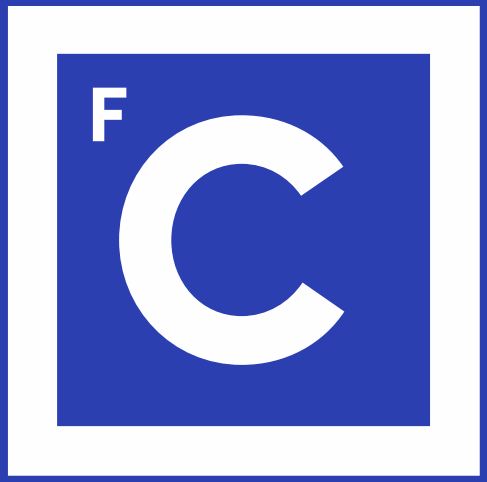


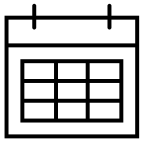
Ciências ULisboa

Faculdade
de Ciências
da Universidade
de Lisboa

Eng Energy & Environment

Combustion

Carla Silva (Teóricas e práticas) /Theory and practice
camsilva@ciencias.ulisboa.pt



Thursday

9h-12h 6.2.44

- Watch recorded lessons
- Doubts, experiments

4 assignements + oral evaluation

Program

Content
Introduction to combustion, definition, applications, world fuels and projections, problems of combustion
Thermochemistry: stoichiometry, chemical reactions, mass and molar concentrations, CO_2 emissions estimation
Thermochemistry: Heating value, chemical equilibrium, flame temperature
Fuels and properties, examples
Ignition- spontaneous and forced, examples Internal combustion engine
Flame types: pre-mixture, diffusion , laminar and turbulent, examples Internal combustion engine
Liquid fuel and solid fuel combustion, examples internal combustion engine, power plants
Pollutant control/standards
Pollutant control/standards
Pollutant formation and estimation
Pollutant formation and estimation
Internal combustion engine
Biomass/Coal/combined cycle natural gas Power plant
Biogas Power plant

At the end you should:

- ✓ Know the contribution of combustion to world energy generatiom and its contribution to emissions;
- ✓ Distinguish between local and global emissions;
- ✓ Know typical values of energy efficiency and typical emission factors e.g. g/($kWh_{electricity}$); g/km; g/MJ_{heat};
- ✓ Know the main combustion technologies, advantages and disadvantages and potential for improvement;
- ✓ Know how internal combustion engines work;
- ✓ Know how a gas turbine work;
- ✓ Estimate emissions from thermoeletric powerplant and compare with regulation;
- ✓ Propose measures to minimize emissions.

Literature

1. **Pedro Coelho e Mario costa. Combustão. 2012.Edições Orion.**
2. Stephen R. Turns. An introduction to combustion. Concepts and applications. 1996. McGraw-Hill.
3. EMEP/EEA air pollutant emission inventory guidebook – 2013. European Environmnent Agency.
4. John Heywood. Internal Combustion Engine Fundamentals. 1988. McGraw-Hill.
5. M.K. Gajendra Babu,K.A. Subramanian. Alternative Transportation Fuels: Utilisation in Combustion Engines. 2013. CRC Press.

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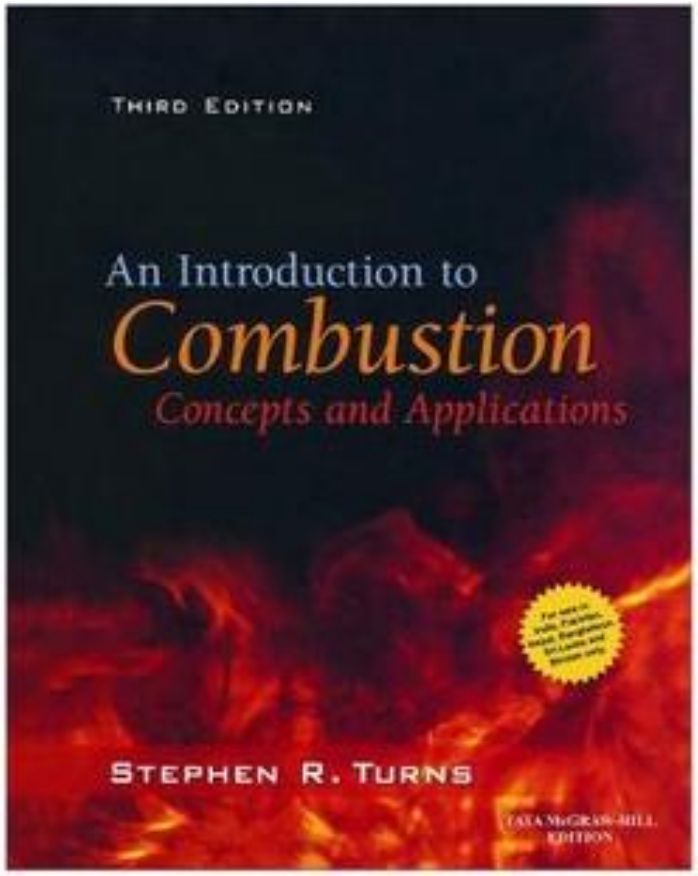
Stephen R. Turns. An introduction to combustion. Concepts and applications. 1996.

McGraw-Hill.



Main chapters 1, 2, 5, 15 (importance of combustion, thermochemistry, mass balances, energy balances, GHG emissions and pollutants)

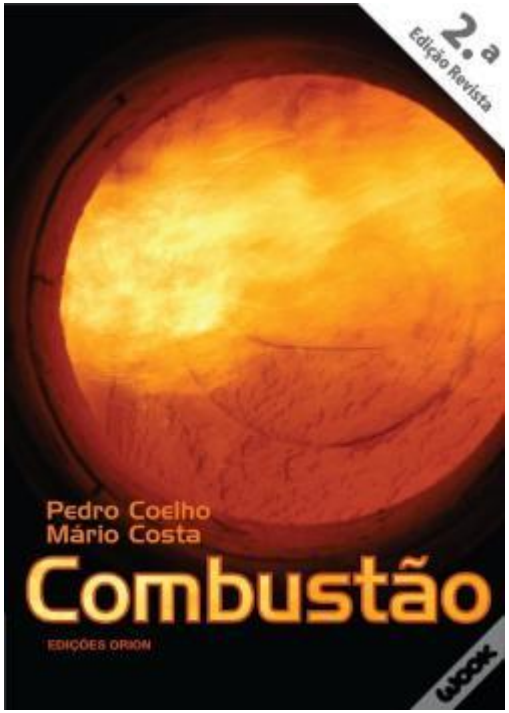
And some notions of 10, 14 (solid and liquid burning)

Diesel, Gasoline, jetfuel, Coal, natural gas, biogas, biocoal, biomass

Pdf available

Literature

Pedro Coelho e Mario costa. Combustão. 2012.Edições Orion.



Main chapters 1, 2, 5, 12

And some notions of 6,10
(gas, solid and liquid burning)

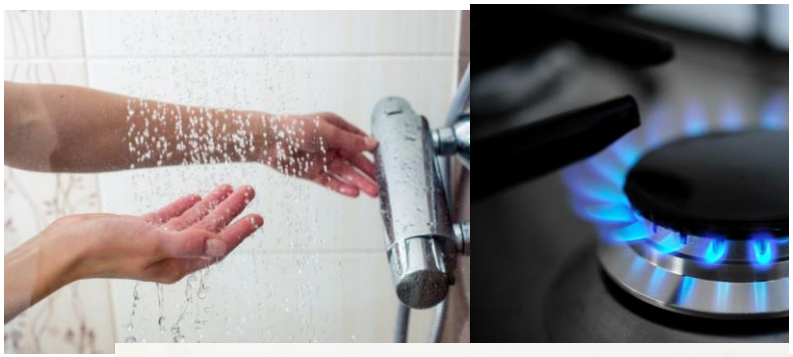
Diesel, Gasoline, jetfuel, Coal, natural gas, biogas, biocoal, biomass

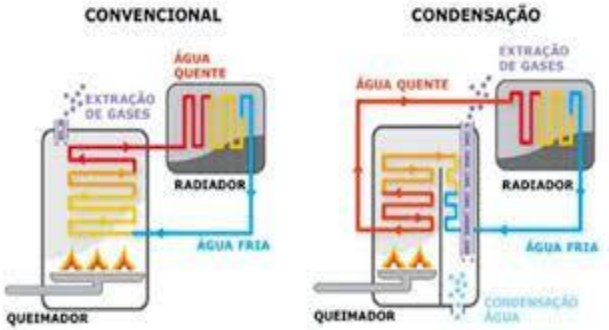
Pdf available

Importance

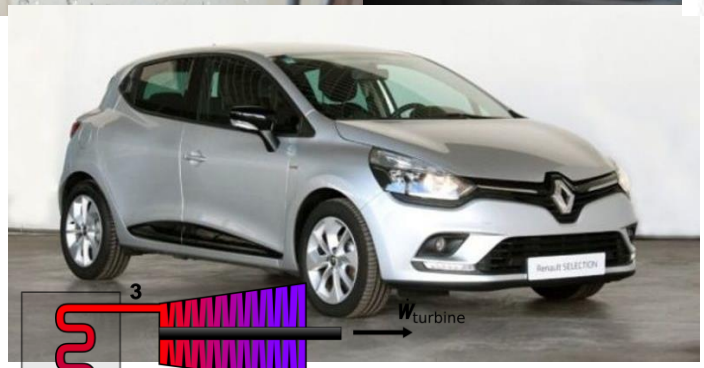
Why **“controlled”** combustion is important????

HEAT

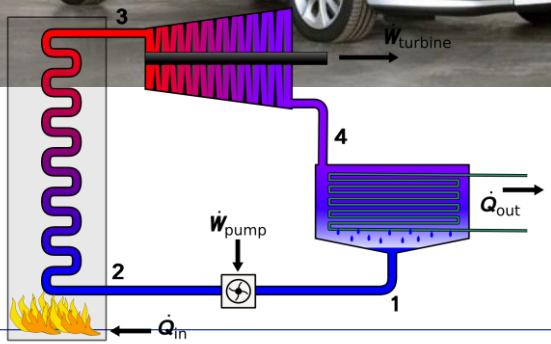




MECHANICAL ENERGY



ELECTRICITY



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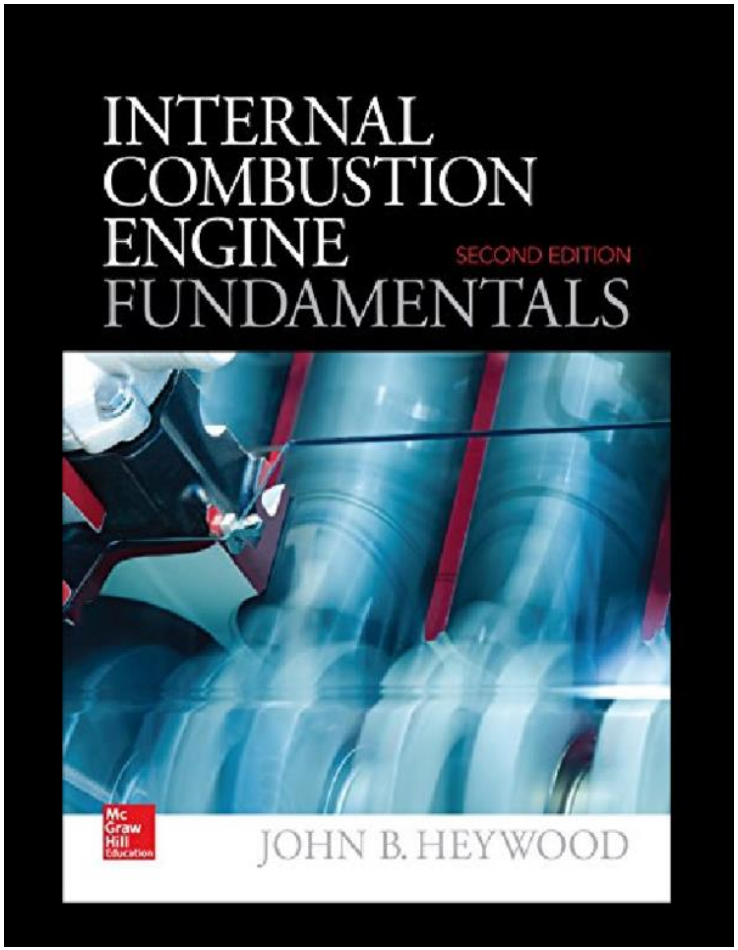
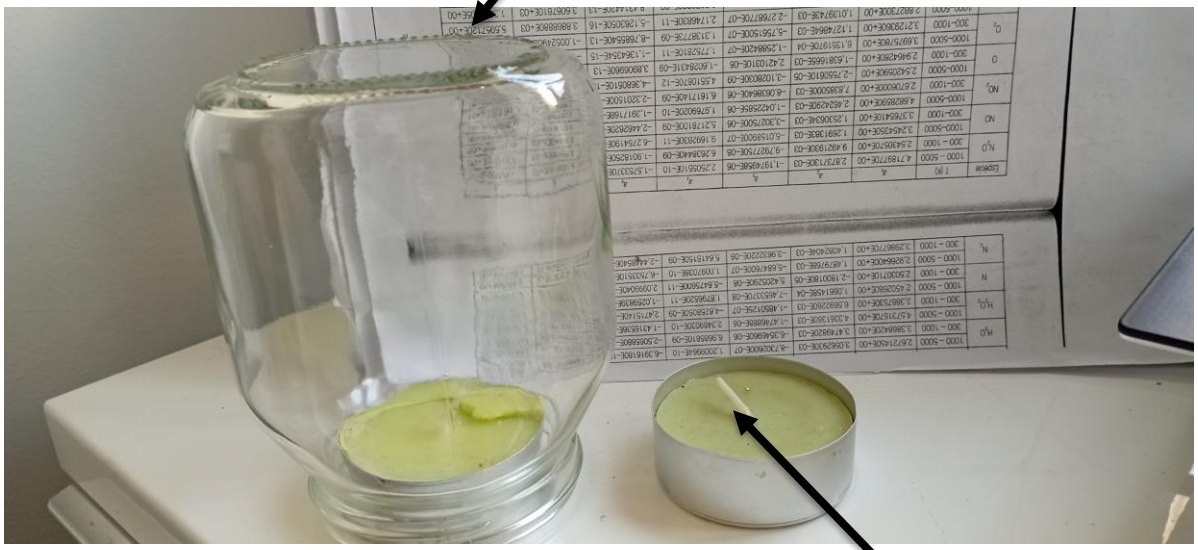


Technology to transform chemical energy into mechanical energy and heat

Pdf available

Candle (birthday, sent, etc)

Glass limiting



Moisture in the candle wick vs no moisture

Candle (birthday, sent, etc)

Magic/Trick candles, how?

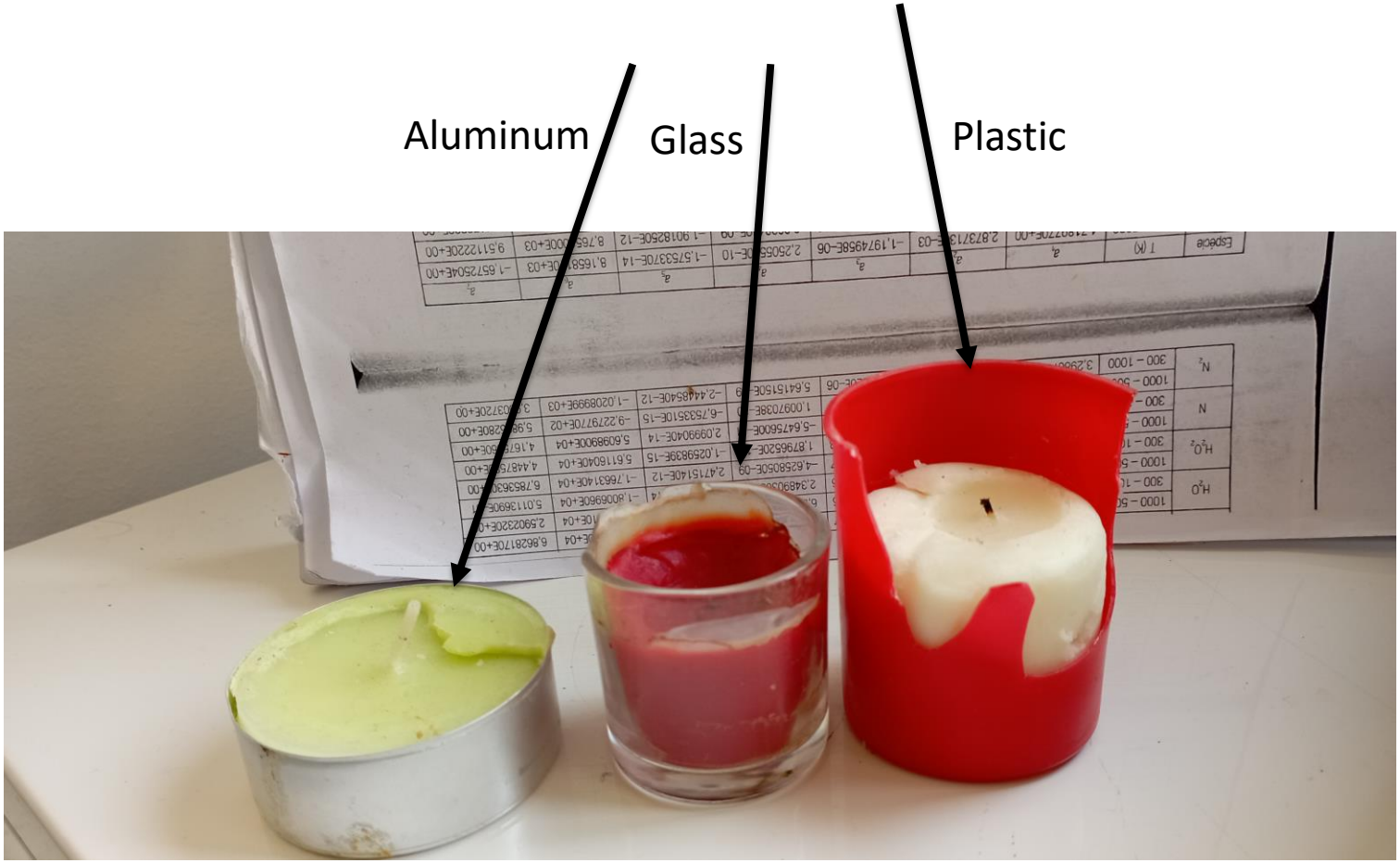
magnesium powder is incorporated into the candle's wick

It produces sparks at 430 ^{o}C

Magnesium + oxygen → magnesium oxide.
2Mg + O2 → 2MgO

Candle (birthday, sent, etc)

Different container materials, the red can burn but not aluminium or glass, why?



Candle (birthday, sent, etc)

Different container materials, the red can burn but not aluminium or glass, why?

Aluminum

Melts at
660 ºC

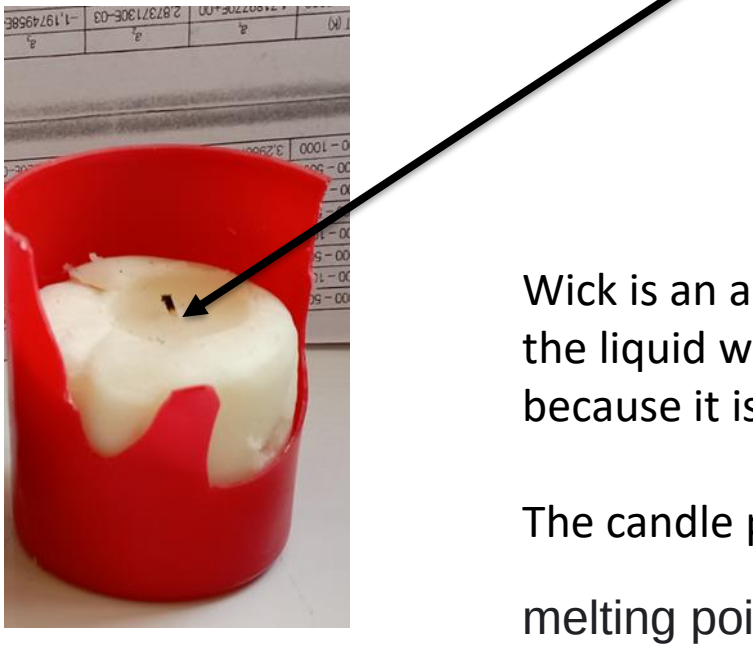
Plastic

$(C_2H_4)n$,
Polyethylene
120 ºC

Glass melts at
1700 ºC

Candle (birthday, sent, etc)

Flame colour, wick colour



Dark wick, why?

Wick is an absorbent and wax is the absorbate the liquid which gets absorbed. It goes black because it is mainly fixed carbon (char)

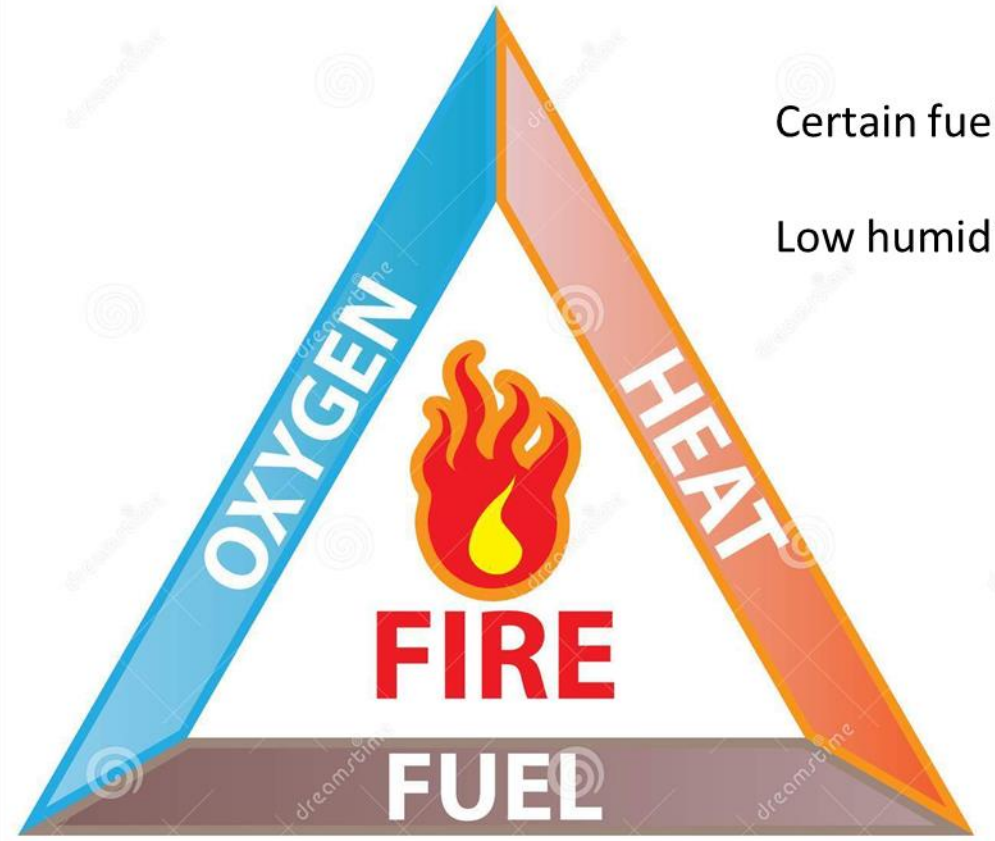
The candle paraffin: C_nH_{2n+2}

melting point ~ 60 ºC

Liquid vaporizes and burn at 310 ºC

Combustion

Combustion is essentially burning, fuels react with oxygen to release energy



Certain fuel/oxygen ratios

Low humidity

1st assignment

Retrive the coal, natural gas and crude oil consumption in Portugal in the years 2017 to 2023. (DGEG - https://www.dgeg.gov.pt/pt/estatistica/energia/petroleo-e-derivados/vendas-mensais/ https://www.dgeg.gov.pt/pt/estatistica/energia/gas-natural/consumos/ https://www.dgeg.gov.pt/pt/estatistica/energia/carvao/consumos/)

i. Represent each fossil fuel consumption troughout time.

ii. Coal, natural gas and crude oil is **mainly** used where and involves combustion or not?

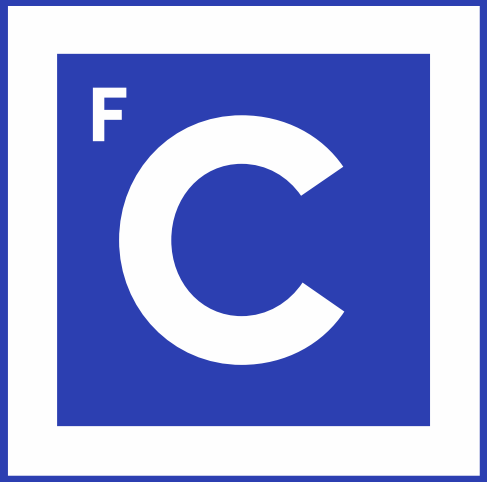
iii. Coment COVID-19 impact, coal powerplant deactivation and decarbonization targets effect on the evolution of fossil fuel consumption.

iv. Look to a household “Consumo médio anual total de energia por alojamento”, and “Consumo médio anual de energia em meios de transporte por alojamento“ in 2010 and 2020, **tep/alojamento**, and discuss if the energy is obtained from combustion.

https://www.ine.pt/xportal/xmain?xpid=INE&xpgid=ine_publicacoes&PUBLICACOEStipo=ea&PUBLICACOEScoleccao=59553032&selTab=tab0&xlang=pt

excel and pdf until 6 March

Thanks



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