Energy Poverty and the Real Energy Transition
What does “little to no energy” really mean?
Annual Energy Consumption

Per Capita kWh/year

- Ethiopia: 52
- Tanzania: 78
- Liberia: 79
- Nigeria: 136
- Kenya: 156
- Ghana: 300
- My Fridge: 459

Source: IEA, 2010
How Prevalent is Energy Poverty?
Electricity and Clean Cooking


Each Color ~ 1 Billion People
Is Energy Poverty Tied to Economic Poverty?
Economic Poverty and Energy Poverty

Circles sized by total population

A Paradox
Energy does not end poverty, but you can’t end poverty without energy.

Sources: World Bank; IEA; World Energy Outlook 2015
Limited Access to Electricity Restricts Standard of Living

Source: World Bank Databank
Limited Access to Electricity Restricts Standard of Living

> 2.5 billion people

Source: World Bank Databank
Limited Access to Electricity Propagates Inequality

Switch

4.5 billion

2040

Switch On

2.5 billion

GDP PER CAPITA, PPP CURRENT INTERNATIONAL $

Source: World Bank Databank
It’s Time to Power the People
What Will it Take to Power the People?
The Global Energy Mix

Global Energy 2017

- 85% fossils
- 28% petroleum
- 23%
- 7%
- 4%
- 1%
- 2%
- 1%

Global Population
Each color on the map represents ~ 1 billion people

Data: BP Statistical View of World Energy (2016)
The world could be wind, water and solar in 50 years if just for political will…

Global Energy (MTOE)

Population and Energy

Data: BP Statistical View of World Energy (2016)
Source: From the UN, as appeared in The Economist, August 23, 2014
The world could be wind, water and solar in 50 years if just for political will...
Global Energy 2065

Business as Usual?

What About CO$_2$?
# Global Anthropogenic CO₂ Emissions

2014, Total 48 Billion Tonnes

<table>
<thead>
<tr>
<th>Sector</th>
<th>Emissions (Billion Tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron &amp; Steel</td>
<td>2.3</td>
</tr>
<tr>
<td>Cement</td>
<td>2.2</td>
</tr>
<tr>
<td>Other Industry</td>
<td>2.2</td>
</tr>
<tr>
<td>Light road</td>
<td>4.8</td>
</tr>
<tr>
<td>Heavy road</td>
<td>2.5</td>
</tr>
<tr>
<td>Heating buildings</td>
<td>1.6</td>
</tr>
<tr>
<td>Chemicals</td>
<td>1.1</td>
</tr>
<tr>
<td>Aluminum</td>
<td>0.3</td>
</tr>
<tr>
<td>Paper</td>
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<tr>
<td>Air</td>
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<tr>
<td>Shipping</td>
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<tr>
<td>Rail</td>
<td>0.2</td>
</tr>
<tr>
<td>Power Generation</td>
<td>13.6</td>
</tr>
<tr>
<td>Water Heating</td>
<td>0.6</td>
</tr>
<tr>
<td>Cooking</td>
<td>0.5</td>
</tr>
<tr>
<td>Other</td>
<td>0.6</td>
</tr>
<tr>
<td>Forestry, Agriculture, Land use</td>
<td>~12</td>
</tr>
</tbody>
</table>

Data: International Energy Agency

Tinker 2019
Don’t blame Asia! They make products for the world.
Carbon Pricing Initiatives

Source: World Bank
Change in CO₂ Emissions
2017, million tonnes

Largest Reductions
- United States
- Ukraine
- Mexico
- Britain
- South Africa

Largest Increases
- Iran
- European Union
- Turkey
- India
- China

Source: BP Statistical Review of World Energy, 2018
How the Heck Did This Happen?
Electricity Generation
Natural Gas v. Coal 1985-2017

Source: BP Stats Review 2018
Total Primary Energy Supply (TPES)

2017 Energy Source (Mtoe)

People’s Rep. of China
- Coal: ~15%
- Oil: ~16%
- Natural gas: ~69%

United States
- Coal: ~16%
- Oil: ~38%
- Natural gas: ~45%

India
- Coal: ~38%
- Oil: ~16%
- Natural gas: ~15%
- Renewables: ~45%

Russian Federation
- Coal: ~15%
- Oil: ~16%
- Natural gas: ~38%

Japan
- Coal: ~16%
- Oil: ~15%
- Natural gas: ~45%
- Renewables: ~38%


1. In this graph peat and oil shale are aggregated with coal.
2. Other includes nuclear, electricity trade, heat, non-renewable waste.
Electric Power Sector U.S. CO₂ Emissions

By 2017 the U.S. had Achieved 75% of its 2030 Paris Accord Targets

- **Shale Gas**
- **Renewable Policy**
- **Coal Pressure**
- **Lower Demand (efficiency, exporting manufacturing)**

Source: EIA

After Jim Sweeney, 2015. Data: EIA
But What About Cars?
Global Anthropogenic CO₂ Emissions
2014, Total 48 Billion Tonnes

Industry
Transportation

Heating
Power
Other

Forestry
Agriculture
Land Use

Data: International Energy Agency
<table>
<thead>
<tr>
<th></th>
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<tbody>
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<td>Brazil</td>
<td>4.5</td>
<td>2.5</td>
<td>3.5</td>
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<td>3.0</td>
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<tr>
<td>Russia</td>
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<td>0.0</td>
<td>QAe5762</td>
<td></td>
</tr>
<tr>
<td>Indonesia</td>
<td>4.5</td>
<td>2.5</td>
<td>3.5</td>
<td>2.0</td>
<td>3.0</td>
<td>4.0</td>
</tr>
<tr>
<td>India</td>
<td>0.5</td>
<td>1.5</td>
<td>1.0</td>
<td>0.0</td>
<td>QAe5762</td>
<td></td>
</tr>
</tbody>
</table>

Source: National car data, Macquarie Research, January 2017
Auto Sales Developed Nations
Rolling 12-month (million)

Source: National car data, Macquarie Research, January 2017
Cumulative Electric-Vehicle Forecasts

I didn’t have any accurate numbers so I just made up this one.

Studies have shown that accurate numbers aren’t any more useful than the ones you make up.

How many studies showed that?

Eighty-seven.

Source: Bloomberg New Energy Finance, Economist.com; EIA, WEO, 2017
Battery Mining

Lithium and Cobalt Production (Thousand Tonnes)

Global Final Consumption by Sector

Electricity

Electricity TFC by sector (Mtoe)


1. Includes agriculture, fishing and non-specified other.
Where Will We Get the Electricity for EVs and Growing Global Demand?
Global Anthropogenic CO$_2$ Emissions

2014, Total 48 Billion Tonnes

- Industry
- Transportation
- Heating
- Power
- Forestry
- Agriculture
- Land Use
- Other

Data: International Energy Agency
Global Electricity Generation
By Region

World electricity generation\(^1\) from 1971 to 2015 by region (TWh)

- **Africa**
- **Non-OECD Americas**
- **Non-OECD Asia\(^2\)**
- **China**
- **Non-OECD Europe and Eurasia**
- **Middle East**
- **OECD**


1. Excludes electricity generation from pumped storage.
Source: Emerging Trends in Electricity Consumption for Consumer ICT, Peter Corcoran and Andres Andrae (2013) and CIA World Factbook. China/Russia/Canada figures are from 2014.
Global Electricity Generation by Source

World electricity generation\(^1\) from 1971 to 2015 by source (TWh)

- Non-hydro renewables and waste\(^2\)
- Hydro
- Nuclear
- Fossil thermal

1. Excludes electricity generation from pumped storage.
2. Includes geothermal, solar, wind, tide/wave/ocean, biofuels, waste, heat and other.

Global Solar Photovoltaic Electricity

United States
Solar photovoltaics

Source: Economist, Solar Energy Industries Association

Average Module Price $ / watt

1. Non-OECD Asia excludes China.
Global Wind Electricity

Growth in U.S. Wind Generation
2000–2014

Million Kwh

1. Non-OECD Asia excludes China.
Global Electricity Generation by Source

World electricity generation\(^1\) from 1971 to 2015 by source (TWh)

- **Non-hydro renewables and waste\(^2\)**
- **Hydro**
- **Nuclear**
- **Fossil thermal**

1. Excludes electricity generation from pumped storage.
2. Includes geothermal, solar, wind, tide/wave/ocean, biofuels, waste, heat and other.

Should Electricity be Distributed Renewable or Centralized Grid?
Distributed Renewable
Centralized Grid
Centralized and Distributed
Centralized Grid
Distributed Renewable
Electricity Access per Dollar
Overseas Private Investment Corporation (OPIC)

New Electricity Access (millions)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Percent of $10b portfolio allocated to renewables

3X-4X with
Centralized
Natural Gas

Natural gas only
Renewables on-grid
Renewables off-grid
300MW/year cap on natural gas
Renewables only

Moss and Leo, 2014, Rethinking US Development Policy

QAe7203
What About the Environment?
Environmental Impact

- Coal, Oil, Natural Gas

- Mining and Manufacturing: Land, Water, Emissions
- Drilling and Completion: Land, Water
- Transportation: Pipelines, Trucks, Ships, Rail
- Refining and Petrochemicals: Emissions
- Combustion: Vehicle and Power Plant Emissions
Mining and Processing

- Land
- Water
- Emissions

Manufacturing:
- Turbines, Panels, Batteries

Production:
- Farms

Transmission:
- Electricity

Disposal:
- Landfill

Environmental Impact

Renewables and Batteries

The sun and the wind are renewable, the stuff to harness and distribute them is not.
Real Energy
Education is Vital
Green New Deal  
Lift Them from Poverty  
Keep Them in Poverty
Can we Address Poverty and $\text{CO}_2$?
Climate Change is the major issue of our time, and fossil fuels are the problem.

Is it really either/or?

Poverty is the major issue of our time, and fossil fuels are the solution.

Tinker, 2015

Tinker 2019

Political

Energy

Environment

Carbon

Legal

Social

Interactive Systems

Radical Middle

Economy

Poverty

Energy

Carbon

Environmental
The Real Energy Transition

✓ Every person on earth is out of energy poverty, and
✓ Minimize energy impacts on land, water and air, and
✓ Global atmospheric emissions peak and roll over

This Requires Non-Partisan Energy Education
One Size Does Not Fit All
We Would Make an Immediate and Substantial Impact on Poverty and Climate with a Fit-for-Purpose Combination of...
- DRE, especially Solar, for poor and rural
- Centralized Wind for sparse, rural, and windy
- Centralized Nuclear for dense and urban
- Centralized Nat Gas, w/CCS, for urban and rural
- Small Modular Reactors (Nuclear and Nat Gas)
- Geothermal and Hydro, where available
- Coal w/CCS and Coal Phase Out
- EVs (battery impact) and ride sharing for urban
- ICE, CNG, LNG, and Fuel Cells for rural
- Centralized Solar and Biofuels as boutique only
- Continued drive towards Efficiency
Thanks!

Join the Switch Energy Alliance

SwitchOn.org

Inspire an Energy Educated Future

Photo Credit: Scott W. Tinker
Thanks!

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For financial interests of Scott Tinker see
http://www.beg.utexas.edu/people/scott-tinker

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