Principles of Economics — Lecture 8 (Energy and Power) • Study Notes

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Big Picture

- **Energy is abundant, but power is scarce.**
- Human progress can be measured by our ability to harness ever more powerful energy sources.
- Hydrocarbons (coal, oil, gas) — not "renewables" — drove industrialization because they provide dense, reliable, on-demand power.
- Industrialization and rising energy consumption explain the abolition of slavery, the empowerment of women, and massive increases in global living standards .

Core Claims

1. **Energy vs. Power**
2. Energy is the capacity to do work (heat or force).
3. Power = energy per unit of time (joules/sec = watts).
4. **Economically, we value power, not energy.** The sun provides more raw energy than we need, but it cannot be channeled on demand .
5. **History of Human Power**
6. Hunter-gatherers: relied on sunlight, rivers, firewood.
7. Agriculture: sedentary life enabled domestication of animals, wood, water wheels, windmills.
8. Industrialization: hydrocarbons multiplied accessible power thousands of times .
9. **Energy Density Progression**

10. Wood: 16 MJ/kg.
11. Coal: 24 MJ/kg (~50% higher).
12. Oil: 44 MJ/kg (double coal).
13. Gas: 55 MJ/kg.
14. Uranium: 3.9 million MJ/kg (≈100,000× oil).
15. Batteries: 0.5 MJ/kg (≈1% of oil).

Key Insight: Humans always economize toward higher energy density .

1. **Power Multipliers Over Time**
2. Human muscle: 200 W.
3. Horse: 750 W.
4. Roman water wheel: 1,800 W.
5. Dutch windmill (1750): 12,000 W.
6. Ford Model T (1908): 15,000 W.
7. Diesel tractor (2015): 300,000 W.
8. Concorde jet (1969): 108,000,000 W.
9. Siemens SGT-9000HL turbine (2022): 410,000,000 W .

→ In 200 years, humanity scaled usable power **2,000,000×**.

1. **Hydrocarbons as Natural Batteries**
2. Stable, portable, energy-dense, usable on demand.
3. Unlike solar/wind, hydrocarbons provide continuous power supply at low marginal cost.
4. Modern life — transport, medicine, steel, plastics — depends on hydrocarbons. Even nuclear reactors require hydrocarbon inputs (steel, plastics, etc.) .
5. **Freedom Through Energy**
6. Pre-industrial societies: slavery valuable because each slave nearly doubled available energy.
7. Industrialization: machines made brute labor uneconomical → slavery abolished.
8. Physical strength gap between men and women mattered less → women gained independence.
9. More energy = more freedom, specialization, and trade .

Key Concepts & Mental Models

- **Energy vs. Power** → Raw abundance vs. usable scarcity.
- **Marginal Analysis of Energy** → Value lies in *availability on demand*.
- **Energy Density Ladder** → Civilizational progress = moving up to denser fuels.
- **Hydrocarbons as Batteries** → Nature's store of portable, reliable energy.
- **Energy & Freedom** → More power = less need for slavery, more human liberty.

Quotable Ideas

- "Energy is not scarce. Power is." — Ammous
- "Hydrocarbons are nature's batteries — far superior to anything we can build." — Ammous
- "Wherever the engine went, slaves were freed." — Ammous

Study Prompts

- Why is power, not energy, the true economic good?
- Explain the historical progression of energy density.
- How do hydrocarbons outperform solar and wind despite being costlier to extract?
- Why did industrialization abolish slavery?
- How did industrialization contribute to female empowerment?

TL;DR

Energy surrounds us in abundance — sunlight, wind, rivers — but it only becomes an economic good when harnessed as **power**. Human progress is the story of mastering denser, more reliable fuels, culminating in hydrocarbons and nuclear energy. Hydrocarbons act as natural batteries, enabling on-demand power that built modern civilization. They powered industrialization, ended slavery, raised living standards, and gave women independence by replacing brute labor with machines. The world does not run on “energy”; it runs on **power at the margin**, delivered when and where we need it.
