

Lesson 5 Handout: Key graphs and questions for discussion of energy trends

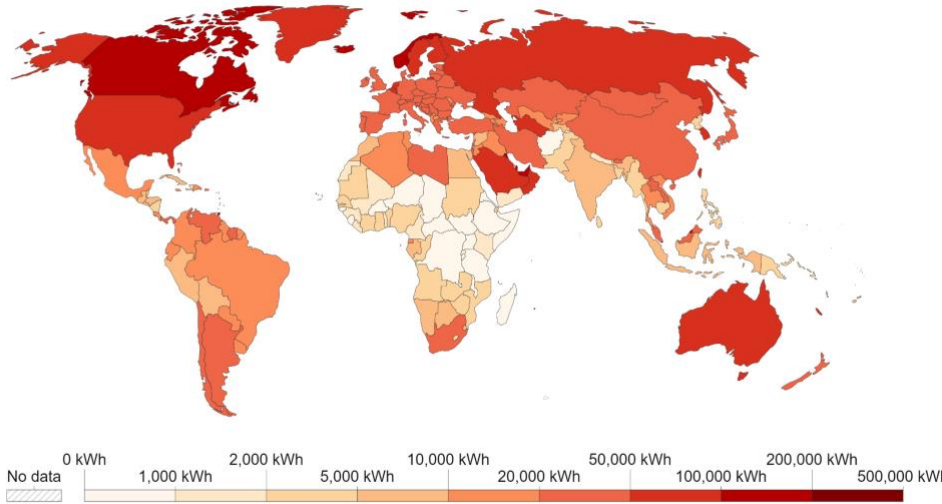
Use these graphs as part of a handout or worksheet for students or create your own. You may wish to include other graphs found in the package for Lesson 2. Members can have access to an already-made PPT of the interactive graphs with

Graph/Image & Source	Questions to discuss
<p>Global primary energy consumption by source</p> <p>Primary energy is calculated based on the 'substitution method' which takes account of the inefficiencies in fossil fuel production by converting non-fossil energy into the energy inputs required if they had the same conversion losses as fossil fuels.</p> <p>Source: Our World in Data based on Vaclav Smil (2017) and BP Statistical Review of World Energy OurWorldInData.org/energy • CC BY</p> <p>https://ourworldindata.org/global-energy-200-years</p>	<p>Summary: This graph and the interactive from the website show how energy sources have changed since 1800 from traditional biomass (wood, peat, dung) to a variety of mostly non-renewable sources, and then more recently renewable energy sources.</p> <p>Questions: When did new energy forms start being used? How do you think this affected society? (See Lesson 3 for more background information.)</p> <p>Examine the renewable energy use on the graph. How would you like to see this graph change over the next 10 years?</p>

Energy use per person, 2021

Energy use not only includes electricity, but also other areas of consumption including transport, heating and cooking.

Our World in Data



Source: Our World in Data based on BP & Shift Data Portal

OurWorldInData.org/energy • CC BY

Note: Energy refers to primary energy – the energy input before the transformation to forms of energy for end-use (such as electricity or petrol for transport).

<https://ourworldindata.org/energy>

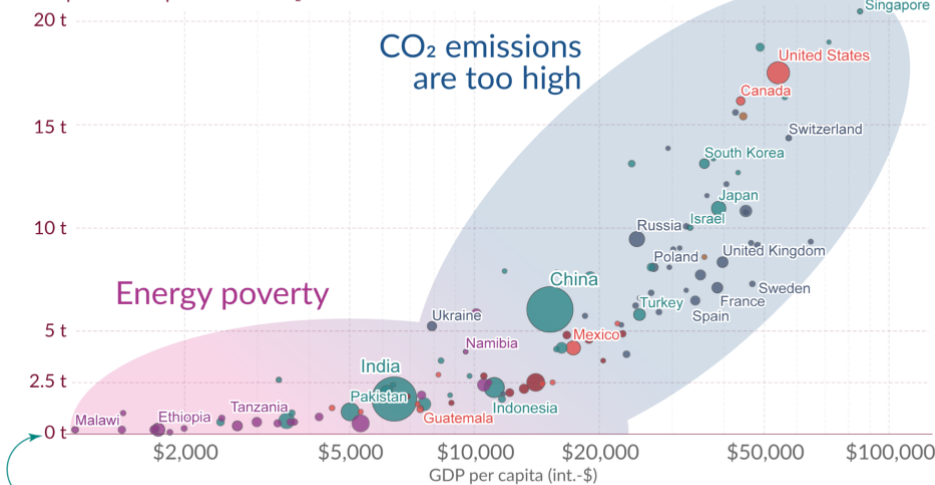
Graph 6: This map clearly shows that Canada's per person (per capita) energy consumption is one of the highest in the world (along with Norway — though Norway leads the world in renewable energy with >50% use of renewables overall).

This graph could serve as a helpful discussion point regarding inequities and which factors are driving our energy use.

CO₂ emissions per capita vs GDP per capita

Our World in Data

Per capita consumption-based CO₂ emissions



To end climate change the long-run goal is that net-emissions decline to zero.

Data for 2017: Global Carbon Project, UN Population, and World Bank.

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<https://ourworldindata.org/worlds-energy-problem>

Graph 7: This graph — with interpretation added — looks at the relationships between “consumption-based CO₂ emissions” and GDP per capita.

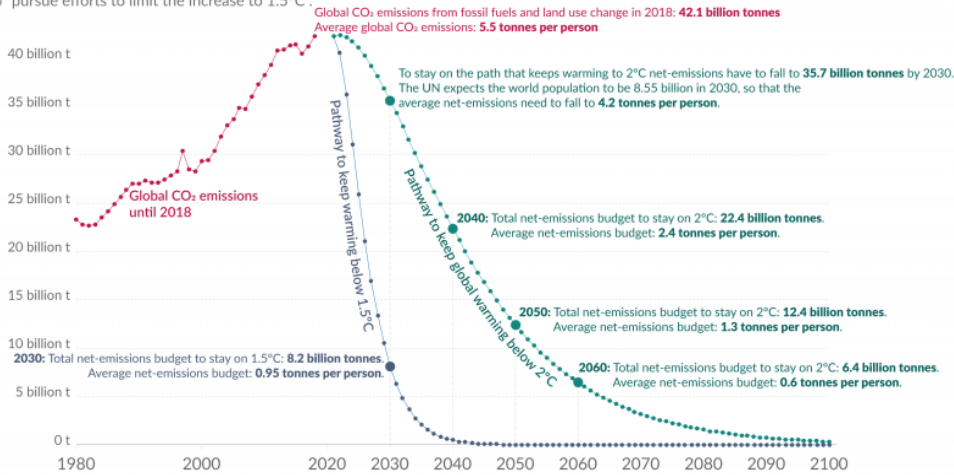
The main message is that there are a number of countries whose citizens do not have access to enough energy to make their lives comfortable, but those who do currently emit a large number of emissions.

Looking through a social justice lens, what needs to be done?

CO₂ pathways to reach the Paris Agreement

Pathways are based on the necessary reductions of net CO₂ emissions if global emissions peak in 2021 and decline thereafter. The Paris Agreement's goal is to keep the increase in global average temperature to well below 2°C above pre-industrial levels and to "pursue efforts to limit the increase to 1.5°C".

Our World in Data



Source: The pathways are based on the global cumulative CO₂ emission budgets from the IPCC Special Report on 1.5°C and refer to carbon budgets that give a >66% chance of staying below the respective temperature increases: 420 GtCO₂ for a 66% of 1.5°C and 1170 GtCO₂ for a 66% of 2°C. Mitigation curves describe approximately exponential decay pathways such that the quota is never exceeded. They were calculated and published by Robbie Andrew. OurWorldInData.org - Research and data to make progress against the world's largest problems. Licensed under CC-BY by the author Max Roser

<https://ourworldindata.org/worlds-energy-problem>

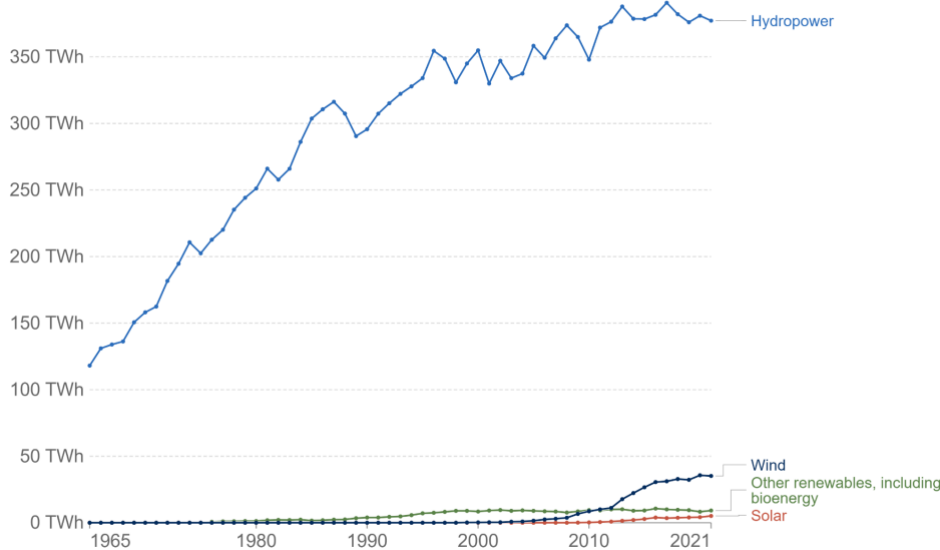
This graph shows the current data for CO₂ emissions worldwide, some projected slopes if we cut emissions to maintain 1.5°C versus 2.0°C, and certain key benchmarks.

Questions: What do the differences in slopes in the two projections tell us?

Do the projections in either, one, or neither of the slopes seem feasible?

Modern renewable energy generation by source, Canada

Our World in Data



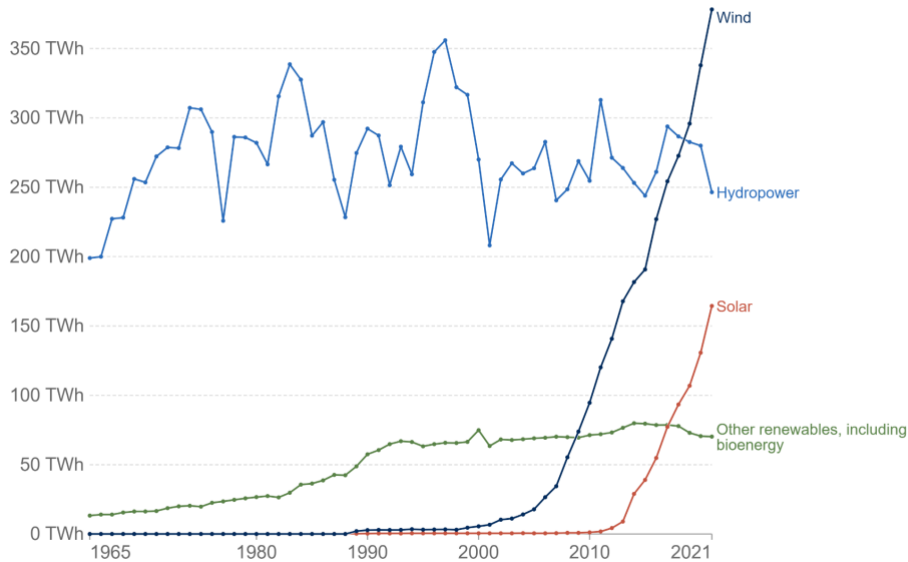
Source: Our World in Data based on BP Statistical Review of World Energy & Ember OurWorldInData.org/renewable-energy • CC BY

Graph 8 & 9: These two graphs come from a world graph where you can select a country to examine or look at world data. Compare these two North American countries or look at a few different ones.

Questions: What trends do you see in the different renewable energy use amounts per country? What may influence the differences (consider politics, economics, geography, etc.)?

Modern renewable energy generation by source, United States

Our World in Data



Source: Our World in Data based on BP Statistical Review of World Energy & Ember [OurWorldInData.org/renewable-energy](https://ourworldindata.org/renewable-energy) • CC BY

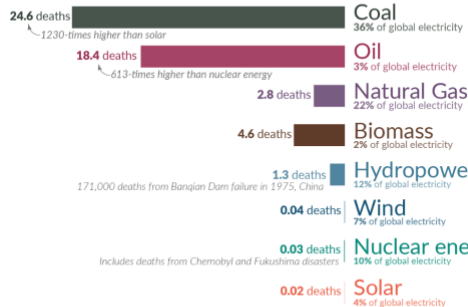
<https://ourworldindata.org/renewable-energy>

What are the safest and cleanest sources of energy?

Our World in Data

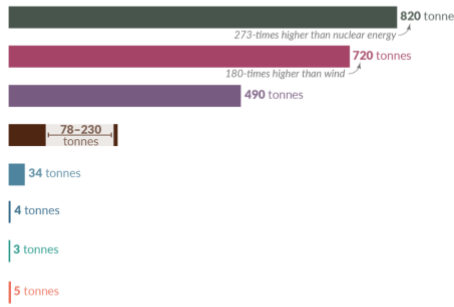
Death rate from accidents and air pollution

Measured as deaths per terawatt-hour of electricity production. 1 terawatt-hour is the annual electricity consumption of 150,000 people in the EU.



Greenhouse gas emissions

Measured in emissions of CO₂ equivalents per gigawatt-hour of electricity over the lifecycle of the power plant. 1 gigawatt-hour is the annual electricity consumption of 150 people in the EU.



Death rates from fossil fuels and biomass are based on state-of-the-art plants with pollution controls in Europe, and are based on older models of the impacts of air pollution on health. This means these death rates are likely to be very conservative. For further discussion, see our article: [OurWorldInData.org/safest-sources-of-energy](https://ourworldindata.org/safest-sources-of-energy). Electricity shares are given for 2021. Data sources: Markandya & Wilkinson (2007); UNSCEAR (2008; 2018); Sovacool et al. (2016); IPCC AR5 (2014); Pehl et al. (2017); Ember Energy (2021). OurWorldInData.org - Research and data to make progress against the world's largest problems. Licensed under CC-BY by the authors Hannah Ritchie and Max Roser.

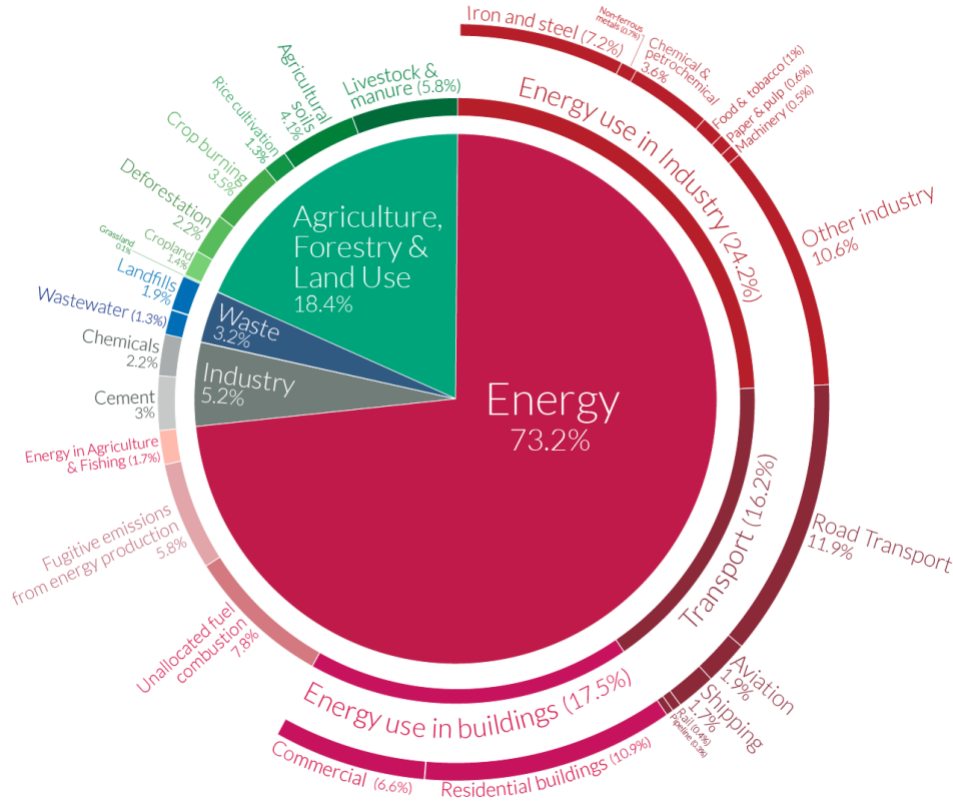
<https://ourworldindata.org/safest-sources-of-energy>

Graph 10: This chart displays the death rate due to air pollution and accidents as well as the greenhouse gas emissions from different sources of energy.

Global greenhouse gas emissions by sector

Our World in Data

This is shown for the year 2016 – global greenhouse gas emissions were 49.4 billion tonnes CO₂eq.



Graph 11: This pie chart shows greenhouse gas emissions by sector.

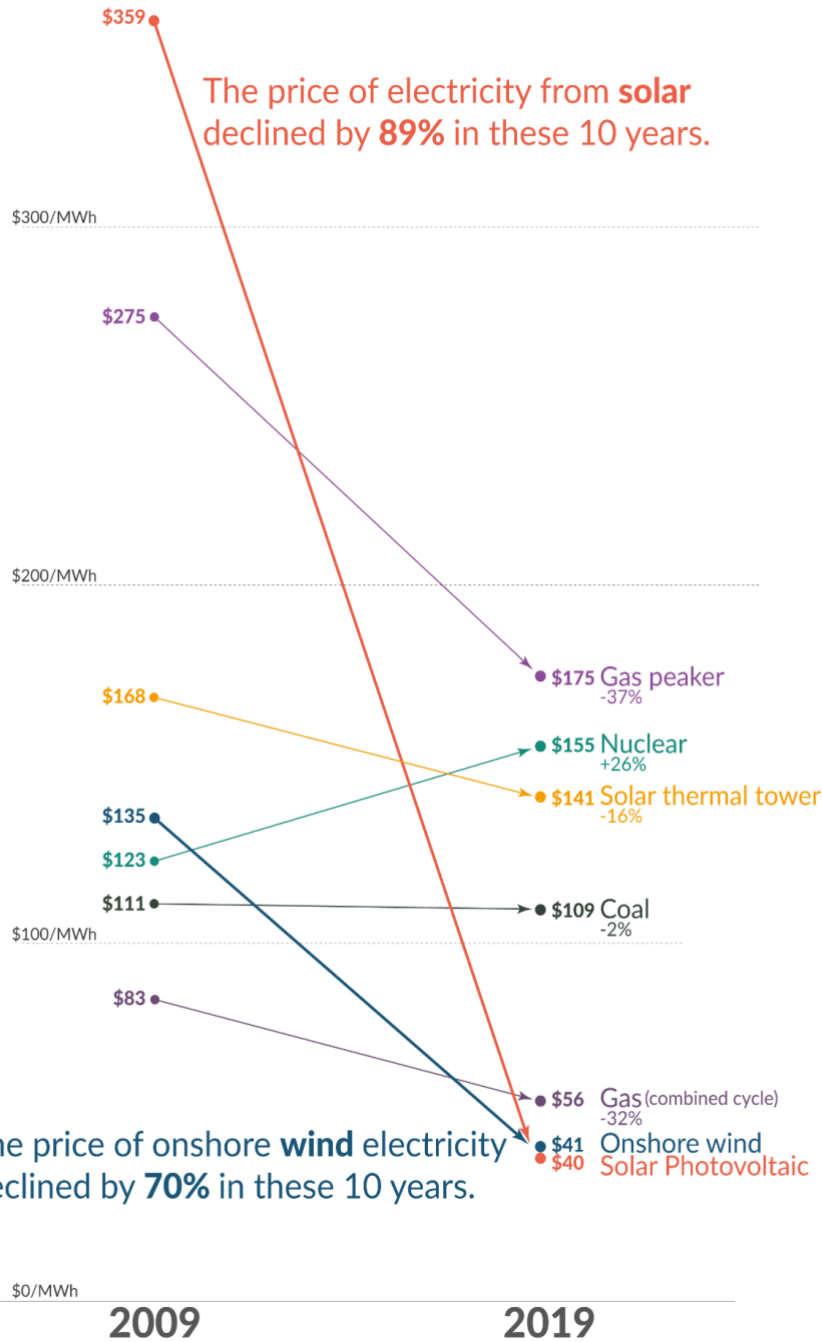
A sound explanation is provided on the website:

<https://ourworldindata.org/ghg-emissions-by-sector>

The price of electricity from new power plants



Electricity prices are expressed in 'levelized costs of energy' (LCOE). LCOE captures the cost of building the power plant itself as well as the ongoing costs for fuel and operating the power plant over its lifetime.



The price of electricity from solar declined by 89% in these 10 years.

The price of onshore wind electricity declined by 70% in these 10 years.

Graph 12: This graph shows the changes in energy prices as new technologies are adopted. The costs of solar and onshore wind decrease significantly.

No data is provided on the cost of gas cost (i.e., natural gas).

Gas peaker refers to gas-peaking power plants, which are power plants that run only when there is a high demand for electricity. Historically, they were used with coal when peak demand required them (gas being more expensive than coal).

Today, they are used during times of peak demand when other sources (renewable and non-renewable) cannot keep up.

Peaker plants in some places are now being replaced by battery storage: https://en.wikipedia.org/wiki/Peaking_power_plant

It is interesting to note how coal is not changing and nuclear is increasing (notes from Our World in Data indicate that this is because nuclear is being regulated for safety, very few new plants are being built, & the market is small).

Data: Lazard Levelized Cost of Energy Analysis, Version 13.0

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Energy Expo Research Notes

Energy Type you are representing: _____

Area of Research	Notes, Images, & Source info
Current trends for development (growth/decline, etc.)	
Financial contribution to sector and trends	
Greenhouse gas emissions (total and relative to other industries)	
Other environmental risks and/or benefits	
Other relevant information (political, social, geographical, etc.)	

Credible Sources Checklist

As you do your research on your energy source, use this credible sources checklist to verify that any information you find is from a credible, unbiased, and reliable source.

WHO? (Author, organization, company)	Yes	No
Can you find a biography of the author or description of the company or organization on the website?		
Is the author or organization an expert in this topic or have a strong educational background on this topic?		
Is the website likely to be peer-reviewed (fact-checked by a number of other experts)?		
Are the authors likely to be unbiased? (or do they have a reason to try to convince readers of their opinion — i.e., for financial or political gain?)		
WHAT is the purpose of this site?		
Does the information seem like a fact (or an opinion)? i.e., Can you find factual references to other reliable scientific or peer-reviewed sources?		
Does the site contain links to more information and other credible sources?		
Is the domain a <i>usually reliable</i> one? If not, does it seem credible? <u>Usually Reliable:</u> .edu (school, college, university) .gc.ca (government of Canada) .gov (government agency USA) <u>Check Carefully:</u> .com (business – likely biased) .ca (could be government or company in Canada) .org (organization – likely biased) wikis & blogs – opinion		
When was the article or site last updated? _____ (If not obvious, check for copyright at the bottom of page)		
Does the article/website date seem recent? (put 'no' if no date found)		
Do all the links still work and does the site use newer graphics?		
Total your YES's and NO's ----->		
Is this source reliable? (It is not just about the total; use your brain!)		

Comparison Table for Energy Expo Participants

Use this table to guide you in your questioning so that you have a thorough understanding of each type of energy that is part of the expo and to help you decide which energy types should be the basis in your country or region's future.

Energy type (List below)	Type of energy, how it is created, & trends you learned about at booth	Opportunities (benefits of this energy)	Drawbacks (environment/emissions)

Which energy sources would you like to see as part of your future and why?

Extension Activity: The Reasons Behind Indigenous Energy Transitions

Quick facts:

Community chosen and location	
Type of project and size of project	
Benefits of project discovered	
Energy challenges or successes discovered	

Reasons for the energy transition project: While there are many reasons why a community may switch to a renewable energy source, Indigenous communities are often driven by three main factors: **Energy autonomy or sovereignty, culture and worldviews, and sustainability.** Place into the various sections of the following Venn Diagram facts, quotes, and reasons that you've found in this community's example.

