Distinguish the solid fuels

Wood, charcoal, peat and coal can all release heat when burned, but they differ in origin and processing. Identify the material before explaining its use.

1. WOOD AND CHARCOAL: COMMON HOUSEHOLD FUELS

Firewood is wood burned directly, often for cooking and space heating. Charcoal is a carbon-rich solid made by heating wood with little or no oxygen, driving off water and volatile substances. It is not the same material as coal. Accessible wood supplies make these fuels important in many developing regions. Producing charcoal requires wood and loses some of its original energy during processing; neither fuel is automatically impact-free.

2. PEAT: PARTLY DECOMPOSED PLANT MATERIAL

Peat accumulates where waterlogged, oxygen-poor conditions slow decomposition. It can be dried and burned as fuel. It is not fresh wood or fully developed coal. Burial and geological change can eventually transform peat into coal; a peat deposit does not become coal simply because someone dries it for burning.

3. COAL RANK REFLECTS ITS GEOLOGICAL HISTORY

Heat and pressure during burial over geological time alter coal. Increasing rank generally means more carbon, less moisture and greater heating value per unit mass. The three ranks named in the APES syllabus are:

Lignite	Low rank; moist, lower heating value. Used mainly to generate electricity.
Bituminous	Higher rank; important for electricity and industrial uses, including coke production for steelmaking.
Anthracite	Highest rank; high carbon content and heating value. Used for specialized heating and industrial purposes.

Extension: subbituminous coal lies between lignite and bituminous in the fuller rank sequence.

Charcoal production: FAO, Developments in Charcoal Production Technology.
Peat accumulation: USGS, Biogeochemical Processes in Peat.
Coal formation, ranks and uses: US EIA, Coal Explained.

Scope: College Board AP Environmental Science CED, Topic 6.3, p. 122.

Match fuel properties to uses

Natural gas and petroleum are mixtures of hydrocarbons. Their composition and processing help explain how they supply electricity, heat and transport.

1. NATURAL GAS: MOSTLY METHANE

Natural gas consists mainly of methane (CH_4). It is used for cooking, building heat, industrial heat and electricity generation. It generally releases less carbon dioxide and fewer air pollutants than coal or petroleum per unit of energy when burned. This is why it is described as the cleanest fossil fuel, not a pollution-free fuel. Combustion still releases carbon dioxide, and methane escaping during production or delivery contributes to warming.

2. CRUDE OIL IS REFINED INTO SPECIALIZED PRODUCTS

A refinery separates crude oil into fractions with different boiling ranges, then converts and treats streams to make useful products. Crude oil is not simply poured into an ordinary car engine.

Gasoline	Spark-ignition engines, including many cars.
Diesel	Diesel engines, including trucks and some trains.
Jet fuel	Turbine engines in aircraft; typically kerosene-based.

3. OIL SANDS: BITUMEN MUST BE RECOVERED

Oil sands, also called tar sands, contain sand, clay or other minerals, water and bitumen. Bitumen is a very thick form of petroleum. Recovering and processing it provides material for petroleum products; the sand itself is not the fuel. Some deposits are mined, while deeper deposits require in-place recovery methods. Additional processing and transport may be needed before refining. Always distinguish the raw deposit, the recovered hydrocarbon and the final fuel used by an engine.

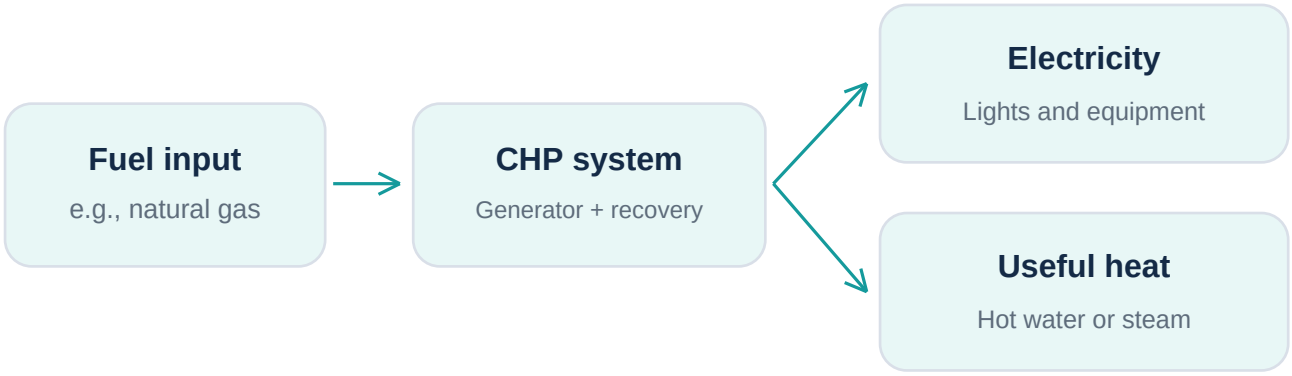
Combustion emissions and methane leakage: US EIA, Natural Gas and the Environment.
Petroleum processing and products: US EIA, Refining Crude Oil.
Oil-sands composition and recovery: Natural Resources Canada, What Are the Oil Sands?

Scope: College Board AP Environmental Science CED, Topic 6.3, p. 122.

Use one fuel for two useful outputs

Cogeneration, or combined heat and power (CHP), provides electricity and useful heat from the same fuel source. The key is recovering heat that would otherwise be rejected.

1. TRACE ELECTRICITY AND RECOVERED HEAT



A hospital or factory can use the recovered heat for hot water, space heating or a process. Heat discharged to the environment is not useful heat output. An actual heat demand must be matched to the system.

2. EXTENSION: ACCOUNT FOR THE ENERGY

Illustrative example: 100 megajoules (MJ) of fuel energy produces 35 MJ of electricity, 45 MJ of useful recovered heat and 20 MJ of unrecovered losses. All values use the same time interval.

Total useful efficiency = (35 + 45) / 100 x 100 = 80%

3. COGENERATION IS NOT A NEW FUEL

CHP is a way of using fuel more effectively, not a renewable energy source in itself. If no one uses the recovered heat, do not count it as useful output: in the example, only 35% of the input provides useful electricity. CHP can reduce fuel demand compared with producing the same electricity and heat separately, but a fossil-fuel CHP system still has emissions.

Definition and useful heat applications: US EPA, What Is CHP?
Total system efficiency: US EPA, Methods for Calculating CHP Efficiency.
Core scope: College Board, ENG-3.C.7; numerical example is illustrative.

Scope: College Board AP Environmental Science CED, Topic 6.3, p. 122.