

1) Where is the sunniest place in the world?

2) What process allows plants to capture sunlight?

3) What do photovoltaic cells do?

4) What are the major downsides of solar power?

5) How can that downside be overcome?

Biomass, Hydroelectric, Solar

Renewable Energy

Renewables in USA

- We obtain only one half of 1 percent from the new renewable energy sources
- Nations and regions vary in the renewable sources they use
- In the U.S., most renewable energy comes from **hydropower and biomass**

Source	Percentage
Hydropower	42.2%
Biomass	47.9%
Geothermal	5.1%
Wind	3.8%
Solar	1.0%

Source	Percentage
Hydropower	74.9%
Biomass	14.4%
Geothermal	3.8%
Wind	6.7%
Solar	0.1%

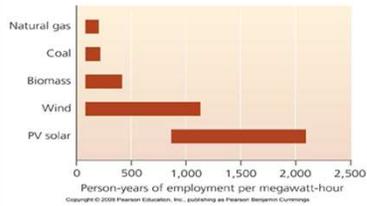
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Expanded quickly because of:

- Growing concerns over diminishing fossil fuels
- The environmental impacts of fossil fuel combustion
- Advances in technology make it easier and less expensive
- **Benefits of the new renewables include:**
 - They alleviate air pollution (SO₂, Hg, As) and greenhouse gas emissions (CO₂, CH₄) that can cause climate change
 - They are inexhaustible, unlike fossil fuels
 - Help diversify a country's energy economy
 - They create jobs and are sources of income and taxes, especially in rural areas

This is important!

New energy sources create jobs

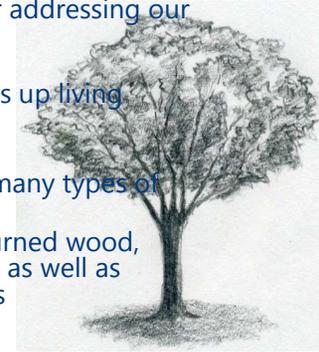


- New technologies require more labor for the same energy
- More jobs will be generated than remaining with a fossil fuel economy
- Jobs are high technology and high paying.

Economic

Biomass energy

- Biomass energy has great potential for addressing our energy challenges
- **Biomass** = organic material that makes up living organisms
- People harness biomass energy from many types of plant matter
 - Wood from trees, charcoal from burned wood, and matter from agricultural crops, as well as combustible animal waste products



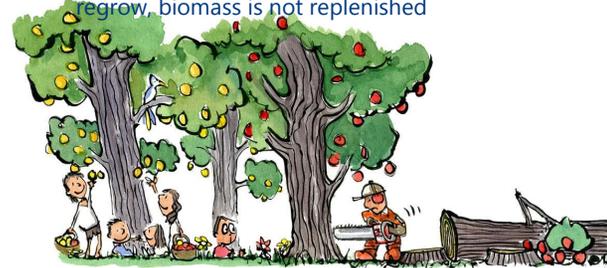
Biomass sources are widely used

- More than 1 billion people use wood from trees as their **principal** energy source
- In developing (not developed) nations, families gather fuelwood for heating, cooking, and lighting
- Fuelwood and other biomass sources constitute 80% of all renewable energy used worldwide



Biomass can be overharvested

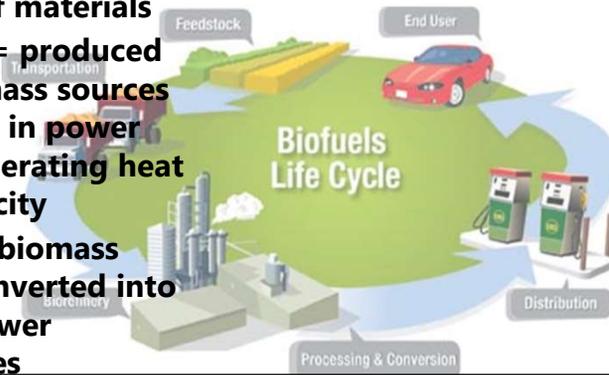
- Biomass is only renewable when it is not overharvested
 - With **rapid** deforestation, soil erosion, and forest failures to regrow, biomass is not replenished



By Frits Ahlefeldt

New biomass strategies

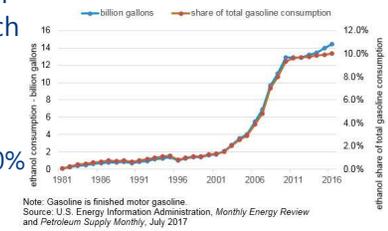
- Biomass sources include a variety of materials
- Biopower = produced when biomass sources are burned in power plants, generating heat and electricity
- Biofuels = biomass sources converted into fuels to power automobiles



Biofuels can power automobiles

- Ethanol = produces as a biofuel by fermenting carbohydrate-rich crops
 - Ethanol is widely added to U.S. gasoline to reduce emissions
 - Any vehicle will run well on a 10% ethanol mix (don't use in lawn equipment though)

U.S. fuel ethanol consumption and share of total U.S. gasoline consumption, 1981-2016



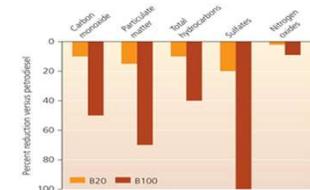
Cars can run on ethanol



- Flexible fuel vehicles = run on 85% ethanol
 - But, very few gas stations offer this fuel

Biodiesel from vegetable oil

- U.S. biodiesel producers use soybean oil
 - Animal fats, used grease, and cooking oil can also be used
 - Vehicles can run on 100% biodiesel, but the engine needs to be modified
 - Biodiesel cuts down on emissions; its fuel economy is almost as good and costs slightly more than gasoline



Biomass energy brings BENEFITS

- It is essentially carbon-neutral, releasing no new carbon into the atmosphere
- Economic benefits include
 - Supporting rural communities
 - Reducing dependence on fossil fuel imports
 - Improved energy efficiency
 - Reduces air pollutants such as sulfur dioxide

Environmental <ul style="list-style-type: none"> Reduce greenhouse gas emissions Reduce carbon footprint Produce healthier forests Improve forest utilization Reduce waste from dumping and burning Recover degraded agricultural lands and forests 	Economic <ul style="list-style-type: none"> Diversify the forest industry Support new investment value-added sector Create new jobs Create export potential Enhance regional growth and competitiveness Increase rural development Increase landowner income
Social <ul style="list-style-type: none"> Social cohesion and stability (migration, rural development, rural diversification) Increased standard of living (improved infrastructure, environmental, health, education) 	Energy Related <ul style="list-style-type: none"> Renewable energy source Increase national security Self sufficiency in energy production Reduce dependence on fossil fuels

Drawbacks of biomass energy

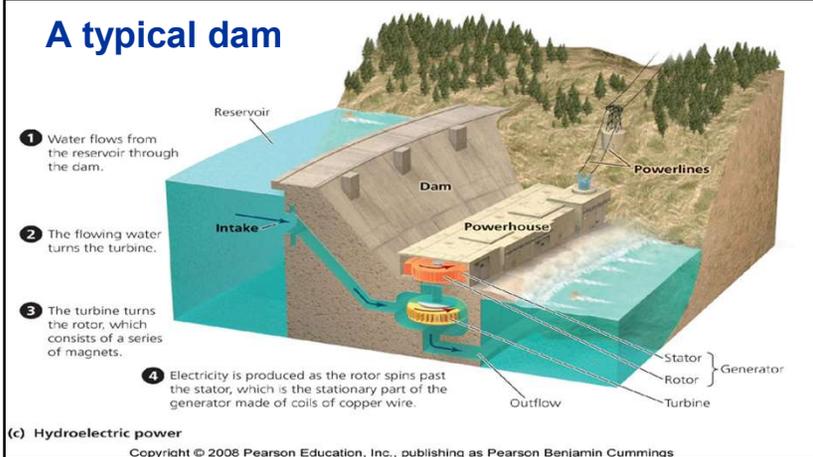
- Health hazards from indoor air pollution
- Rapid harvesting can lead to deforestation**
- Growing crops exerts tremendous impacts on ecosystems
 - Fertilizers and pesticides
 - Land is converted to agriculture
 - Biofuel is competing with food production
 - Substantial inputs of energy are required

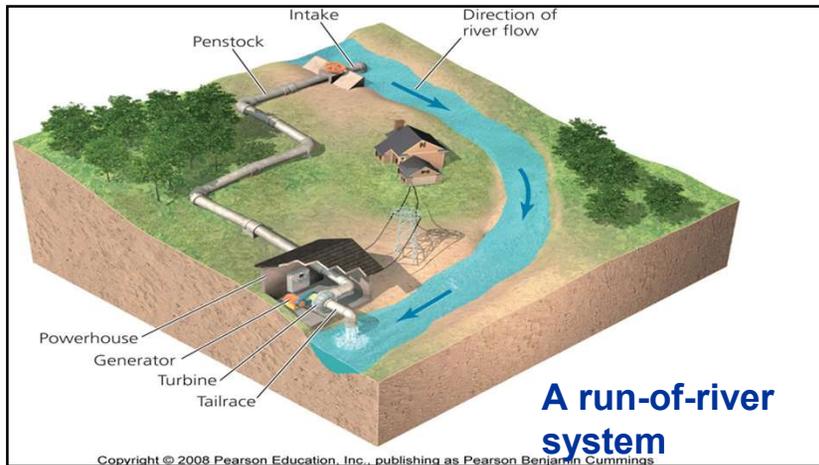
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Hydroelectric power

- Hydroelectric power** = uses moving water to turn turbines and generate electricity
- Water passing through the dam turns turbines

A typical dam





Hydroelectric power is widely used

- Hydropower accounts for 2.2% of the world's energy supply
- Nations with large rivers and economic resources have used dams
- However, many countries have dammed their large rivers
- People want some rivers left undammed



Advantages of Hydroelectric Power

- Hydropower has TWO clear advantages over fossil fuels for producing electricity:
 - It is renewable: as long as precipitation fills rivers we can use water to turn turbines
 - It is clean: no carbon dioxide is emitted
- Hydropower is efficient
 - It has an EROI (energy return on investment) of 10:1, as high as any modern-day energy source

Hydropower has negative impacts

- Damming rivers destroys habitats
 - Upstream areas are submerged
 - Downstream areas are starved of water
- Natural flooding cycles are disrupted
- Dams block passage of fish, fragmenting the river and reducing biodiversity



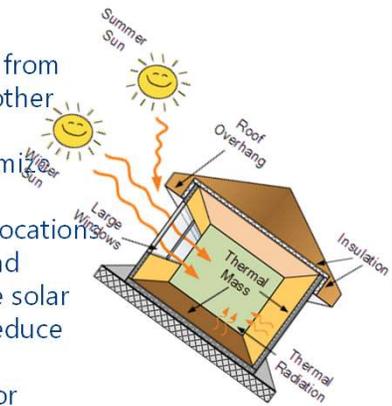
Solar energy



- Sun provides energy for almost all biological activity on Earth
- Each square meter of Earth receives about 160 watts of solar energy
- There is great potential in solar energy
- Solar energy has been used for hundreds of years

Passive solar

- Passive solar uses heat and light from the sun to replace the need for other energy sources.
- Low south-facing windows maximize heat in the winter
- Planting vegetation in strategic locations
- By heating buildings in winter and cooling them in summer, passive solar methods conserve energy and reduce costs
- Use of windows to provide indoor lighting.



Active solar energy collection

- Converts sunlight into another useable form of energy
 - Converted directly to electricity
 - Converted and stored as heat

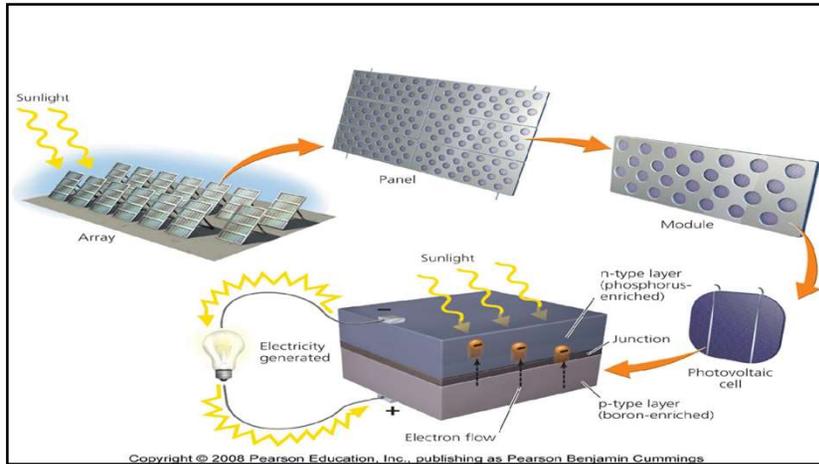


Photovoltaic cells generate electricity

- **Photovoltaic cells** = collect sunlight and convert it into electrical energy

These are what we think of when we hear "solar panel"





Concentrating solar rays magnifies energy



- Focusing solar energy on a single point magnifies its strength
- **Solar cookers** = simple, portable ovens that use reflectors to focus sunlight onto food
- **Power tower** = mirrors concentrate sunlight onto receivers to create electricity
- **Solar-trough collection systems** = mirrors focus sunlight on oil in troughs

Solar power BENEFITS

- The Sun will burn for 4 - 5 billion more years
- Solar technologies are quiet, safe, use no fuels, contain no moving parts, and require little maintenance
- They allow local, decentralized control over power
- Developing nations can use solar cookers, instead of gathering firewood
- **Net metering** = PV owners can sell excess electricity to their local power utility
- New jobs are being created
- Solar power does not emit greenhouse gases and air pollution

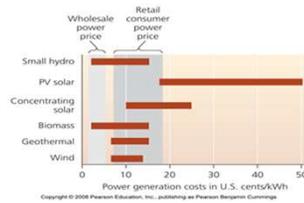
Location Problems

- Not all regions are sunny enough to provide enough power, with current technology
- Daily and seasonal variation also poses problems



Cost is a drawback

- Up-front costs are high and solar power remains the most expensive way to produce electricity
- The government has subsidized fossil fuels and nuclear energy at the expense of solar energy



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