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Why is energy fundamental to understand economic growth? Why does that make the energy transition so hard?

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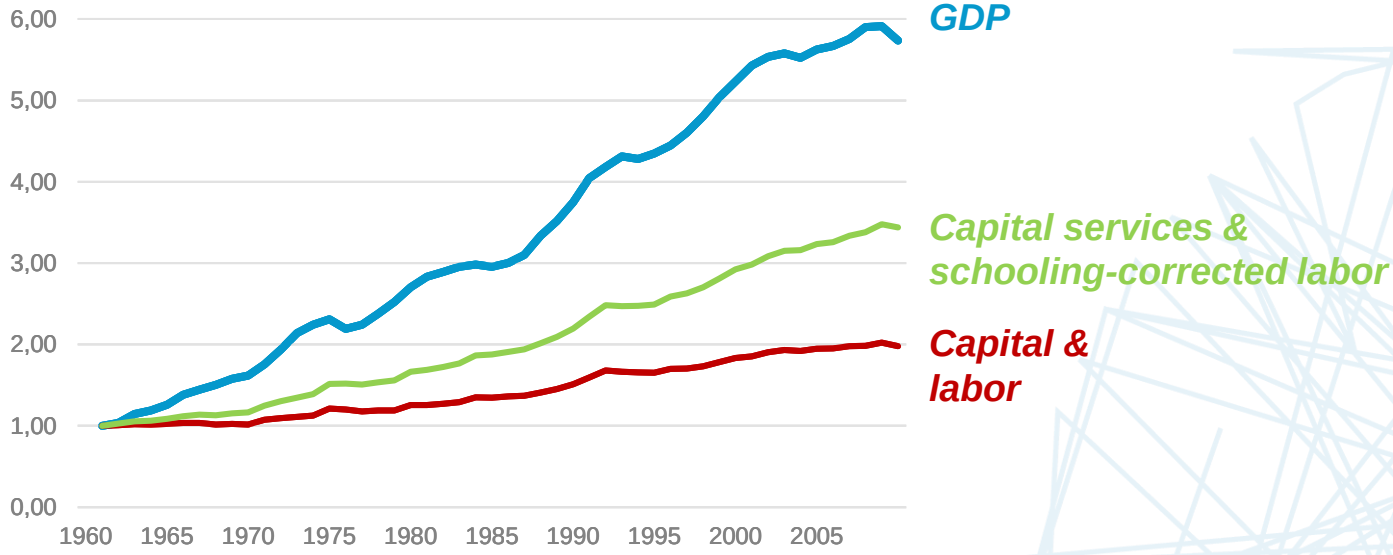
TÉCNICO LISBOA

GDP and production factors: Portugal 1960-2009



Exergy

- The statement “a lamp consumes energy” is WRONG
- Energy is conserved, so a lamp cannot consume energy
- A lamp degrades energy, reducing its quality
  - We can do much more with electricity than with heat and light
- So, electricity has a higher exergy than heat and light
- The statement a “lamp consumes exergy” is RIGHT

Primary, final and useful exergy

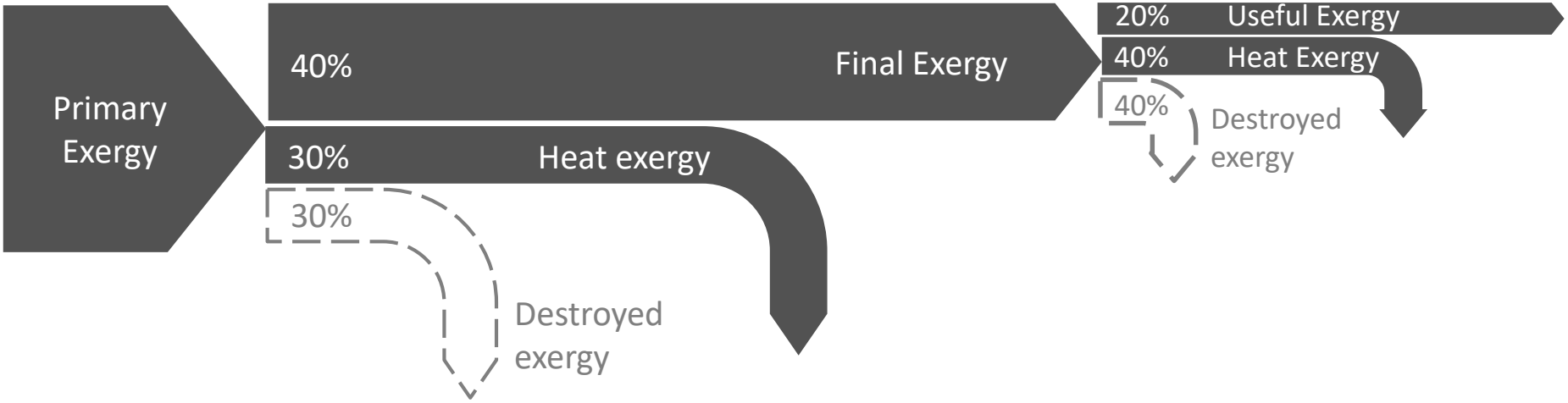
Coal (30 g)
0.27 kWh

Power station

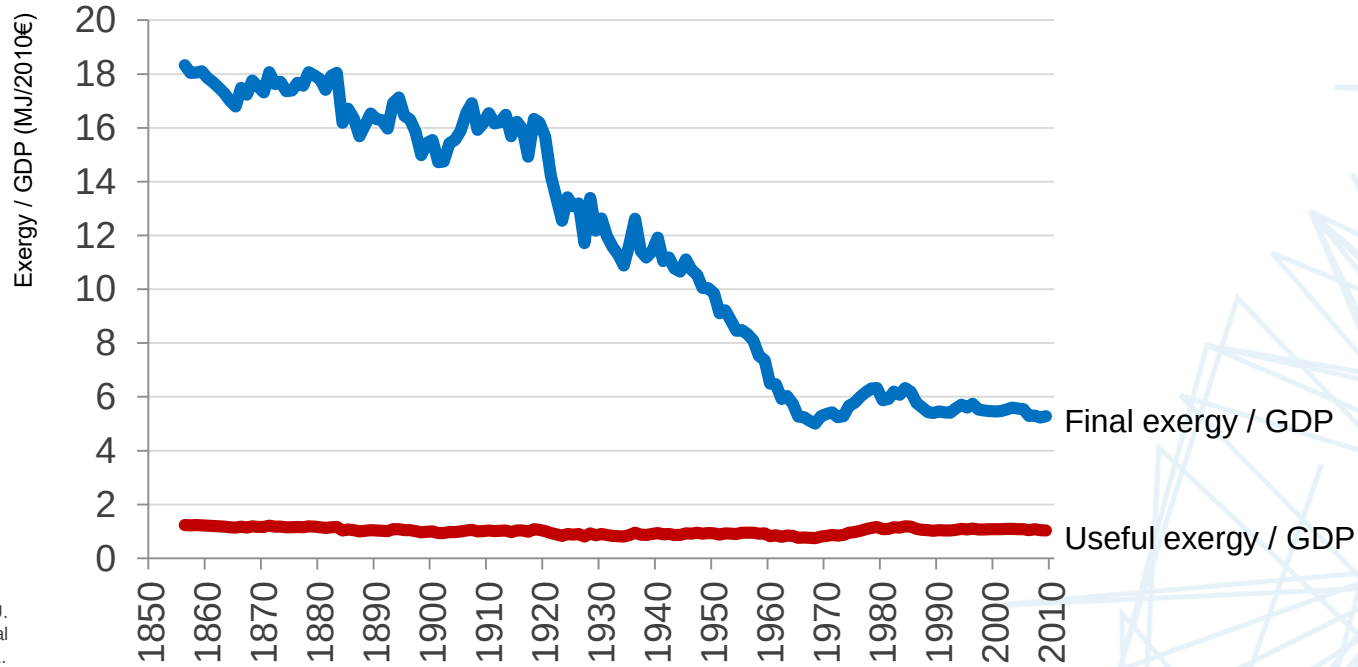
Electricity
0.08 kWh

Lightbulb

Light
0.02 kWh

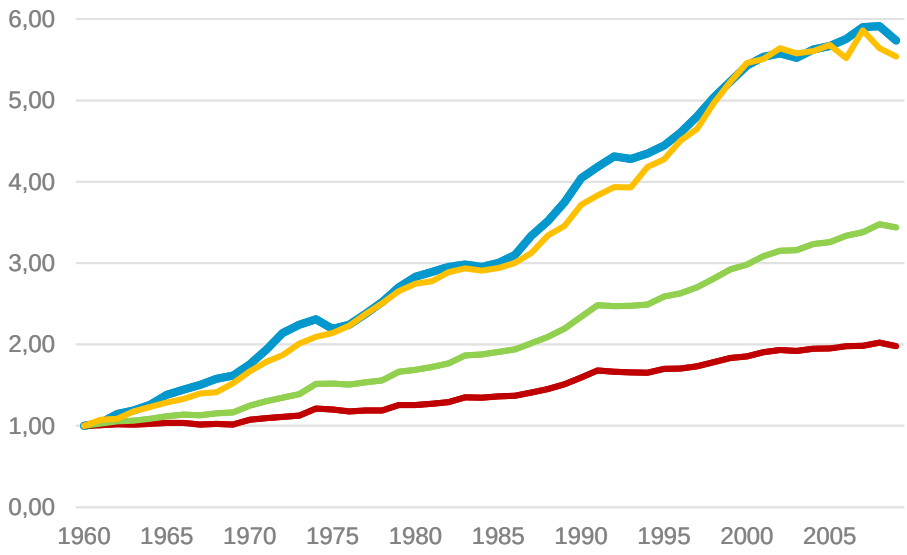


Final and useful exergy intensities



Serrenho, A. C., B. Warr, T. Sousa, R.U. Ayres, T. Domingos (2016). Structural Change and Economic Dynamics, 36, 1-21.

Energy-corrected capital explains the Solow residual



GDP

Energy-corrected capital and schooling-corrected labor

Capital services & schooling-corrected labor

Capital & labor

The Parable of the English Farmer

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