# Energy and Society

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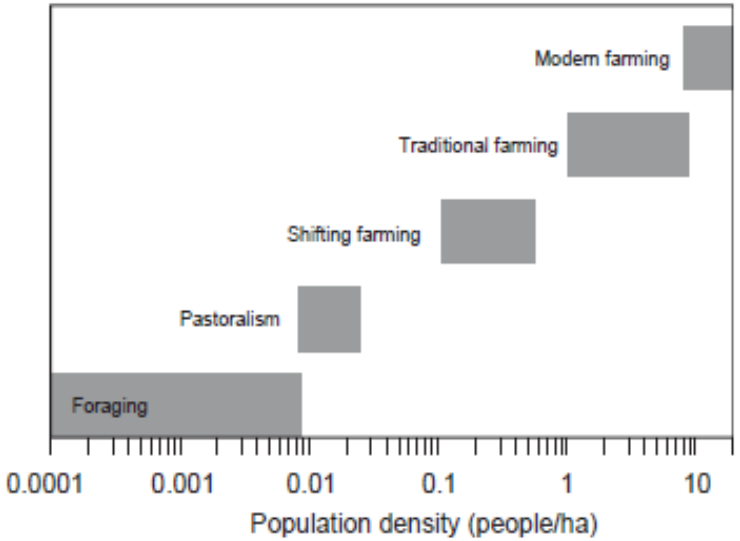
# Energy-intensive society: how did we get there?

# Foraging society

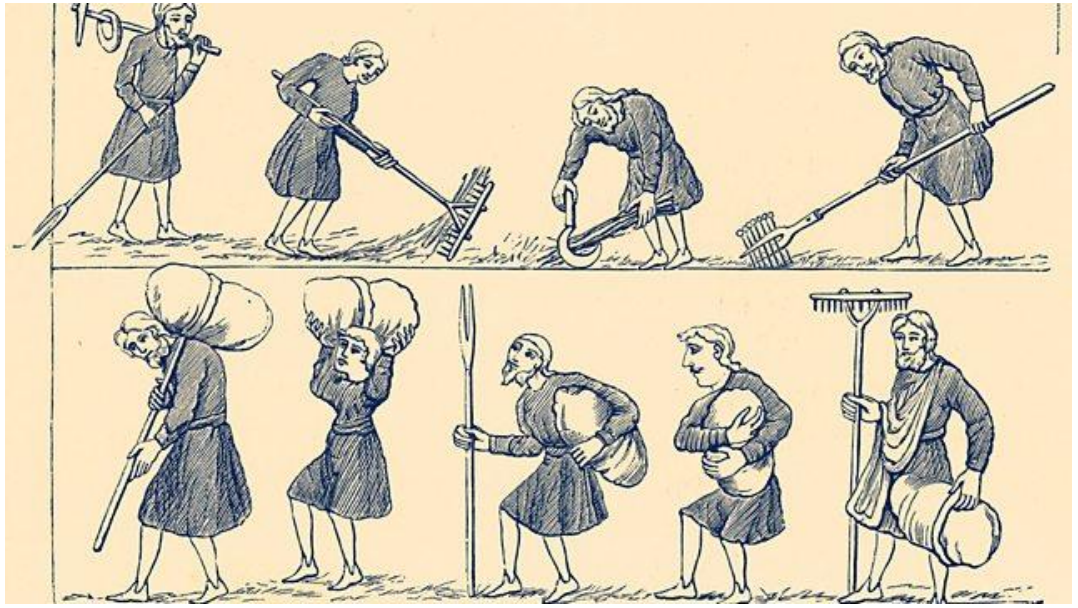
- Human body and exosomatic sources of power - fire, body extensions (bows)
- Energy return on investment (EROI) up to 40, usually around 3, often around 1.
- Very low population density (0,1 person/sq. km)

# Agricultural society

- Greater population density (20-30 persons/sq. km)
- First exosomatic sources of power:
  - Oxes (200-500 W)
  - Charcoal (29 MJ/kg, no smoke)
- Metallurgy: low efficiency, high energy intensity (until 1750)



# Progress in the Middle Ages: prime movers

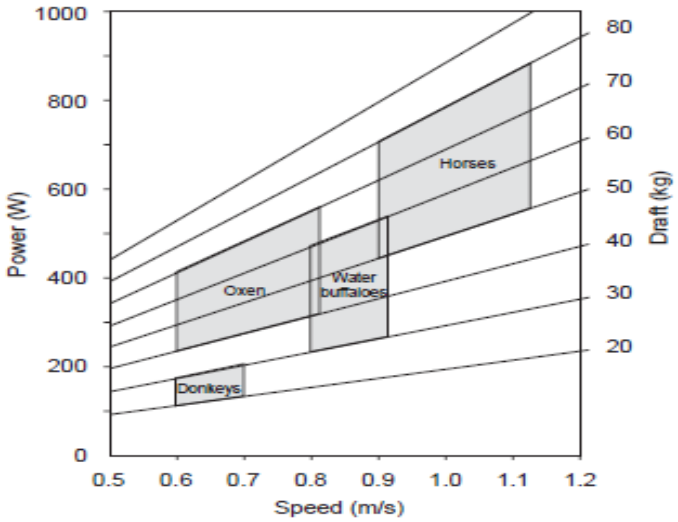


Organic prime movers still dominant

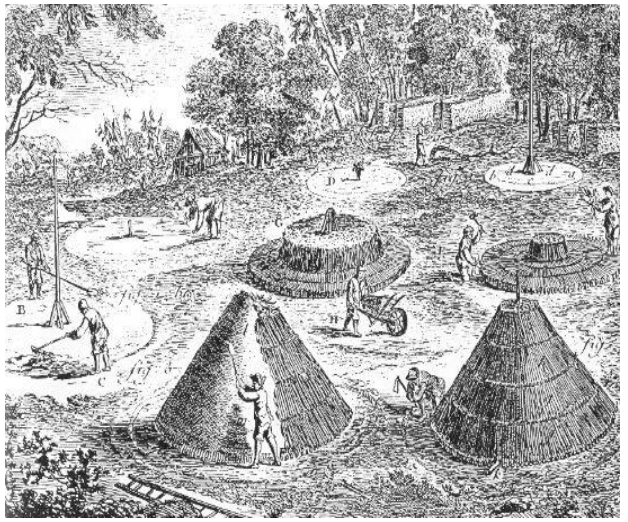
- Increased efficiency in energy transformation (treadwheels, horseshoes, fodder, breeding)

Non-organic prime movers

- Watermills (England, 11th century)
- Wind power: sails (+ compass, heavy cannons, rear stear = colonization)



# Progress in the Middle Ages: fuel scarcity

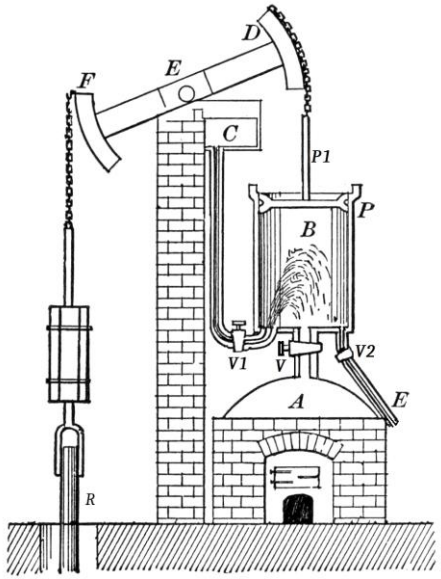


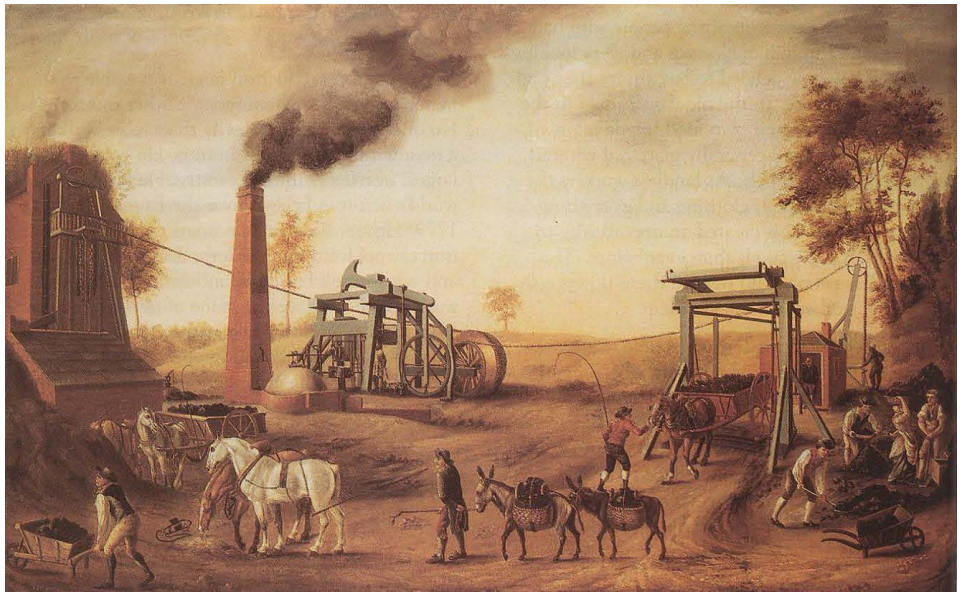
Early 18th century England

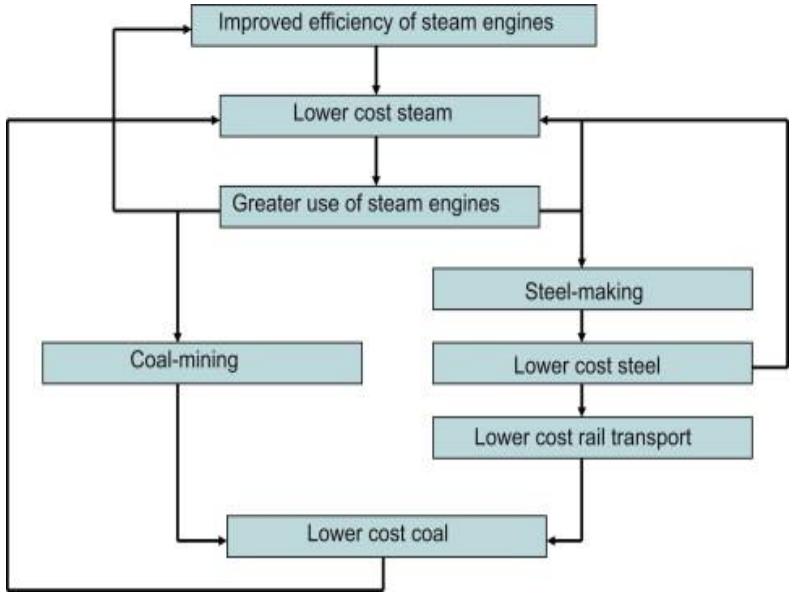
- Average furnace
  - 300 tons of iron per year
  - 12,000 tons of wood
  - 20 square km of forest

- Total production: 20,000 tons of iron (1,100 $km^2$ of forest)
- Total production in early 19th century: 1,000,000 tons of iron

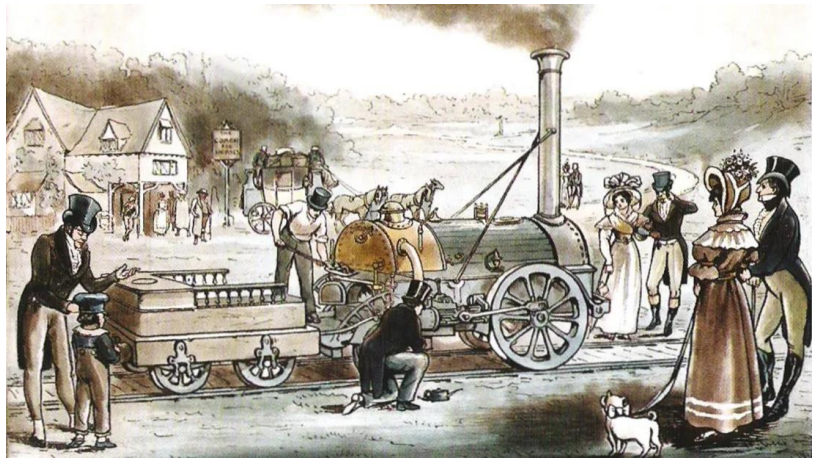
# Towards modernity: steam engine



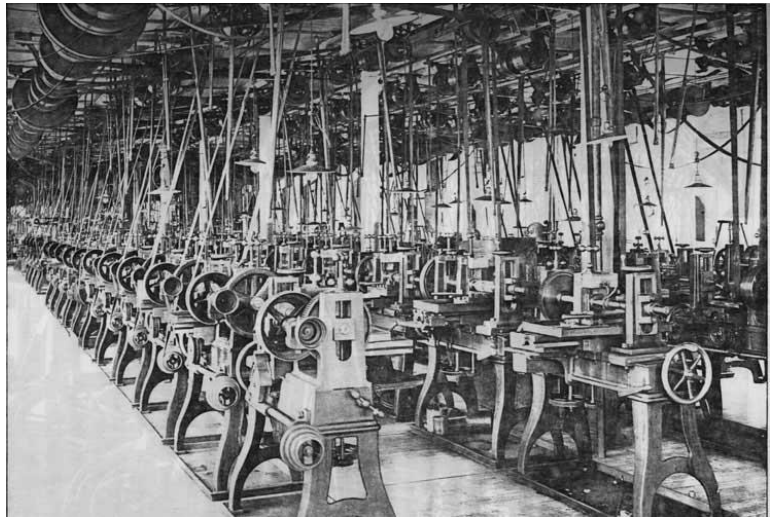



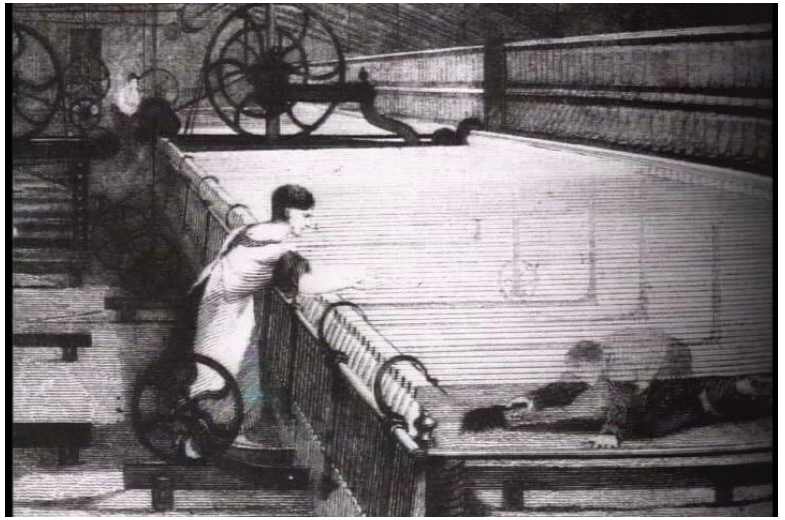



- Early steam engine (Newcomen): 20 kW, efficiency 5%
- Coal – steam – steel positive feedback
- Later (19th century): inland transport revolution



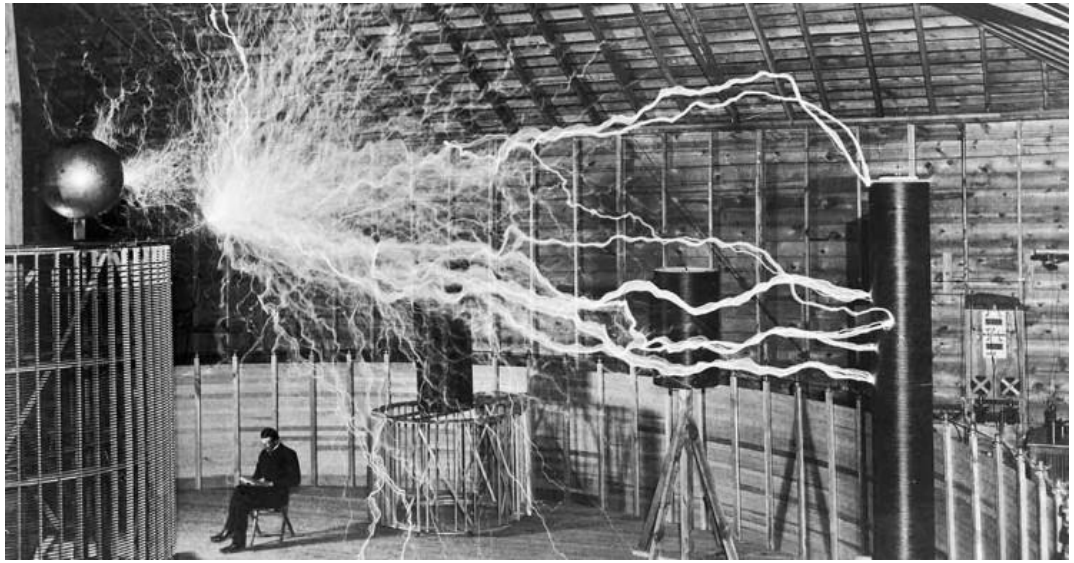
# Towards modernity: industrial revolution





- Powered by watermills and later steam
- Europe 1800-1950: Five distinct prime movers: humans, animals, watermills/turbines, windmills, steam engines
- USA 1870: mechanical power outweighs organic  power
- North Sea 1900: installed capacity in windmills: 100 MW

# Towards modernity: 1880-1900



- T. A. Edison: the basics of electricity production and use
- G. Westinghouse and N. Tesla: alternating current
- Ch. Parsons: steam turbine
- W. Stanley: transformer
- N. Tesla: electric motor

- USA 1930s: 80% of all mechanical power electrified
- Profound change in work and personal life

- G. Daimler: spark ignition engine
- W. Maybach: carburator
- K. Benz: electrical ignition
- R. Diesel: compression ignition engine

- Three waves of automobile dissemination
- Aviation: 1904: the Wright brothers, 1969 Boeing 747, 1969: Apollo 11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# Energy-intensive society

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| Prime Mover | Sustained Power (W) |
|---|---|
| *Working child* | 30 |
| *Small woman* | 60 |
| *Strong man* | 100 |
| *Donkey* | 150 |
| *Small ox* | 300 |
| *Typical horse* | 600 |
| *Heavy horse* | 800 |
| *Early small tractor (1920)* | 10,000 |
| *Ford's Model T (1908)* | 15,000 |
| *Typical tractor (1950)* | 30,000 |
| *Honda Civic (2000)* | 79,000 |
| *Large tractor (2000)* | 225,000 |
| *Large diesel engine (1917)* | 400,000 |
| *Large marine diesel engine (1960)* | 30,000,000 |
| *Four gas turbines of Boeing 747 (1970)* | 60,000,000 |

- Mechanization of agriculture and industry

- Last 10,000 years:
  - Maximum power of the prime movers has increased 15,000,000x
  - 99% of this change occurred in 20th century

# Energy-intensive society

- Increased quality of life
- Increased inequality
  - 10% consumes 40% of all primary energy
  - 50% consumes 10% of all primary energy
- Anthropocene

# Conclusions


- Development stages reflect the power, efficiency, and flexibility of employed prime movers
- Harnessing more energy leads to greater complexity of society
- Maintaining the level of complexity requires energy

# Now, about the course..

# What will we be doing here?

- Identify and analyze the most influential trends in the past and present energy system.
- Learn about the contemporary energy policies.
- Discuss the future of energy.

# Who will be guiding you through the course?

Tereza Stašáková

Matěj Hrubý

Jan Osička

Anežka Konvalinová

# Masaryk University Center for Energy Studies

Founded by Břetislav Dančák in 2009

Dpt. of International Relations and European Studies: 8 full-time researchers

Multidisciplinary research platform dealing with energy

- Social dimension of energy transactions (public participation, local opposition, energy poverty)
- Energy geopolitics (Russia, pipelines, power)
- Energy transition (renewable energy, decarbonization)

# Center for Energy Studies

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