CARBON NEUTRALITY ROADMAP 2045 FOR PORTUGAL

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TFIAM

Task Force on Integrated Assessment Modelling

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CENSE
center for environmental and sustainability research

Context

2015 2016 2017 2018 2019 2020 2021 2022 2023 2024

Paris Agreement

PARIS2015
UN CLIMATE CHANGE CONFERENCE
COP21·CMP11

Portugal Mitigation Goal

"Portugal reaffirms its firm commitment to be neutral in GHG emissions by the end of the first half of the century"

António Costa
Portugal Prime Minister
@COP22, dez-2016

Portugal Carbon Neutrality Roadmap 2050

RNC2050
Carbon Neutrality Roadmap

Alternative pathways for all sectors of economy that allow the achievement of net carbon emissions up to 2050

Carbon Neutrality Roadmap 2045

+

Revision of the National Energy and Climate Plan

Context & Objective

- Update of the ‘net zero GHG pathways’

Antecipate climate neutrality for 2045

- Integrate Carbon Neutrality Roadmap 2045 & National Energy and Climate Plan revision
- Envisage Transport & Mobility Sector

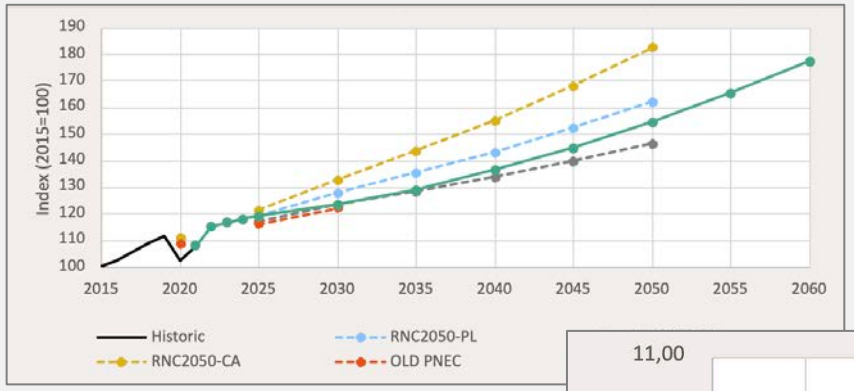
Cuurent process stages

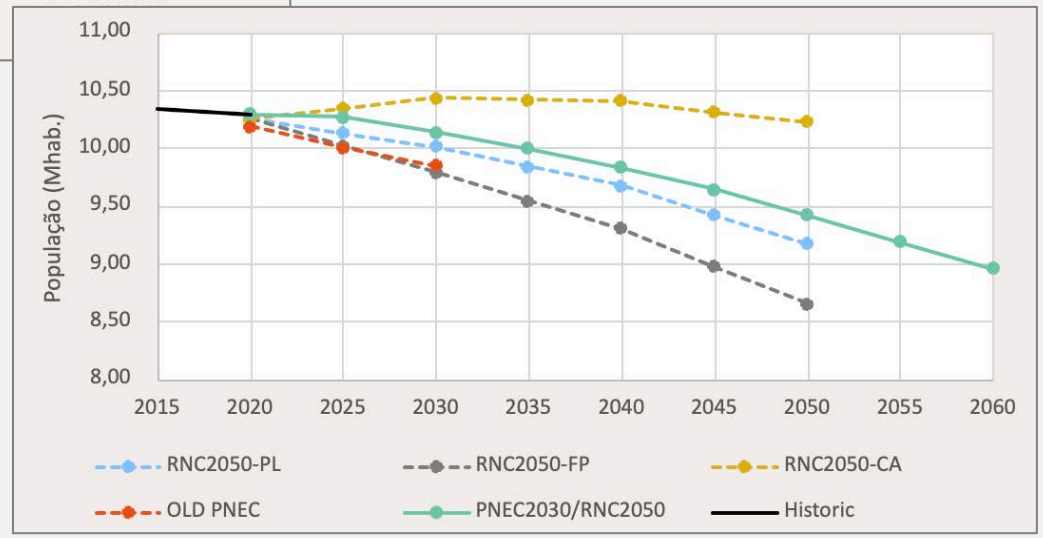
- Update of socio-economic drivers and other assumptions
- Update of technical-economic parameters of energy technologies
- Review of endogenous energy potentials
- Establish P&M integration in effect until the end of the 1st half of 2022 -> frontier between **Scenarios With Existing Measures** and **Additional measures**
- Energy services and materials demand projection stakeholder validation
  - Key infrastructure deployment (ex. New Lisbon airport) can influence climate policy definition and also air pollutant targets;

Storylines and Socioeconomic Scenarios

- Economic growth led by greater integration of Portugal in international circuits
- The production structure and population living standards do not change significantly
- Deep environment conscience and severe mitigation policies
- Circularity levels increase

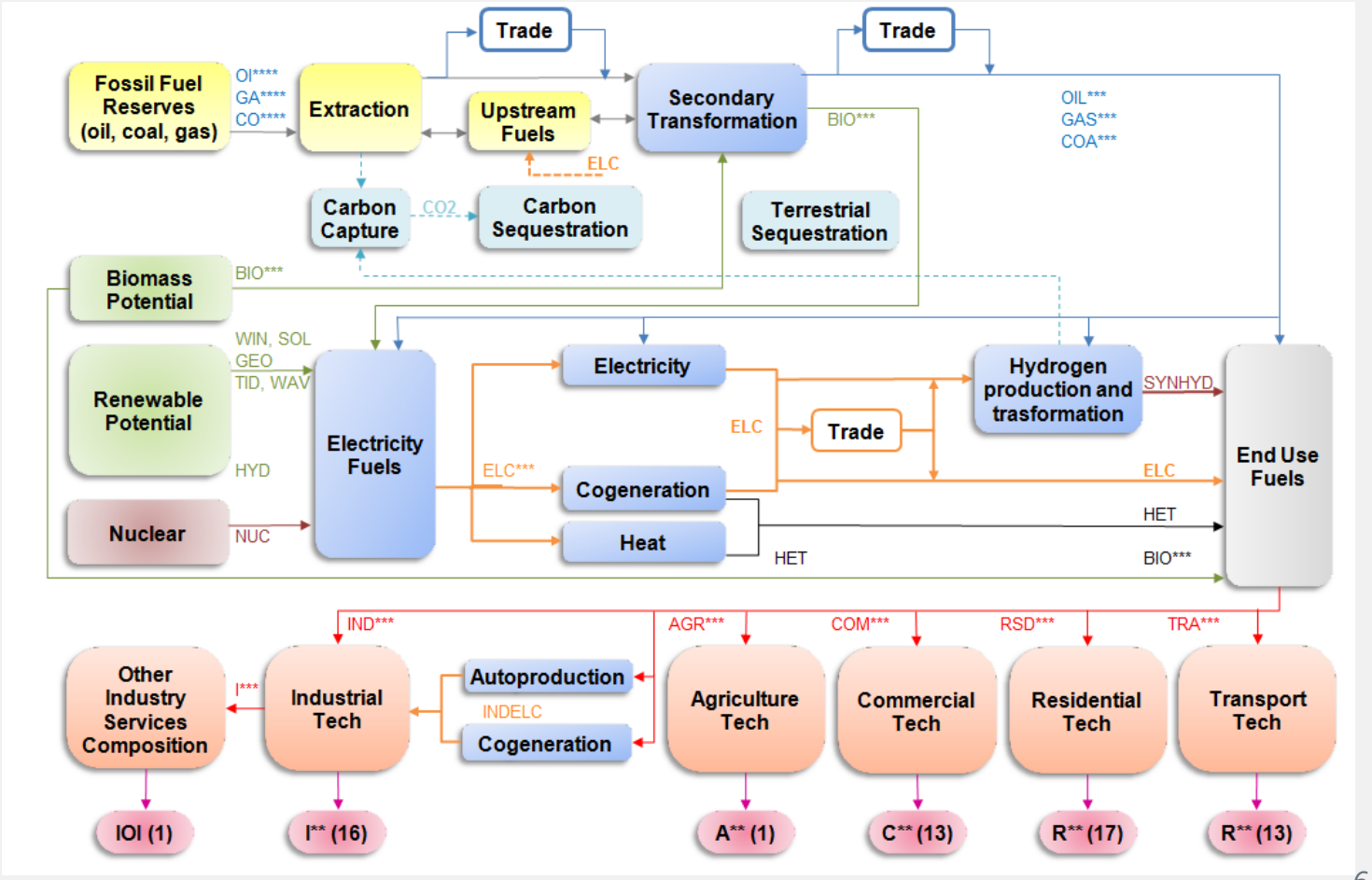
- New macroeconomic and population projections & New and validated demand for energy services and materials



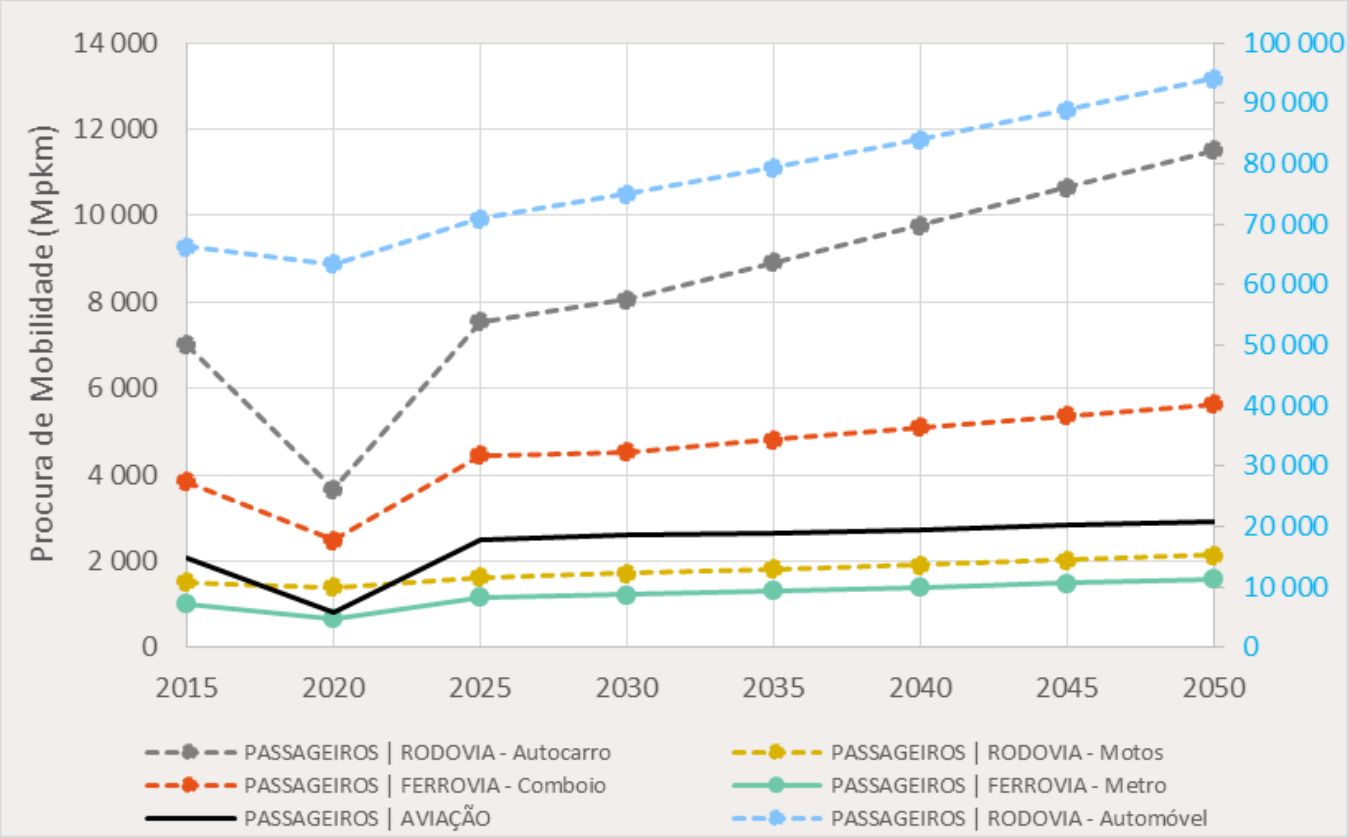


TIMES_PT modelling tool

- Bottom-up, linear **optimization energy system model**
- Represents the entire net structure of the Portuguese energy system up to 2050 with a very detailed technology description:
  - Investment, operation & maintenance costs;
  - Life time, starting year, efficiency, availability;
  - Emission factors



Methodology | decarbonisation transition
TRANSPORTS & MOBILITY



Mobility demand projections were updated to reflect transport activity post-COVID19;

Previous results

Transports transition
↓
+electrification
+sharing

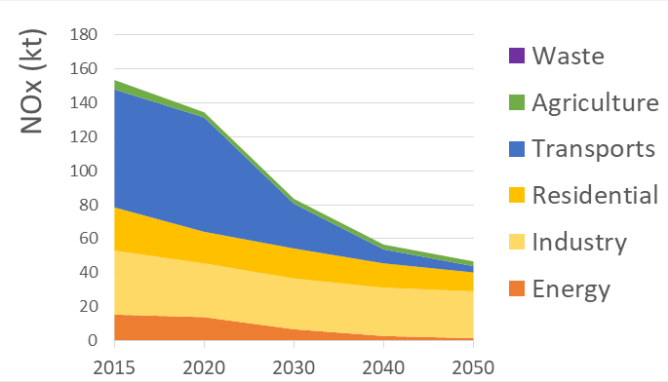
- Fast decarbonisation of the sector, even with higher demand for mobility in all modes (-98% in 2050 compared to 2005 GHG emissions)
- Traditional fossil fuels are progressively replaced by **electricity, biofuels and H2** (93% of the energy consumption in 2050)
- Electricity is preponderant in most of the means of transport (70% of the energy consumption in 2050)

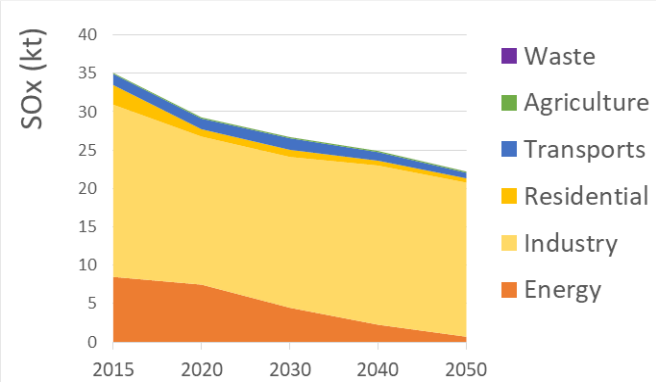
New - preliminary results

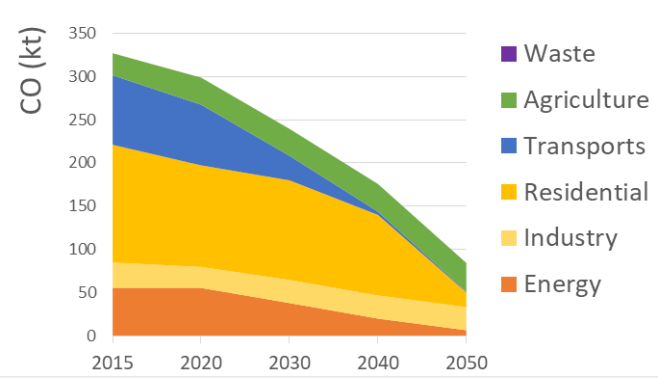
Transports transition
↓
+electrification
+sharing

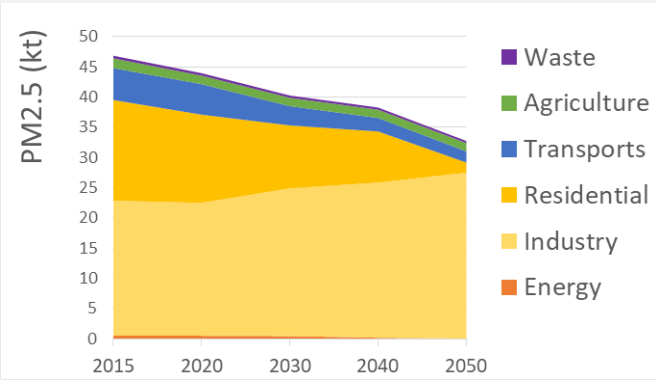
- Electricity maintains its preponderance in most means of transport;
- Biofuels reducing its predominance due to higher sustainability origin restrictions/criteria
- High uncertainty in aviation decarbonization reveals the potential for SAF.

Air pollutant emissions by sector (i)









- **Transports** (mainly road transport):

  →will reduce 95% of NOx and 99% of CO emissions in 2050

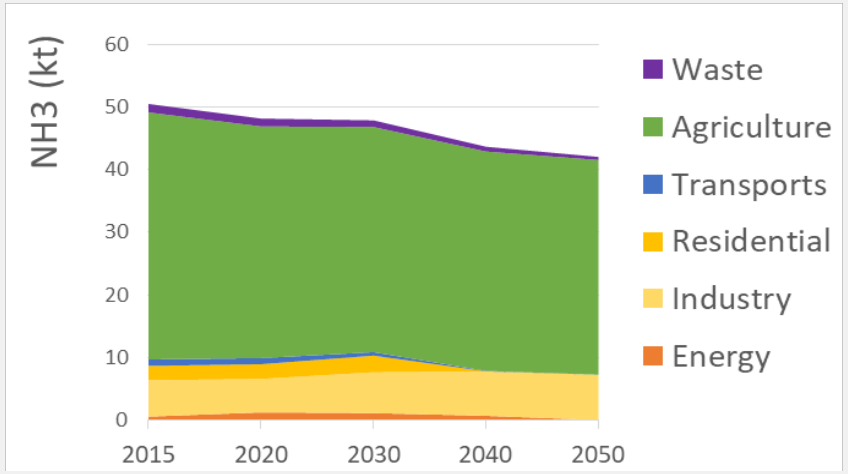
  → 2030 air emission targets (NECD) are highly dependent on the fulfilment of expected electric vehicle penetration

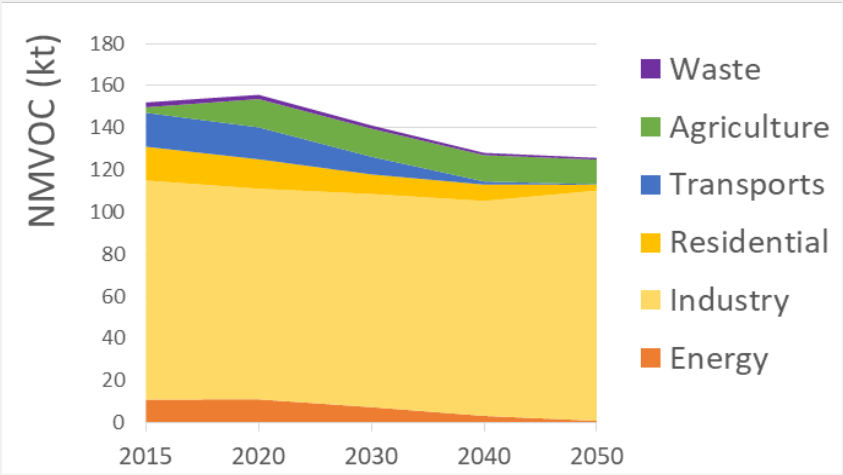
- **Industry** is one of the least cost-effective sector to reduce GHG emissions

  → also verified for air pollutants

  → for PM2.5, there is an increase of 23% in 2050, due to the shift to biomass fuels use and to the weight of process emissions

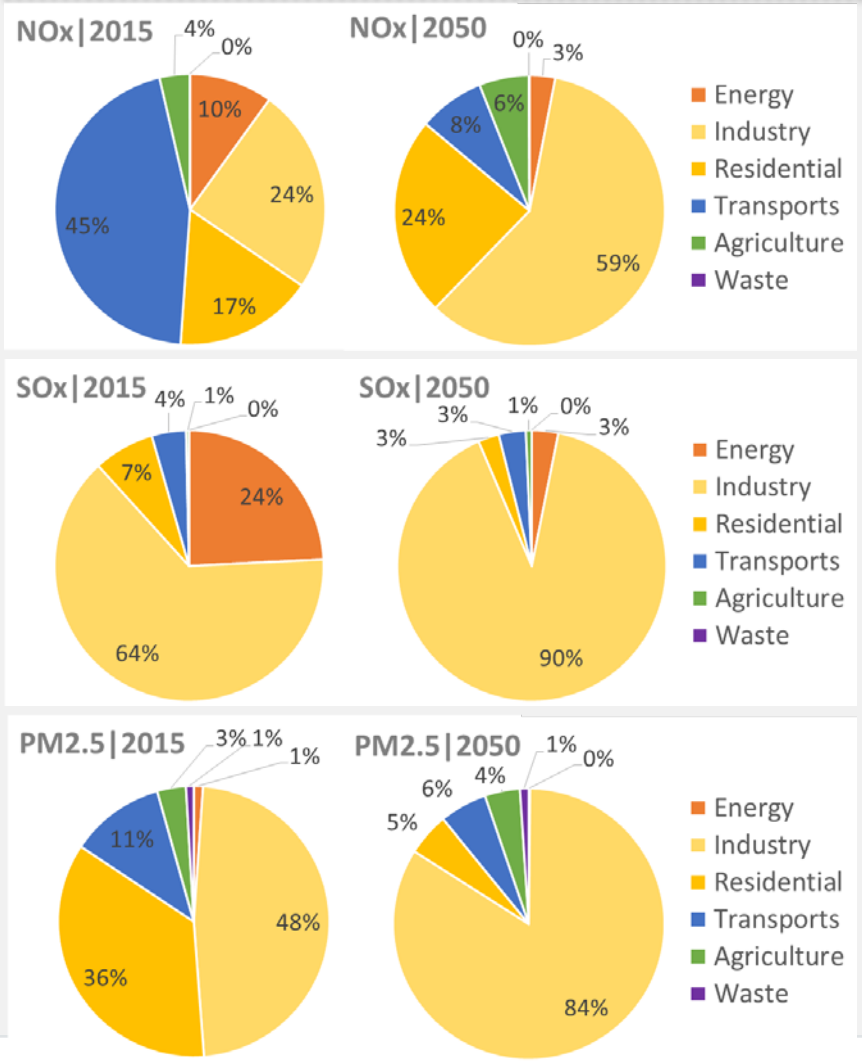
Air pollutant emissions by sector (ii)





- **Agriculture** is major source of **NH3** (78% in 2015, 82% in 2050)
- **NMVOC** emitted mainly by **Industrial sector** (68% in 2015, 87% in 2050)
- Global reduction by 2050 of **17%** for NH3 and NMVOC

Air pollutant emissions by sector (iii)



- Main sectors contributing to atmospheric emissions will change:
  - **NOx**: less Transports weight in emissions (8% in 2050). Industry is major sector in 2050 (59% in 2050)
  - **SOx**: less weight of Power generation (from 24% to 3%). Industry is major source in 2050 (90%)
  - **PM2.5**: less Residential contribution (from 36% to 5%). Industry gains relevance

Industry appears to be a relevant sector to tackle air pollution in the future, when designing strategies to control emissions

Air pollutant emissions by 2050

- Under the previous scenarios '**Yellow Jersey**' and '**Pack**', Portugal reaches carbon neutrality goal, in 2050, with strong benefits to air pollutant emissions
- These levels of emission reductions imply:

  →significant levels of **renewable sources** on final energy consumption, reaching 85-90% by 2050, in particular in the production of electricity, and consequently on road transport, which reaches full **electrification** by 2050

  →a significant increase in the **economy efficiency**, resulting in a reduction in primary energy consumption of around 40% and a significant reduction in the **energy intensity** of the economy

NEC DIRECTIVE 2016/2284

- In the **industrial** sector, it was not possible to achieve a significant reduction in process emissions (contrary to combustion), particularly in the subsectors responsible for the largest emissions, such as cement, paper and glass
- The **agriculture sector**, was the only one with a positive trend of GHG emissions 2005-2020 with ammonia emissions above the ceiling.
- In the **long term**, this sector acquires the highest weight in national emissions, due to the current technological limitations, which does not allow significant reductions, especially in the fraction related to process emissions

Additional measures to comply with 2030 reduction commitments must be mainly oriented to **industrial** and **agriculture** sectors

National Energy and Climate Plans (NECP), NEC Directive and the revised Air Quality Directive

- Portugal is **under non-compliance** since it does not have a National Air Pollution Control Programme (NAPCP); working in a 'revised' version as the first version
- Process chosen due to interlinked timelines:
  - National Energy and Climate Plans (NECP) ->
  - Air quality related emissions / revised NAPCP->
  - Air quality expected concentrations ->
  - Policies and measures defined to revisit NECP and comply with the revision of the Ambient Air Quality Directive ->
  - Final NECP compliant / NAPCP consistent / AAQD aligned

Challenges for air pollutant emissions projections

- The Portuguese compliance with NEC and revised AAQD is highly dependent of climate mitigation and policy measures, for example:
  - Inclusion of **aviation in ETS** and their impact on mobility demand trends and **fuel alternatives** -> SAF will maintain air pollutant emissions;
  - **Biomass use** for household space heating and in industry; heat pumps can benefit air pollutant emissions but still very expensive and with technical difficulties in the installation;
  - **H2 and/or biomethane blending with natural gas** grid and consequent burning in household appliances can result in the maintenance of air pollutant emissions in the building sector.

Thank you

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