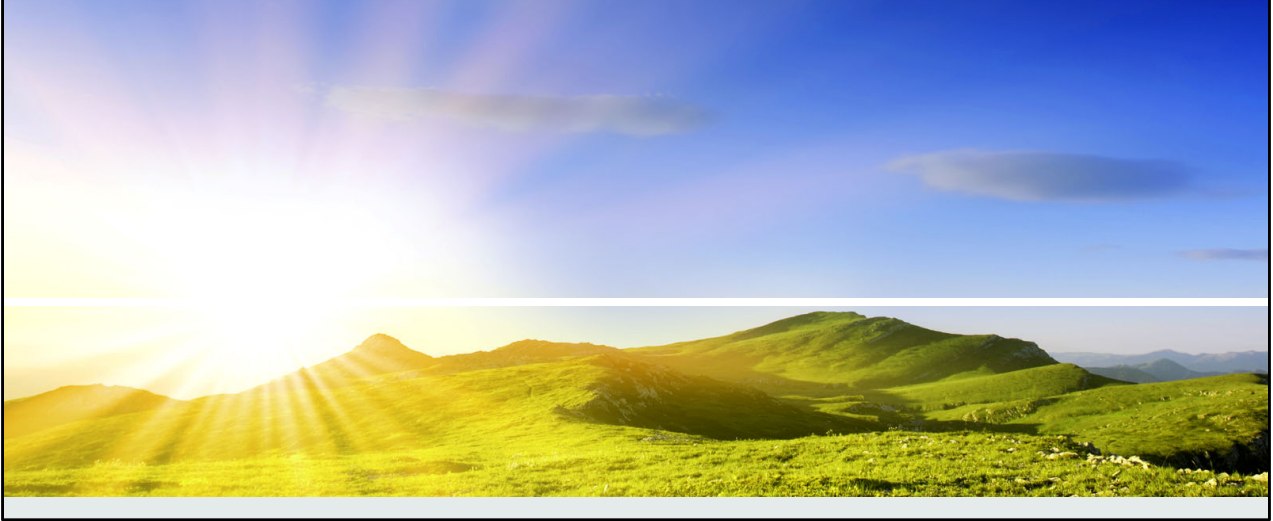
- "A Finer Future – Creating an Economy in Service to Life, A Report to the Club of Rome", 2018, by L. Hunter Lovins, Stewart Wallis, Anders Wijkman, John Fullerton
- US DOE's Energy Information Administration (EIA)
- Earthworks
 - A nonprofit organization dedicated to protecting communities and the environment from the adverse impacts of mineral and energy development while promoting sustainable solutions.
- Google News
- NPR
- Android Authority
 - The largest independent publication dedicated to the world's most widely used operating system
- Additional resources provided at the end of the presentation



The Club of Rome is an organization of individuals who share a common concern for the future of humanity and strive to make a difference.

Founded in 1968 at the Accademia dei Lincei in Rome, Italy, the Club of Rome consists of current and former heads of state, UN bureaucrats, high-level politicians and government officials, diplomats, scientists, economists, and business leaders from around the globe.

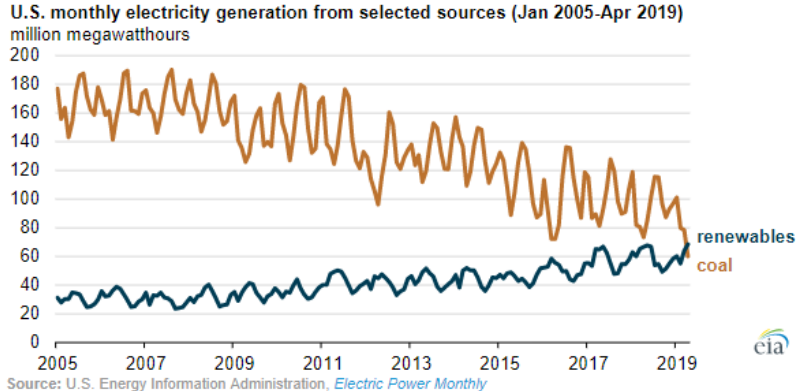
The Future Looks Bright for Renewables



Renewables Surpass Coal for 1st Time

JUNE 26, 2019

U.S. electricity generation from renewables surpassed coal in April



Wind and Solar are Crushing Fossil Fuels

- “The best minds in energy keep underestimating what solar and wind can do.”
- “Since 2000, the International Energy Agency (IEA) has raised its long-term solar forecast 14 times and its wind forecast five times.”
- “Every time global wind power doubles, there’s a 19% drop in cost, and every time solar power doubles, costs fall 24%.”

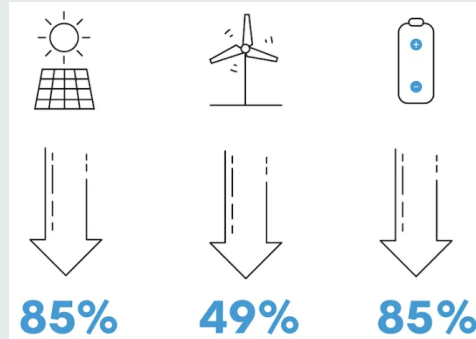
Tom Randall, Wind and Solar are Crushing Fossil Fuels, Bloomberg News Energy Finance, April 6, 2016

Yahoo Finance: SunPower Riding Wave of U.S. Solar Growth.

<https://finance.yahoo.com/news/sunpower-riding-wave-u-solar-130200597.html>

Cheap Renewable Energy and Batteries Will Fundamentally Reshape the Electric System

- Since 2010, global pricing for solar, wind and batteries has dropped significantly
- Wind Power by nearly 50%
- Solar and batteries by as much as 85% for both



Bloomberg: A Deluge of Batteries Is About to Rewire the Power Grid.

<https://www.bloomberg.com/news/features/2019-08-03/a-deluge-of-batteries-is-about-to-rewire-the-power-grid>

ThinkProgress: A 100% renewable grid isn't just feasible, it's in the works in Europe.

<https://thinkprogress.org/europe-will-be-go-renewable-powered-in-two-decades-experts-say/>

Ponder Six Doublings of Solar Energy

- The global solar market doubled twice between 2012 and 2016
 - Roughly *one every two years on an exponential curve*
- With six more doublings over the next 12 years – we could generate 100% of the global energy need!



Jeremy Leggett, jeremylegget.net, is a British social entrepreneur and writer. He founded and is a director of Solarcentury, an international solar solutions company, and founded and is chair of Solar Aid, a charity funded with 5% of Solarcentury's annual profits that builds solar lighting markets in Africa

Today, China invests more each year in wind, hydro and solar power than any other country on earth. This year, China switched on the world's largest floating solar power plant.

The facility is located in the city of Huainan, in China's eastern Anhui province. It has a capacity of 40 megawatts (MW), enough to power a small town. Ironically, the plant floats over a flooded former coal-mining region.

China has also been putting the brakes on its fossil fuel consumption. In January, the country's energy regulator brought a stop to more than 100 coal-fired power plants under construction across the country, with a combined output of 100 gigawatts (GW).

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“Fossil Fuels are Finished.... The Rest is Detail”

- “Fossil fuels are finished... and once everyone wakes up to the reality, it will die faster because the market will discount it, taking away capital and shifting it to the future winners.”
- “This process will drive [large] scale deployment and innovation of renewables while denying capital to fossil fuels.”
- “The fossil fuel industry will be all but gone in 15-30 years.”

Paul Gilding, Fossil Fuels are Finished.... The Rest is Detail, Reneweconomy, July 13, 2015

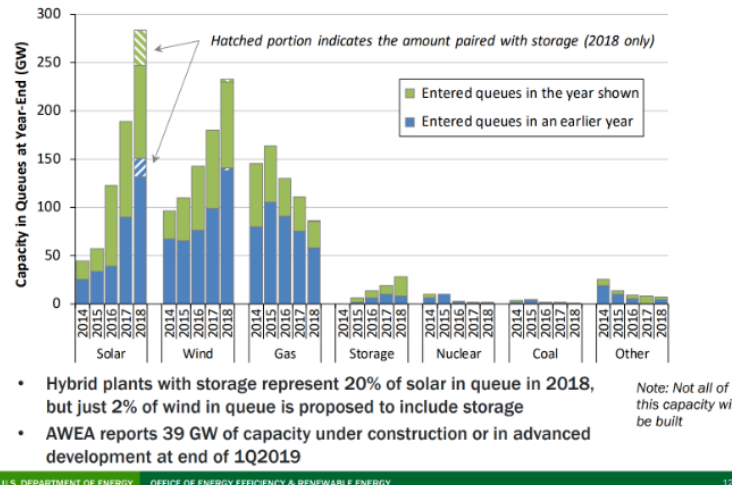
Michael Milken, Sept. 19, 2019: Big investors such as pension funds and sovereign wealth funds are indicating they want climate-focused strategies with high Environmental, Social and Governance (ESG) scores. In fact, they want to do so “not just in terms of investing properly for their pension fund holders or the country but also because they want the return.”

Old, small plants were the early retirees, but several of the biggest U.S. coal burners—and CO₂ emitters—will be shuttered by year’s end.

<https://www.scientificamerican.com/article/and-now-the-really-big-coal-plants-begin-to-close/>

D.O.E: Wind and Solar Will Dominate Fossil Fuels

A Record Level of Wind Power Capacity Entered Transmission Interconnection Queues in 2018; Solar and Storage Also Growing



August 30, 2019

<https://pv-magazine-usa.com/2019/08/30/departement-of-energy-shows-wind-and-solar-power-dominating-fossils/>

“Fossil Fuels are Finished.... The Rest is Detail”

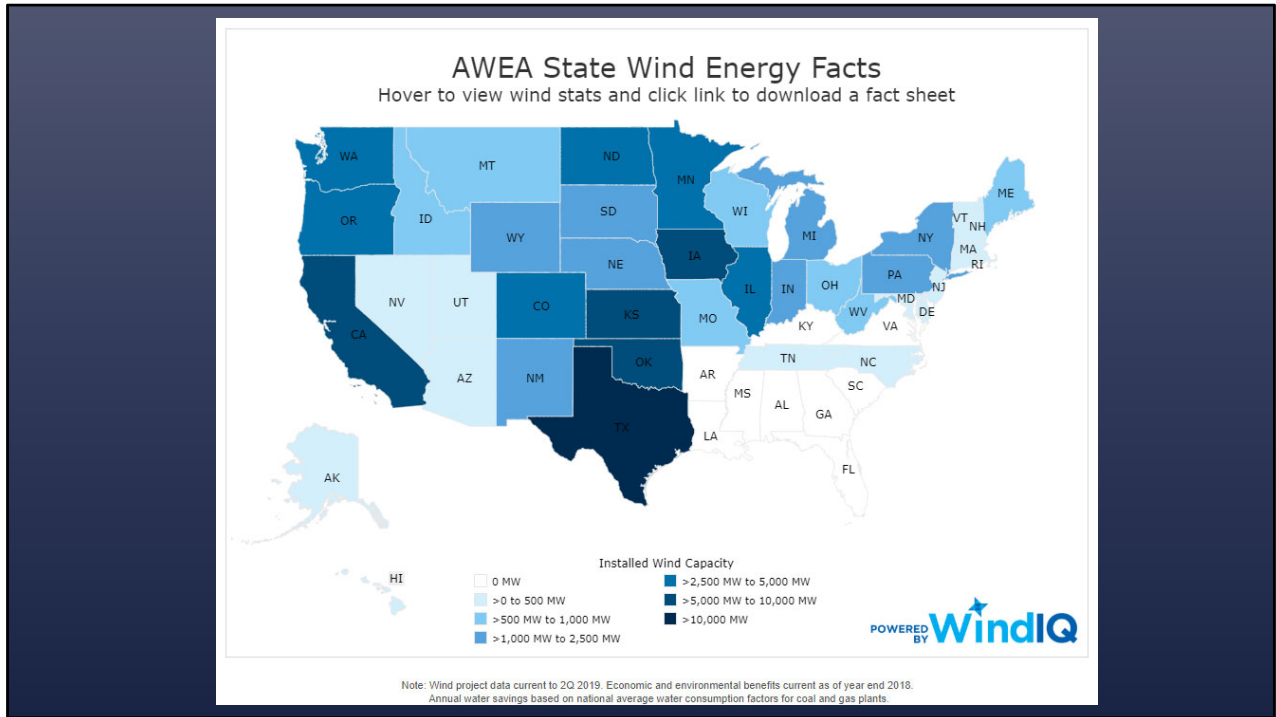
- “The key driver is not... climate change policy.”
- “It’s that ...renewables and batteries, *in a system with electric vehicles*, will behave as a disruptive technology,
- ...delivering ever lower prices and ever higher quality in a decades’ long period of innovation and deployment, which fossil fuels can’t match.”

Paul Gilding, Fossil Fuels are Finished.... The Rest is Detail, Reneweconomy, July 13, 2015

Michael Milken, Sept. 19, 2019: Saving the environment is no longer the only compelling argument for switching to renewable energy, said Michael Milken, chairman of think tank Milken Institute, who pointed out that such energy sources are now cheaper than many fossil fuels.

Today, “for two-thirds of the world, renewables are cheaper than a significant amount of carbon-based energy, so it isn’t just an argument of environment, it’s now just pure economics,” Milken told CNBC at the Milken Institute Asia Summit in Singapore.

<https://www.cnbc.com/2019/09/19/renewable-energy-is-cost-effective-says-michael-milken.html>



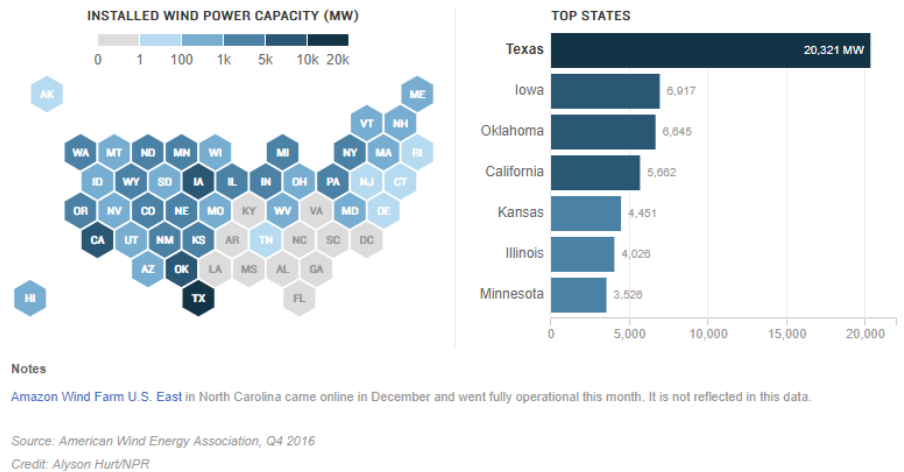
Best, worst ranked states for wind power 2018

<https://www.chooseenergy.com/news/article/best-worst-ranked-states-wind-power/>

American Wind Energy Association, State Facts Sheets 2019

<https://www.awea.org/resources/fact-sheets/state-facts-sheets>

Texas produces more wind energy than the next 3 states combined.

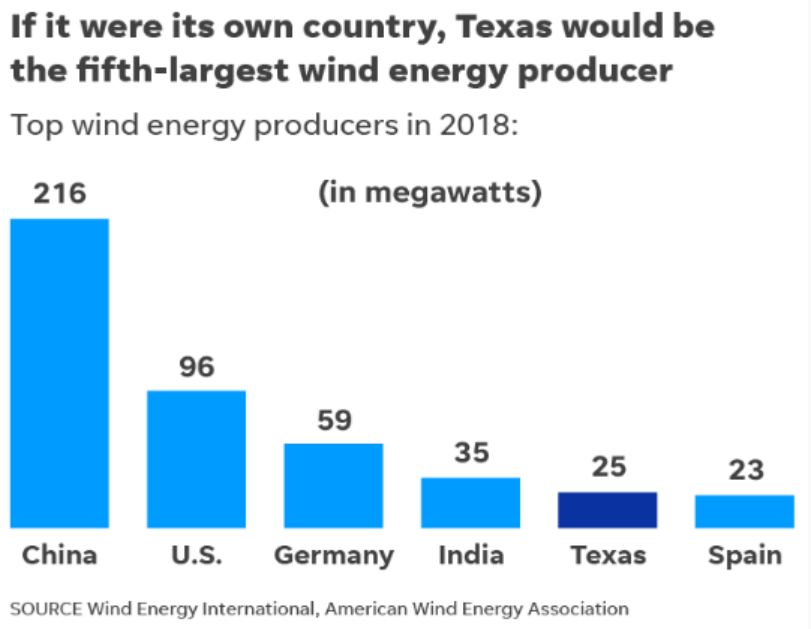


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Wind Energy Takes Flight In The Heart of Texas Oil Country

- If it were a country, Texas would be the [fifth largest wind-producing country](#) in the world (2018, American Wind Energy Association).
 - In 1999, while governor of TX, George W. Bush laid the groundwork for the state's rapid wind energy growth by signing a bill that deregulated the electric sector.
 - Rick Perry oversaw the deregulation effort that established a renewable-energy requirement for wind energy development.
 - In 2005, Perry signed legislation that required Texas to increase its renewable energy capacity to 5,880 megawatts by 2015.
- Rick Perry's energy legacy is more complicated than you think, <https://www.texastribune.org/2016/12/13/recap-rick-perrys-texas-energy-legacy>

USA TODAY: Texas wind energy blows away the competition

<https://www.usatoday.com/story/news/2019/10/18/texas-wind-energy-so-strong-its-beating-out-coal-power/3865995002/>

Michael Milken, Sept. 19, 2019, "The state that has the lowest cost energy, Texas, is the state in the United States that has the largest amount of wind power," said Milken.

Statistics published July 25, 2019 by the Electric Reliability Council of Texas (ERCOT).

Texas wind generation narrowly edged out coal in the first half of this year — a first since the Electric Reliability Council of Texas began tracking the state's fuel mix in 2003.

ERCOT's [Demand and Energy Report](#) shows wind energy contributed 21.78% of the grid's generation through June, compared with 21.37% for coal. Gas-fired resources generated more than 40% of Texas' electricity, with nuclear adding about 10%.

WIND ENERGY IN COLORADO

Pages 17 and 18 were discussed during the presentation and are added here.



Colorado is a national leader in the wind energy industry.

Colorado ranks eighth in the country for installed wind capacity and generates over 17% of its electricity from wind power. There are also 17 manufacturing facilities in the state creating high quality jobs and producing components for the wind industry, including global companies such as wind turbine manufacturer Vestas and steel producer O'Neal Steel. Thanks to companies like these, Colorado ranks third in the nation for wind industry employment. Xcel Energy recently completed the 600 MW Rush Creek Wind Project, injecting \$1 billion into the economy.

BENEFITS Jobs & Economic Benefits

The U.S. wind industry is a major economic development driver. In addition to job creation and billions of dollars in project investment, the wind industry invests heavily in local communities, providing significant revenue in the form of property, state, and local taxes.

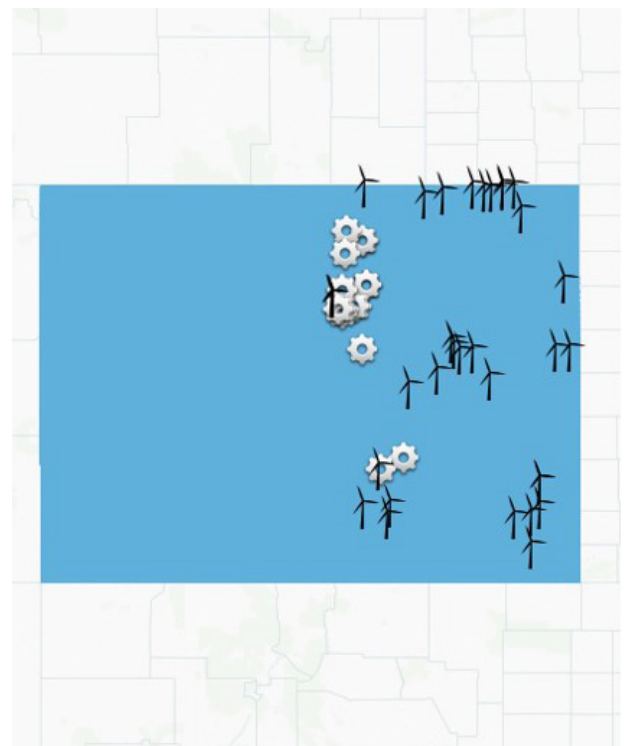
- Direct wind industry jobs in 2018: **7,001 to 8,000**
- Capital investment in wind projects through 2018*: **\$7 billion**
- Annual state and local tax payments by wind projects: **\$10.5 million**
- Annual land lease payments*: **\$10 - \$15 million**

*Source: Based on state and national averages from LBNL, NREL

Wind-Related Manufacturing

Over 500 manufacturing facilities in the U.S. make products for the wind industry, from blades, towers, and turbine nacelles to raw components such as fiberglass and steel.

- Number of active manufacturing facilities in the state: **17**



 Online Wind Project  Wind-related Manufacturing Facility

Wind Projects as of 2Q 2019

- Installed wind capacity: **3,703 MW**
 - » State rank for installed wind capacity: **8th**
- Number of wind turbines: **2,248**
 - » State rank for number of wind turbines: **8th**
- Wind projects online: **26** (Projects larger than 10 MW: 19)
- Wind capacity under construction: **500 MW**
- Wind capacity in advanced development: **463 MW**

Wind Generation

In 2018, wind energy provided **17.3%** of all in-state electricity production.

- State rank for share of electricity: **9th**
- Equivalent number of homes powered by wind in 2018: **944,100**

Wind Energy Potential

- Land-based technical wind potential at 80 m hub height: **395,378 MW**
(Source: AWS Truepower, NREL)
- Offshore net technical wind potential at 100 m hub height: **NA**

Environmental Benefits

Generating wind power creates no emissions and uses virtually no water.

- 2018 annual state water consumption savings*: **3.8 billion gallons**
- 2018 equivalent number of water bottles saved: **29 billion**
- 2018 annual state carbon dioxide (CO₂) emissions avoided: **7.4 million metric tons**
- 2018 equivalent cars' worth of emissions avoided: **1.6 million**

*Based on national average water consumption factors for coal and gas plants.

Renewable Portfolio Standard

The Colorado Renewable Portfolio Standard (RPS) requires investor-owned utilities to provide 30% of their 2020 electricity through renewable energy, large cooperatives (>100,000 customers) to provide 20%, and small cooperatives (<100,000 customers) and municipalities to provide 10%. Wind energy has historically been the renewable resource of choice to meet RPS requirements in Colorado.



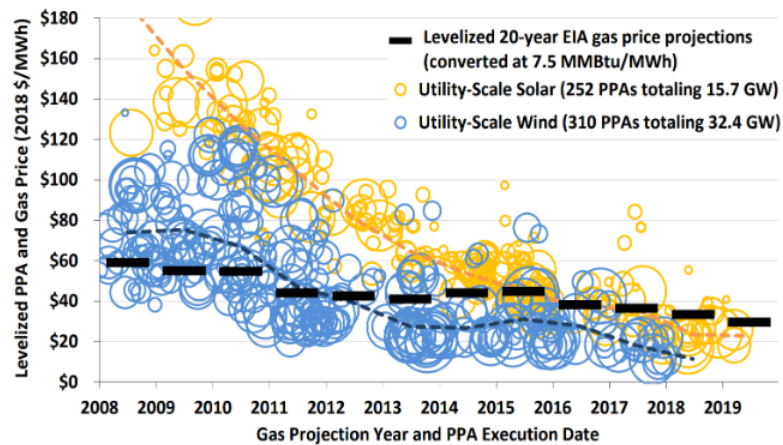


- August 2017 – Xcel (and others) and the State of Colorado reached an agreement known as the **Clean Energy Plan**.
- Xcel agreed to close two older coal plants in Pueblo, if lower-cost alternatives could replace their 660 megawatts, which includes *the added costs for shutting the plants down 10 years early*.
- **Customers would save \$175 million if:**
 - Wind bids came in at \$20 megawatt hour (MWh)
 - Solar bids came in at \$30/MWh.
- Results:
 - >430 bids were received
 - 350 bids just for renewables
 - Median price **WIND ONLY: \$18/MWh**
 - Median price WIND + STORAGE: \$26/MWh
 - Median price **SOLAR ONLY: \$29.50/MWh.**
 - Median price SOLAR + STORAGE : \$36/MWh

- **August 2018 – Xcel** and several other parties reached an agreement known as the Clean Energy Plan to shutter two older coal plants in Pueblo, if lower-cost alternatives could replace their 660 megawatts, which includes *the added costs for shutting the plants down 10 years early*.
- Backers of the plan estimated Xcel’s customers would save \$175 million if wind bids came in at \$20 megawatt hour (MWh) and solar at \$30/MWh.
- More than 430 bids were received with 350 just for renewables. Wind-only bids had a median price quoted of \$18/MWh, meaning half of the bids were below that. Solar only came in at a median price of \$29.50/MWh.

D.O.E: Solar and Wind Costs Versus Natural Gas

Despite Recent Low PPA Prices, Wind Faces Competition from Solar and Natural Gas



August 30, 2019

<https://pv-magazine-usa.com/2019/08/30/department-of-energy-shows-wind-and-solar-power-dominating-fossils/>

Wind power prices now lower than the cost of natural gas
In the US, it's cheaper to build and operate wind farms than buy fossil fuels.

<https://arstechnica.com/science/2019/08/wind-power-prices-now-lower-than-the-cost-of-natural-gas/>

Xcel Energy Aims for Zero-Carbon Electricity by 2050

Company sets new, industry-leading carbon reduction goals

Another sign that zero-carbon energy is going viral



100% clean. | Shutterstock

The energy world got some big news in December: Xcel Energy, one of the **biggest utilities in the US**, committed to going completely carbon-free by 2050 (and 80 percent carbon-free by 2030).

Business Wire, December 4, 2018

<https://www.businesswire.com/news/home/20181204006050/en/Xcel-Energy-Aims-Zero-Carbon-Electricity-2050>

A major US utility is moving toward 100% clean energy faster than expected
Another sign that zero-carbon energy is going viral.

<https://www.vox.com/energy-and-environment/2018/12/5/18126920/xcel-energy-100-percent-clean-carbon-free>

Green Jobs and The Economy

- Data published Oct 15, 2019, indicates that by 2016 the U.S. green economy was generating more than US\$1.3 trillion in *annual* revenue and employed approximately 9.5m people
- In the US, nearly ten times more people were employed in the green economy and its supply chains **than employed directly in the fossil fuel industry** (roughly 1m) – that is, miners, electricity grid workers, infrastructure manufacturers and construction workers
- Between 2013 and 2016, employment in the US green economy grew by 1.5m full-time jobs while coal mining jobs declined by 37,000

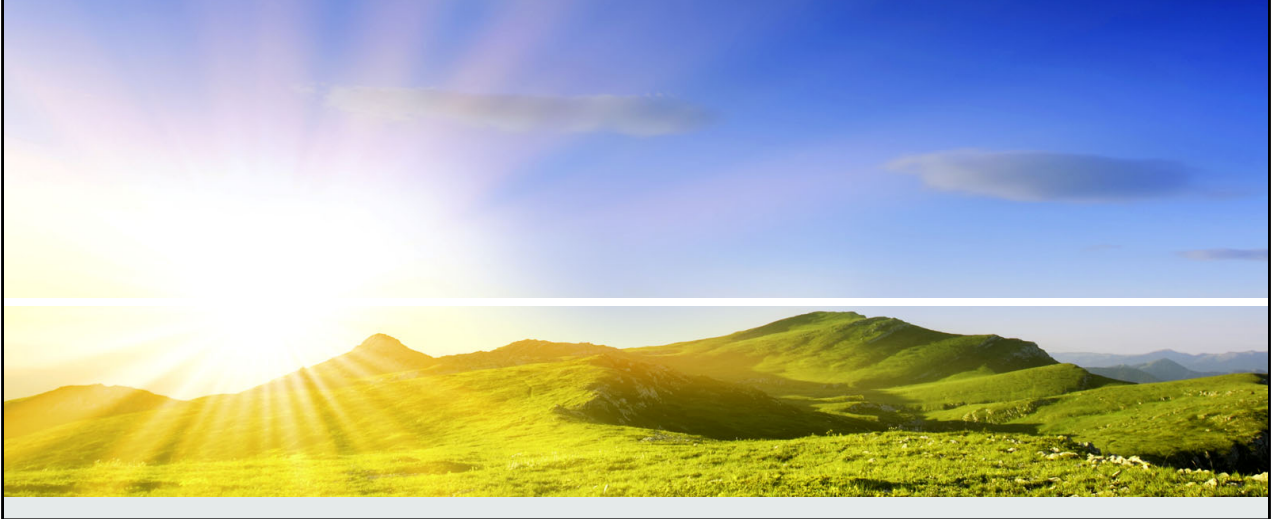
US green economy growth dwarfs Donald Trump's highest hopes for the fossil fuel industry

<https://theconversation.com/us-green-economy-growth-dwarfs-donald-trumps-highest-hopes-for-the-fossil-fuel-industry-123062>

Estimating the scale of the US green economy within the global context

<https://www.nature.com/articles/s41599-019-0329-3>

But There is a Dark Side?



But There Is a Dark Side

- With any business, technology, process, or activity there are environmental, health and safety considerations
- Risks must be evaluated, mitigated, and if possible, eliminated.
- For example:
 - Wind farms kill birds and bats
 - Large scale solar installations impact animal habitat
 - Some solar power plants ignite birds mid-flight killing up to 1000 per year



ISO 14001 Environmental Management System



Environmental Management Systems (EMS) provide a framework that helps an organization achieve its environmental goals through consistent review, evaluation, and continuous improvement of its environmental performance.

An EMS helps an organization address its regulatory demands in a systematic and cost-effective manner.

An EMS can also help address non-regulated issues, such as energy conservation, and can promote stronger operational control and employee stewardship.

ISO 14001 Environmental Management System

Continual Improvement

Checking and Review

- Compliance and Management
- Systems Monitoring
- Corrective and Preventative Actions
- Management Reviews

Policy

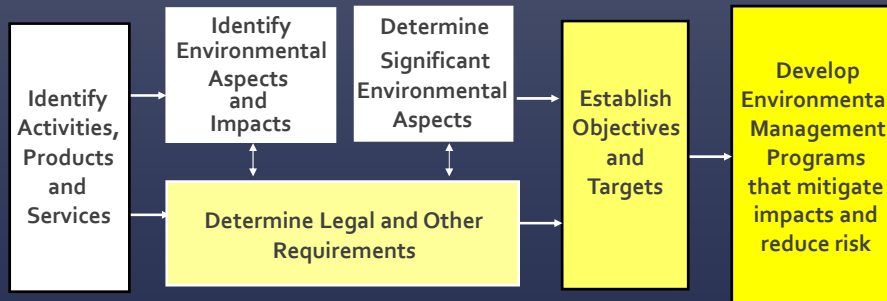
Planning

- Aspects and Impacts Analysis
- Legal and Other Requirements
- Objectives and Targets
- Environmental Programs

Implementation & Operation

- Structure and Responsibility
- Training, Awareness and Competence
- Communication
- Documentation
- Document Control
- Operational Controls
- Emergency Preparedness & Response

EMS* Planning Phase



- An **ASPECT** is an element of your organization's activities, products or services that can interact with the environment
- An **IMPACT** is the change or effect it has on to the environment.

*EMS = Environmental Management System

Life Cycle Analysis (LCA)



LCA is a detailed analysis that provides information needed to make the MOST environmentally responsible decisions throughout:

- Material extraction
- Manufacturing/production
- Product utilization/reuse
- Disposal/recycling
- ...and all of the transportation in between

Think about your cell phone

Material extraction: environmental, safety and social issues

Manufacturing/production: energy, air emissions, water impacts, chemical handling and storage, packaging, safety

Utilization/reuse: Health impacts, energy, combustible metals

Disposal/recycling: Hazardous materials, disposal of packaging, non-recyclables

Aspects and Impacts of Renewable Energy

Wind

- **Biological Impacts (High)**
 - Avian/bat collisions
 - Research into collisions, bird and bat behavior, mitigation measures, and design protocols
 - Careful site selection/Biologic studies
 - Endangered Habitat and Plants
 - Careful site selection/Biologic studies
- **Waste Management (High)**
 - Blade and Turbine disposal/recycling
- **Human Health Impacts (Moderate – High)**
 - Noise - Low frequency sound
 - Proper siting
 - Modify design
 - Use Insulating Materials
- **Aesthetic Impacts (Moderate)**
 - Visual Impacts
 - Proper siting
 - Use fewer, larger and more efficient units
- **Air and Water Quality (Low)**
 - Transportation exhaust
 - Low-sulfur fuel
 - Ultimately use EVs
 - Stormwater runoff (during construction)
 - Regulatory compliance activities

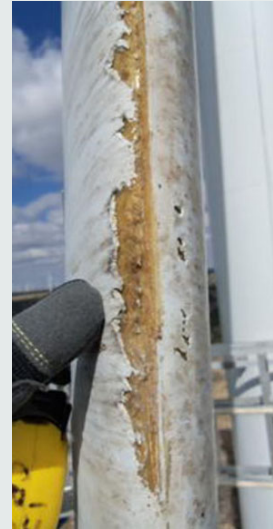
Solar (Utility Scale and Distributed)

- **Human Health Impacts (High)**
 - Mining of metals, silica
 - Use conflict free sources
 - Use of numerous hazardous chemicals and metals in manufacturing
 - Choose safer technologies, processes, and materials
 - Use of proper health and safety practices
 - Personnel training
- **Waste Management (Moderate – High)**
 - Generation of hazardous wastes
 - Panel and battery disposal/recycling
- **Biological Impacts (Moderate)**
 - Endangered Habitat and Plants
 - Careful site selection/Biologic studies
- **Natural Resource Depletion (Moderate)**
 - Land use and mineral depletion
- **Aesthetic Impacts (Low – Moderate)**
 - Visual Impacts
 - Proper siting
- **Air and Water Quality (Low, See Wind)**

When evaluating impacts, you must look at the entire supply chain from the mining and manufacturing phase, through transport, receipt, handling and storage, maintenance, decommissioning and ultimately, disposal.

Waste Disposal and Recycling – Turbines & Blades

- The average lifespan of a wind turbine is 20 to 25 years.
- Wind farms repurpose and recycle 90 percent of the materials in a wind turbine unit.
- Materials that are not recycled:
 - Fiberglass blades (100 to 300 feet long)
 - Motor housings
- “Researchers estimate the U.S. will have more than 720,000 tons of blade material to dispose of over the next 20 years
 - ...that doesn't include newer, taller, higher-capacity versions.”



NPR, Sept 10, 2019

Unfurling The Waste Problem Caused By Wind Energy

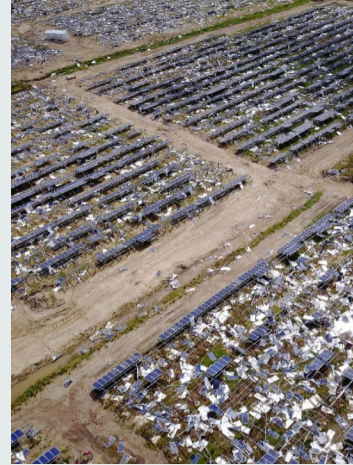
<https://www.npr.org/2019/09/10/759376113/unfurling-the-waste-problem-caused-by-wind-energy>



Motor housings

Waste Disposal and Recycling – Solar

- Solar panels generally last about 20-30 years
- Currently, much of the waste is generated when a severe storm or hurricane damages large numbers of panels
- “There is a problem now, and it’s only going to get larger, expanding as rapidly as the PV industry expanded 10 years ago.”
- There will be an estimated 60 million tons of cumulative solar photovoltaic waste by 2050
- Recycling is expensive, as is the transportation of cells to recycling facilities



Hurricane Maria destroyed a solar panel field in Puerto Rico

The Environmental Disaster of Solar Energy

<https://www.americanexperiment.org/2019/08/environmental-disaster-solar-energy/>

Center of the American Experiment is Minnesota’s leading public policy organization. The Center is more than a think tank. It not only researches and produces papers on Minnesota’s economy, education, health care, the family, employee freedom and state and local governance. It also crafts and proposes creative solutions that emphasize free enterprise, limited government, personal responsibility and government accountability.

Aspects and Impacts of Renewable Energy

Batteries

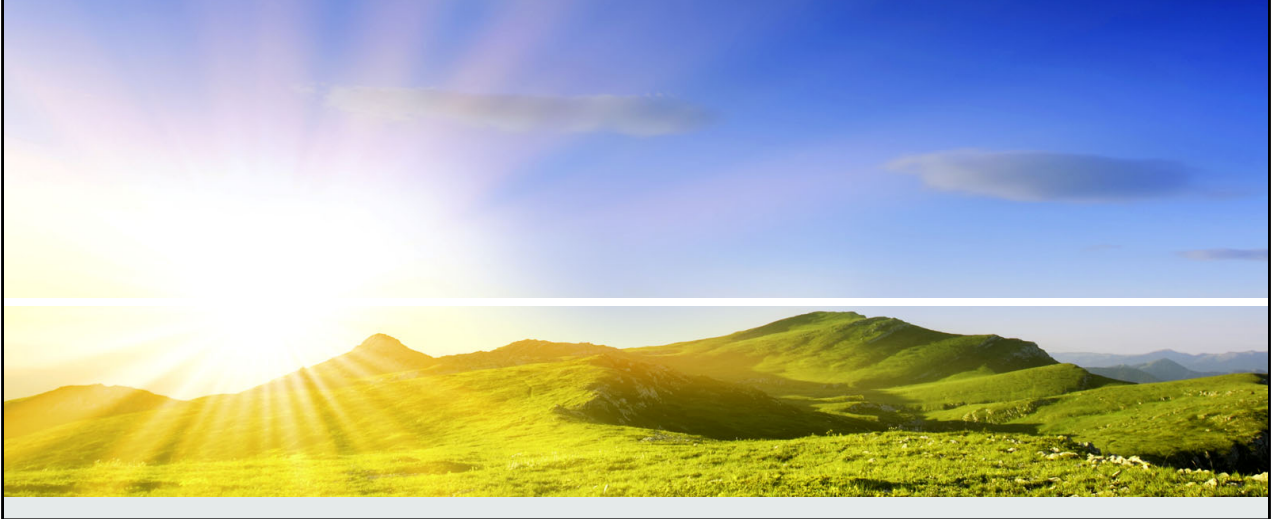
- **Human Health Impacts (High)**
 - Mining of metals, heavy metals
 - Control exposure through:
 - Use of proper health and safety practices
 - Personnel training
 - Use of numerous hazardous chemicals and metals in manufacturing
 - Choose safer technologies, processes, and materials
 - Use of proper health and safety practices
 - Personnel training
 - Generation of hazardous wastes
- **Waste Management (High)**
 - Generation of hazardous wastes
 - Battery disposal/recycling (5-15 yr. lifespan)
- **Societal Impacts (High)**
 - Human rights violations
 - Security risks and violent conflict
 - Use only conflict-free sources
- **Air and Water Quality (High)**
 - Dust and fumes from Cobalt and heavy metal mining
 - High water use/Water pollution
 - Toxic spills from mining operations
- **Energy Use (High)**
- **Resource Depletion (High)**

Transmission of Electricity

- **Ecological Impacts (High)**
 - Displaced species
 - Endangered Habitat and Plants
 - Degradation of habitat
 - Removal of vegetative cover
 - Biologic studies /Careful siting
- **Natural Resource Depletion (Moderate)**
 - Land Used
- **Aesthetic Impacts (Moderate)**
 - Visual Impacts
 - Proper siting
- **Air and Water Quality (Low)**
 - Transportation exhaust
 - Low-sulfur fuel
 - Ultimately use EVs
 - Stormwater runoff (during construction)
 - Regulatory compliance activities
- **Waste Management (Low)**
 - Disposal/recycling of decommissioned materials most of which is recycled
- **Safety/Fire Risk (High)**

Mention Safety and Fire Risk associated with transmission and distribution of electricity.

Environmental and Social Impacts of the Renewable Energy Supply Chain



"100% Renewable Energy Isn't Very Green"

- "Historically, batteries for electric cars and phones were the primary driver of accelerated minerals demand. This need has only increased with the advent of battery storage for renewable energy."
- "Creating the infrastructure to rely on 100% renewable energy, electric vehicles, and battery storage dramatically increases the need for metals" including:
 - Cobalt, nickel, lithium, copper, aluminum, silver, and rare earth metals
- "Minerals extraction already exacts significant cost on people and the environment, *fueling conflict and human rights violations, massive water pollution, and wildlife and forest destruction.*"
- "A spike in demand for metals could drain the planet's reserves and lead to dire social and environmental consequences."

Jane Easton, University of Technology, Sydney, Earthworks, April 17, 2019

REPORT: Clean Energy Must Not Rely on Dirty Mining

New research exposes extent of mineral demand for clean technologies

<https://earthworks.org/media-releases/report-clean-energy-must-not-rely-on-dirty-mining/>

“100% Renewable Energy Isn’t Very Green”

- “Cobalt, lithium and rare earth metals are of greatest concern for the need for increasing clean tech and supply risks.”
- “As much as 60% of cobalt comes from the Democratic Republic of Congo.”
 - The DRC has been charged with using child labor in unsafe conditions in its mines.
- “Moving toward a 100% renewable energy future will increase demand for metals”:
 - Lithium by 280% (2.8 times current production levels)
 - Nickel by 136% (1.36 times current production levels)
- This year in Brazil, two tailings dams failed at Vale’s Brumadinho mine that produces iron ore and nickel killed 247 workers and local residents with 23 still missing.

Jane Easton, University of Technology, Sydney, Earthworks, April 17, 2019



Freeport's Chino copper mine in New Mexico is one of the largest copper producers in the United States



Codelco's Chuquibambilla Copper Mine in Calama, Chile -- the world's largest copper mine



Lithium mine at Salinas Grandes salt desert, Jujuy province, Argentina



Tantalum (Ta)/Niobium (Nb)
child miners in Congo



Child miner Eastern Congo



Mining cobalt by hand, Congo

Tantalum is dense, ductile, very hard, easily fabricated, highly conductive of heat and electricity and resistant to corrosion by acids.

Cobalt may cause an asthma-like allergy. Further exposure can cause asthma attacks with shortness of breath, wheezing, cough, and/or chest tightness. Cobalt may affect the heart, thyroid, liver and kidneys. Repeated exposure to Cobalt dust can cause scarring of the lungs (fibrosis) even if no symptoms are noticed.

Tantalum exposure happens by skin contact, ingestion, and inhalation and may cause respiratory problems and skin and eye irritation. **Health hazards** and dangers include dangers of explosion, inhalation, and exposure.

Tantalum Atomic Number: 73



Gold, tin, tantalum and tungsten miners work in a wide region covering parts of the eastern Democratic Republic of Congo, northwest Uganda, southern areas of South Sudan, and Rwanda. Workers as young as 10 dig in an environment lacking health or safety standards, often with only handheld tools.

Tristan Rayner, Android Authority, July 15 2018

You wouldn't buy a blood diamond, but do you own a conflict phone?

<https://www.androidauthority.com/conflict-minerals-883973/>

Making Green Energy Clean, Just & Equitable

- Recycled sources can significantly reduce primary demand.
- Responsible sourcing is needed when supply can not be met by recycled sources.
- *"[A] responsible materials transition will need to be scaled up just as ambitiously as the 100% renewable energy transition."*
- "The renewable energy transition will only be sustainable if it ensures human rights for communities where the mining takes place."

Earthworks, April 16, 2019

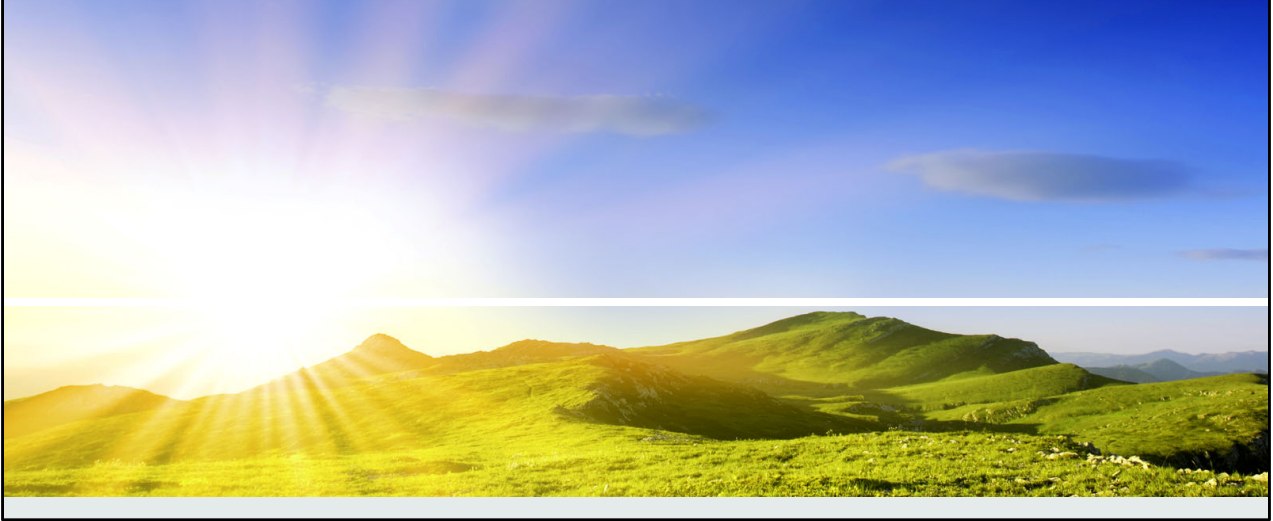
Making Green Energy Clean, Just & Equitable

- This will require a concerted commitment from businesses and governments to:
 - Dramatically scale up the use of recycled minerals,
 - Use materials more efficiently, and
 - *Require mining operations to adhere to stringent, independent environmental and human rights standards.
- *There is an urgent need to invest in recycling and reuse schemes to ensure metals used in these technologies are recovered, so only what is necessary is mined.*
- If manufacturers commit to responsible sourcing, this will encourage more mines to engage in responsible practices and certification.

Earthworks, April 16, 2019

Recycling cobalt is feasible but expensive. One article I read stated that recycled cobalt is about 5 times more expensive than freshly mined cobalt.

Disruptive Technologies



Disruptive Technologies – Mobile Phones

- Initially experts totally underestimated the sales of mobile phones.
- In the 1990s, AT&T was advised to expect 900,000 mobile subscribers by 2000.
- They were off by 108,000,000.
- By 2014 there were more mobile phones on earth than all 7 billion people.
- The telephone industry underwent massive change and thousands of new companies arose to take advantage of the new technology and new business models.

Tony Seba, "Clean Disruption of Energy and Transportation", May 20, 2014

Clean Disruption of Energy & Transportation

The industrial age of energy and transportation will be over by 2030. Maybe before.

<https://tonyseba.com/portfolio-item/clean-disruption-of-energy-transportation/>

A Disorderly Transition to Renewables

- Time is not on the side of fossil industries and this *represents a significant threat to the global economy*.
- The natural gas industry is reeling as the political climate begins to shift against the industry *faster and earlier* than many expected.
- This year, *Berkeley, California became the first U.S. city to ban new natural gas hookups* in new buildings; and dozens of other cities are either banning new natural gas hookups (Basalt, CO) or exploring similar prohibitions.
- Several industry executives in the past few weeks have made references to *gas becoming the new coal*.

Charlie Riedl, executive director of industry trade group Center for Liquefied Natural Gas

Might the fossil fuel industries implode faster than the clean energy industries can grow to replace them?
<https://jeremyleggett.net/2016/08/03/state-of-the-transition-july-2016-might-the-fossil-fuel-industries-implode-faster-than-the-clean-energy-industries-can-grow-to-replace-them/>

A Draconian Crackdown Looms Over Natural Gas

<https://oilprice.com/Energy/Energy-General/A-Draconian-Crackdown-Looms-Over-Natural-Gas.html>

The Guardian: BlackRock lost \$90bn investing in fossil fuel companies, report finds.

<https://www.theguardian.com/environment/2019/jul/31/blackrock-lost-90bn-investing-in-fossil-fuel-companies-report-finds>

A Burning Question for Coal's Brightest Star

India is the world's fastest-growing market for the fossil fuel. So why are investors fleeing?

<https://www.bloomberg.com/opinion/articles/2019-08-16/a-burning-question-for-coal-s-brightest-star>

As many as 65 gigawatts of the 90GW of private-sector generators in India are under financial stress, [according to a parliamentary report](#) in 2018. The resulting [1.8 trillion rupees \(\\$26 billion\) in bad loans](#) is contributing to a nonperforming asset crisis that risks undermining the Indian financial system.

Financial lending to coal-fired power fell 90% in 2018, to 60 billion rupees from 608 billion rupees the previous year. In India, 65% of funding to coal-fired projects in 2018 came from government-controlled institutions, whereas three-quarters of loans to renewables came from the private sector

MarketWatch: Whiting Petroleum, Chesapeake Energy stock plunges highlight energy sector selloff.

<https://www.marketwatch.com/story/whiting-petroleum-chesapeake-energy-stock-plunges-highlight-energy-sector-selloff-2019-08-01>

The Guardian: Rise of renewables may see off oil firms decades earlier than they think.

<https://www.theguardian.com/environment/2019/oct/14/rise-renewables-oil-firms-decades-earlier-think>

A Disorderly Transition to Renewables

- “If large institutional financial banks stop funding fossil fuel companies, that's going to be a real challenge,”
 - Charlie Riedl, executive director of industry trade group Center for Liquefied Natural Gas
- There are signs we are in a fossil industries bubble and are creeping closer to a second recession. One that potentially could be much worse than what followed the housing bubble.
- ...because governments and central banks have exhausted their resources to bail out failing banks, companies and countries.

But it will be a far bigger deal economically

Might the fossil fuel industries implode faster than the clean energy industries can grow to replace them?

<https://jeremyleggett.net/2016/08/03/state-of-the-transition-july-2016-might-the-fossil-fuel-industries-implode-faster-than-the-clean-energy-industries-can-grow-to-replace-them/>

Forbes: Why Energy Storage Is Proving Even More Disruptive Than Cheap Renewables.

<https://www.forbes.com/sites/jeffmcmahon/2019/08/02/why-energy-storage-is-proving-even-more-disruptive-than-cheap-renewables/>

A Disorderly Transition to Renewables

- The transition is happening so fast that fossil industries may implode before renewables are ready to take its place.
- Reasons for concern:
 - Chinese retreat from coal
 - The divestment of fossil industry stocks
 - The bankruptcies of coal (Peabody) and oil companies around the planet
 - The fall of oil prices and the rising costs of extraction
 - The fall of Venezuela

Jeremy Leggett, State of the Transition: Might the Fossil Fuel Industries Implode Faster than the Clean Energy Industry Grow to Replace Them?

COVER NOTES BELOW

A Finer Future: It is essential that a just transition be found for mining companies and all of the workers abandoned by the fossil industry.

Resource extraction has massive impacts for the environment. Due to regulation, fossil industries have been allowed to self-bond for cleanup costs.

Peabody coal, previously the world's largest coal miner, is expected to default on its environmental obligations and on lease payments to various governments

Might the fossil fuel industries implode faster than the clean energy industries can grow to replace them?

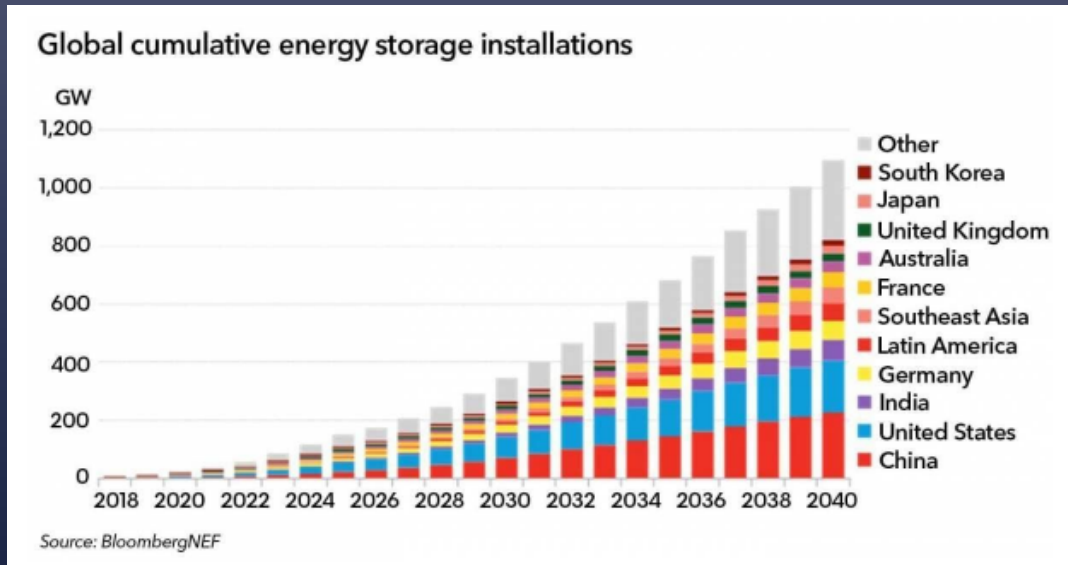
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A Disorderly Transition to Renewables

- Big electric utilities burning fossil fuels face the risk of batteries solving the intermittency problem of wind and solar.
- If batteries start supplying peaking power, gas peaker plants will not be able to compete and gas generation will not be far behind.
- It also endangers financial institutes like banks and insurance companies.
 - A quarter of all corporate debt is related to utility and car industry bonds tied to fossil fuel.

Forbes: Why Energy Storage Is Proving Even More Disruptive Than Cheap Renewables.
<https://www.forbes.com/sites/jeffmcmahon/2019/08/02/why-energy-storage-is-proving-even-more-disruptive-than-cheap-renewables/>

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The Profound Transformation Begins

- In 2012, “Tesla... sells \$10 billion worth of orders in one day for cars that would not be built for at least a year.”
- By spring 2017, the company’s market cap exceeded \$52.7 billion
 - Besting both Ford and GM who together produce 500 times as many cars.
- Tesla’s Master Plan states that it is not a car company or a battery company. It’s an integrated energy company.



Tesla Giga Factory

The Tesla Gigafactory 1 is a lithium-ion battery and electric vehicle subassembly factory near Reno, Nevada. The facility is owned and operated by Tesla, Inc. to supply the battery packs for its electric vehicles and stationary storage systems

The Profound Transformation

- Transportation accounted for 55% of oil use in 2014
- In 2009, there were no EVs on the road. Today there are more than 2 million.
- “Plunging prices for batteries and renewables are driving an electric vehicle (EV) revolution so rapidly that the economics of oil “are now in a relentless and irreversible decline.”
- Bloomberg believes EVs will constitute half the cars on the road by 2040. (OPEC predicted 1%)

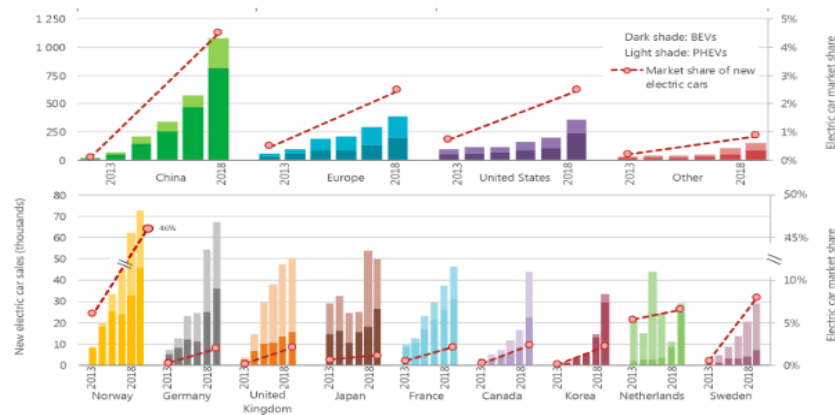
ThinkProgress: One of the world’s largest banks thinks the writing is on the wall for the oil industry.

<https://thinkprogress.org/oil-faces-irreversible-decline-thanks-to-electric-cars-and-solar-warns-worlds-8th-largest-bank/>

“Within a few years, electric vehicles (EVs) will be [superior to gasoline powered cars](#) in every respect. In part, that’s because electric motors are vastly more efficient than gasoline engines. And it’s also in part because solar and wind power and batteries have seen staggering price drops in the past decade — and are projected to see equally big drops in the coming years.”

The Profound Transformation

Global electric car sales and market share, 2013-18



Source: IEA analysis based on country submissions, complemented by ACEA (2019); EAFO (2019); EV Volumes (2019); Marklines (2019); OICA (2019).

Global EV Outlook 2019

Scaling up the transition to electric mobility

<https://www.iea.org/publications/reports/globalevoutlook2019/>

One last nail...



Clean Disruption of Energy & Transportation

The industrial age of energy and transportation will be over by 2030. Maybe before.

<https://tonyseba.com/portfolio-item/clean-disruption-of-energy-transportation/>

One last nail...

- Another disruptive technology – driverless cars and trucks
- Transportation as a Service (Uber and Lyft) has already become a significant and very popular new business model
 - Many urban dwellers see no need for a personal vehicle
- When a new technology has enabled a tenfold savings, it has driven disruption of the dominant industry. (Tony Seba)
- Using driverless cars, transportation as a service is estimated to be *10 times cheaper than current ownership* of internal combustion cars.

Clean Disruption of Energy & Transportation

The industrial age of energy and transportation will be over by 2030. Maybe before.

<https://tonyseba.com/portfolio-item/clean-disruption-of-energy-transportation/>

The End?

- The convergence of four key disruptive technologies and business models make a renewable world inevitable:
 1. The fall of the cost of wind and solar electric generation
 2. The fall of the cost of batteries
 3. The electric car
 4. Driverless cars

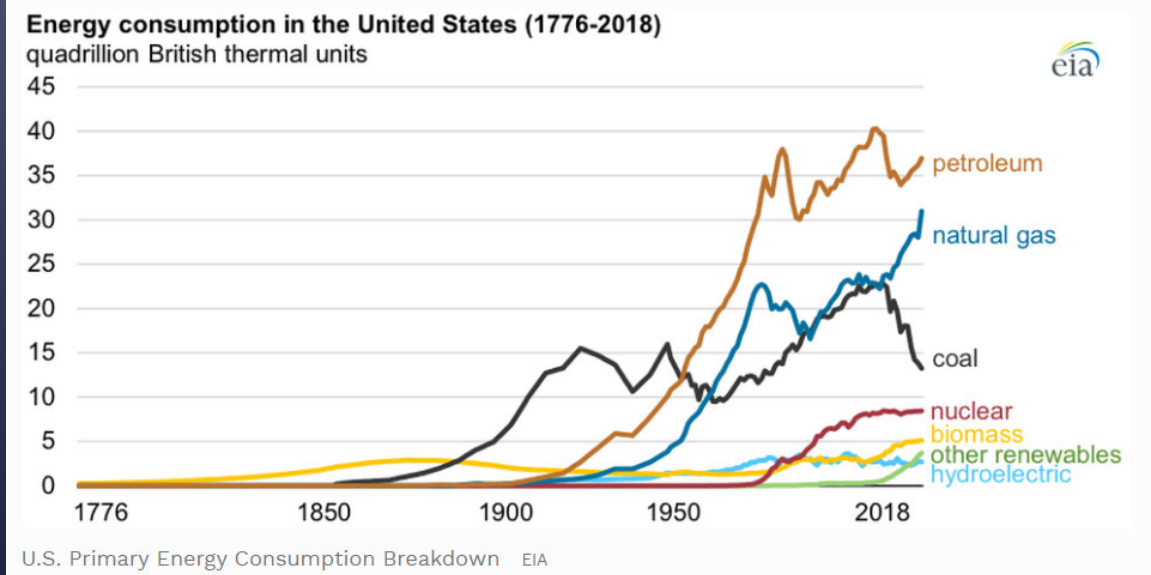
Unless managed well, the changes that are already upon us will lead to an economic collapse on a scale never seen, coming at us in about 10 years.

A Finer Future, Chapter 10

ThinkProgress: Renewables are winning the economics battle against new coal and gas, stunning study shows.

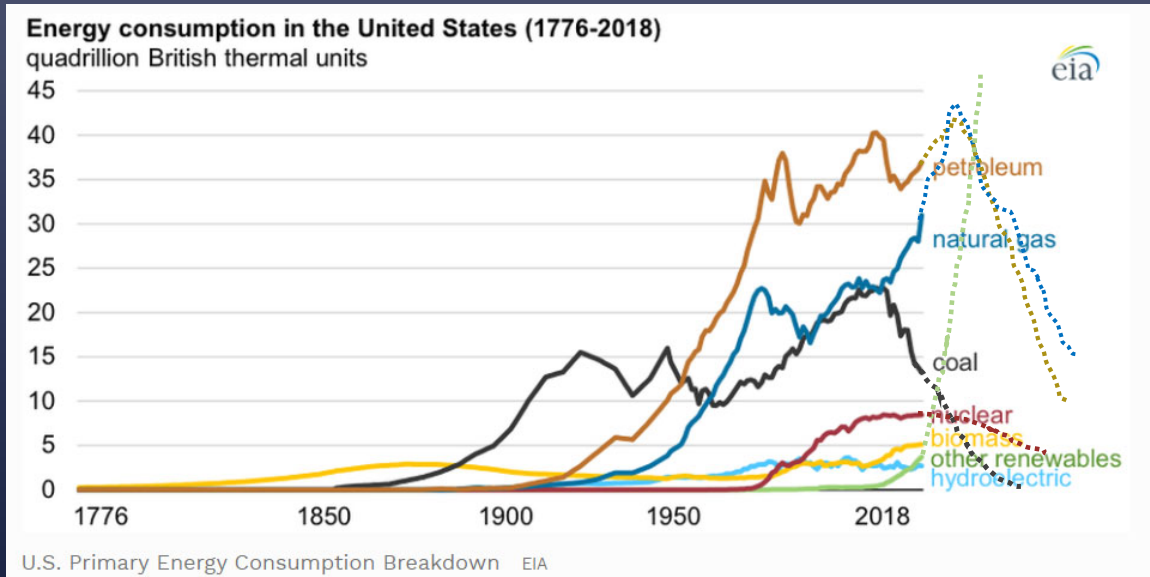
<https://thinkprogress.org/renewables-now-cheaper-than-new-coal-or-gas-across-two-thirds-of-the-world-c4980412cb53/>

The End?



The Guardian: Rise of renewables may see off oil firms decades earlier than they think.
<https://www.theguardian.com/environment/2019/oct/14/rise-renewables-oil-firms-decades-earlier-think>

The End?



Discuss the next 10 years.

Coal goes to near zero, oil and natural gas follow the documented trend of coal. When these curves reach peaks is uncertain. If renewables rise as quickly as cell phone use did, it may happen faster than expected, stranding the assets of all other forms of energy.

The Guardian: Rise of renewables may see off oil firms decades earlier than they think.
<https://www.theguardian.com/environment/2019/oct/14/rise-renewables-oil-firms-decades-earlier-think>

The End?

- If the predictions discussed play out, it could mean trillions of dollars worth of stranded assets, the dissolution in value, diminished presence, and possibly complete loss, of the following industries:
 - Oil, gas, coal, uranium, and nuclear industries and all of the supporting services including extraction, mining, and transportation-related services;
 - Utilities, independent power producers;
 - The automotive and trucking industries;
 - Banks that hold loans for these industries; and
 - Insurance companies that are invested in these industries.

John Fullerton's article "Big Choice" 2011, states:

"Given that the fossil assets are on the balance sheets of some of the world's wealthiest companies and sovereign wealth funds of the nations of the world, this implies a write-off at least 20 trillion dollars in stranded assets*.

In contrast, the 2008 financial collapse was triggered by the stranding of only 2.7 trillion in mortgage assets.

This an order of magnitude greater disruption.

[Stranded asset - https://en.wikipedia.org/wiki/Stranded_asset](https://en.wikipedia.org/wiki/Stranded_asset)

Stranded assets are "assets that have suffered from unanticipated or premature write-downs, devaluations or conversion to liabilities". ... In this context, **stranded assets** are also **defined** as an **asset** that has become obsolete or non-performing, but must be recorded on the balance sheet as a loss of profit.

The End?

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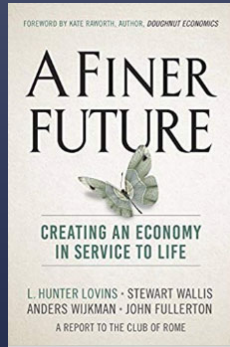
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A Finer Future



While “A Finer Future” provides solutions to the economic issues presented, it takes you beyond the solution into a regenerative economy that will:

1. *“Enable all people to achieve a flourishing life within ecological limits.”*
2. *“Deliver universal well being as we meet the basic needs of all humans.”*
3. *“Deliver sufficient equality to maintain social stability and provide the basis for genuine security.”*

Thank You!

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