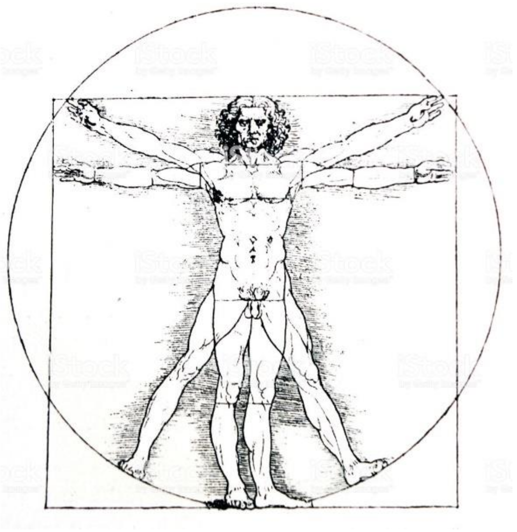
Energy and Society

Jan Osička

What is the average power output of human body?

How much power deliver the following devices?



Energy-intensive society: how did we get there?

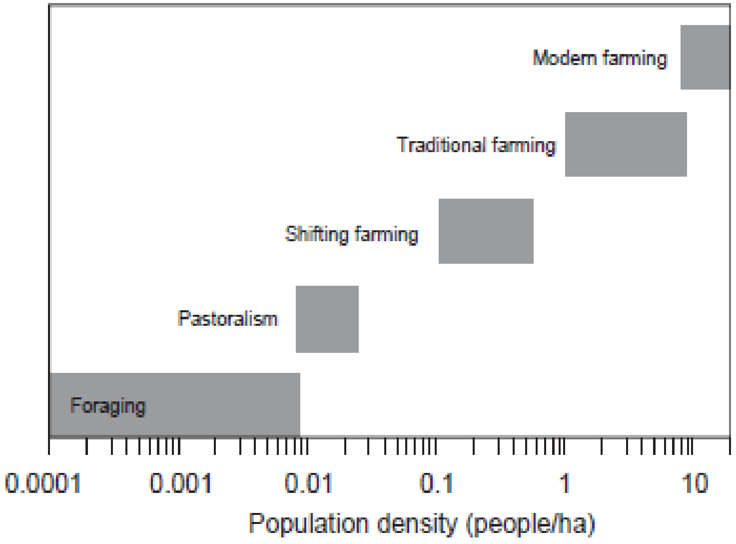
Foraging society

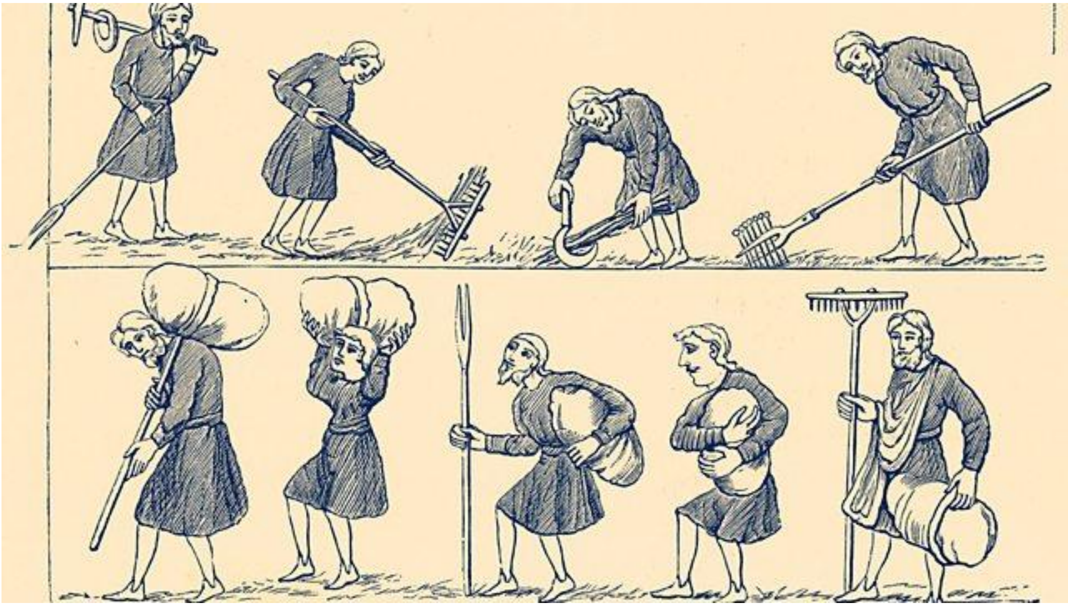
- Human body and exosomatic sources of power - fire, body extensions (bows)
- Energy return on investment (EROI) up to 40, usually around 3, often around 1.
- Very low population density (0,1 person/sq. km)

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

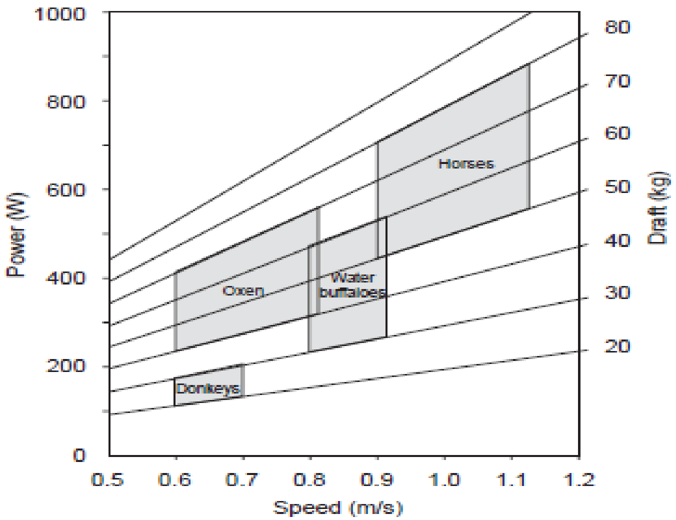


Organic prime movers still dominant

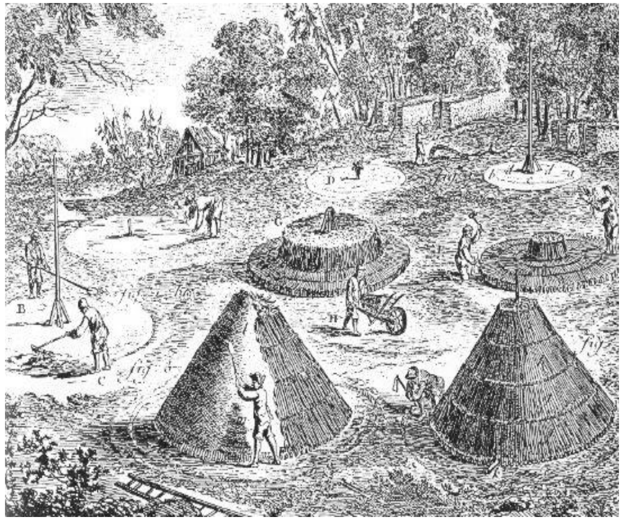
- Increased efficiency in energy transformation (treadwheels, horseshoes, fodder, breeding)

Non-organic prime movers

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



Progress in the Middle Ages: fuel scarcity

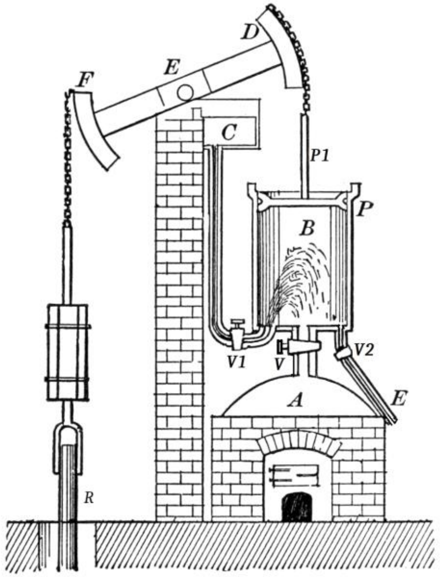


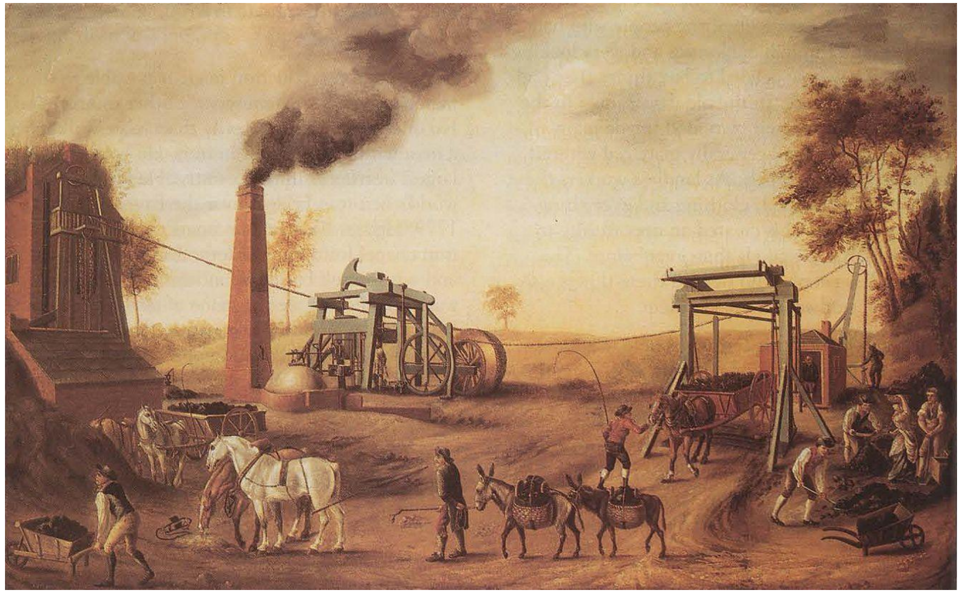
Early 18th century England

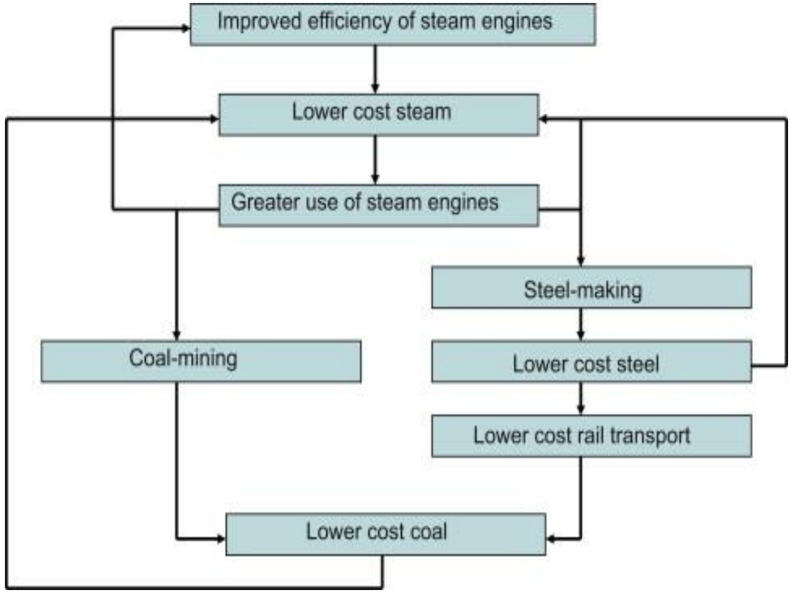
- Average furnace
  - 300 tons of iron per year
  - 12,000 tons of wood
  - 20 square km of forest

- 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

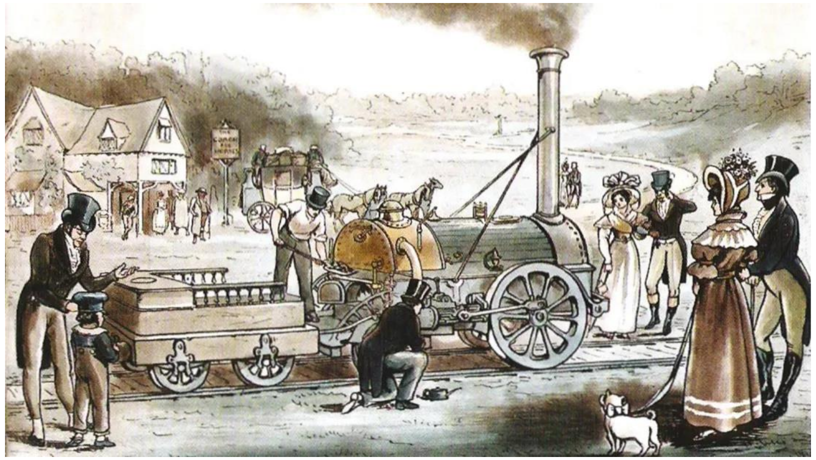
Towards modernity: steam engine



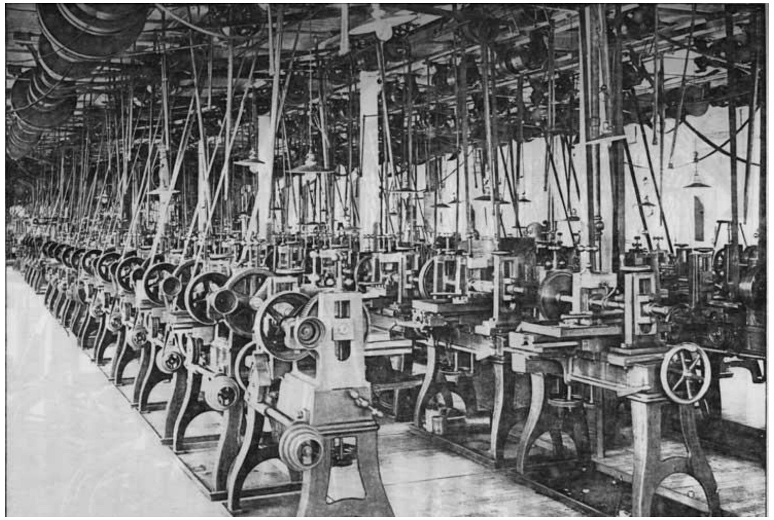
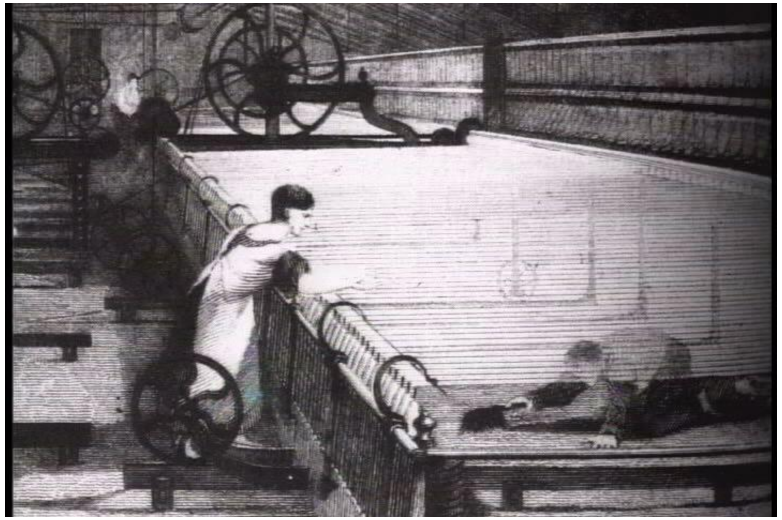




- Early steam engine (Newcomen): 20 kW, efficiency 5%
- Coal – steam – steel positive feedback
- Later (19th century): inland transport revolution

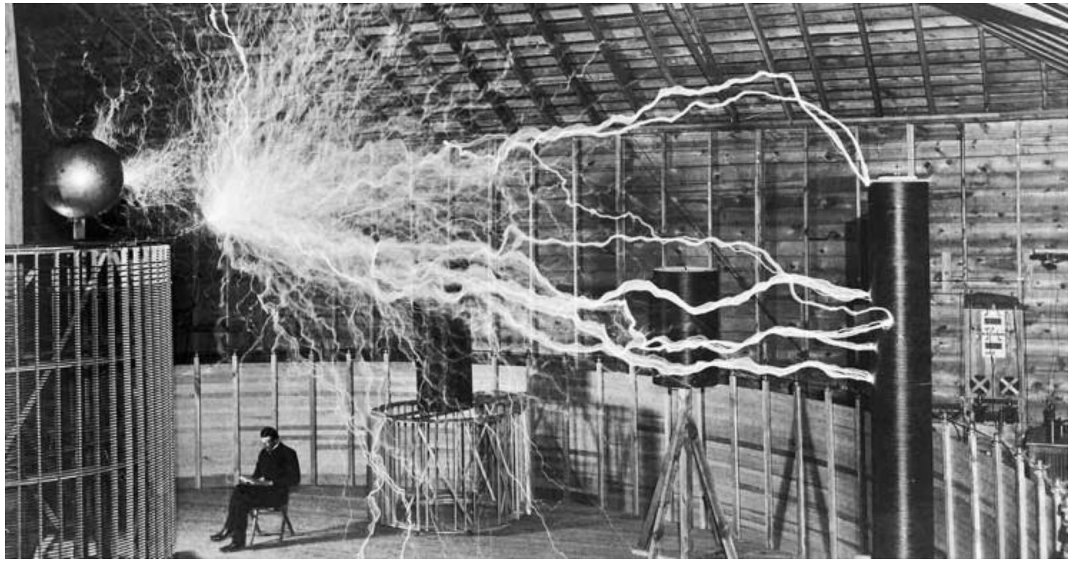


Towards modernity: industrial revolution

- 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



PAN AM


Energy-intensive society

Energy-intensive society

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?

Jan Osička

PhD thesis: Gas flows through the V4 region (linear modeling)

- Energy markets
- Energy transitions
- Cross-border effects of energy policies

Filip Černoch

PhD thesis: Energy policy of the EU

2016 Energy advisor to PM Sobotka

- Energy policy in the EU
- Energy transitions
- The regulation behind Energiewende

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

Energy research and education platform of the Faculty of Social Studies, Masaryk University, the Czech Republic.

Mezinárodní vztahy a energetická bezpečnost

(Czech language masters degree)

Energy Policy Studies

(English language masters degree)

Summer school

(In cooperation with Energy Community)

Energy research

(Research areas and activities)

www.energy.fss.muni.cz