Energy Efficiency 2050 Roadmap

Portugal

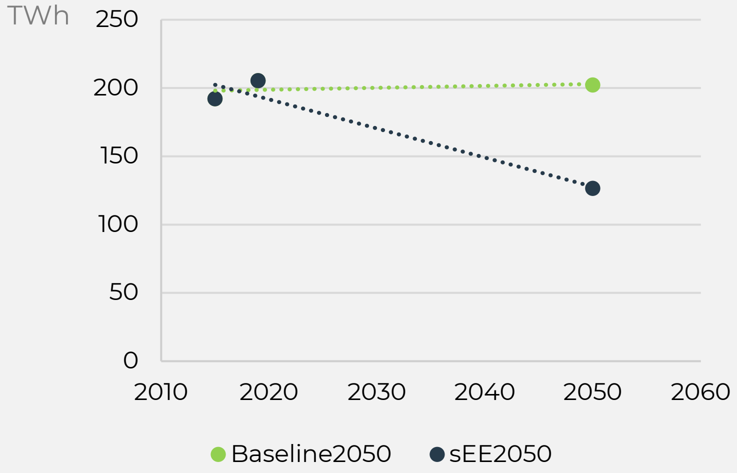
Korberg, Andrei David; Berthillot, Baptiste ; Mathiesen, Brian Vad; Maya-Drysdale, David William; Dahl Nielsen, Frederik; Abid, Hamza; Skov, Iva Ridjan

Publication date:
2022

Document Version
Publisher's PDF, also known as Version of record

PORTUGAL

Final energy demand

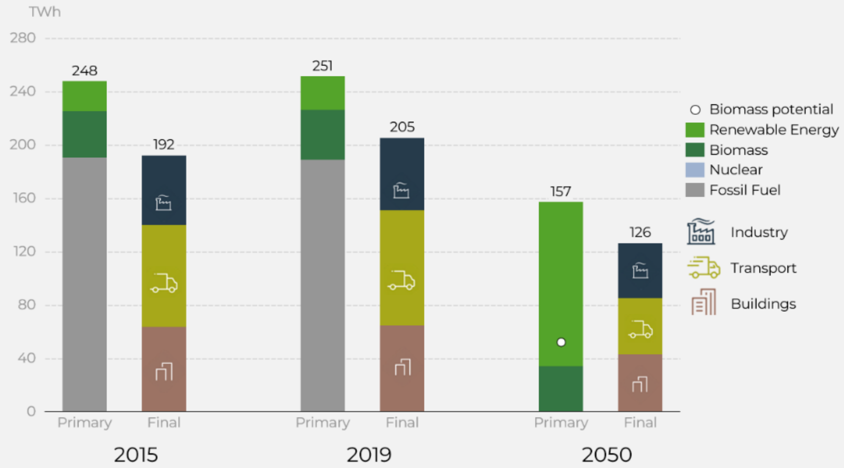


100% renewable energy transition overview

- Portugal can reduce its final energy demand cost-effectively following the Energy Efficiency First Principle by 37% from the 2050 baseline scenario
- The annual energy system cost remains similar to today even with massive electrification of transport and industry and new energy storages
- The population in Portugal is expected to decrease from 10.4 million to 9.1 million inhabitants in 2050

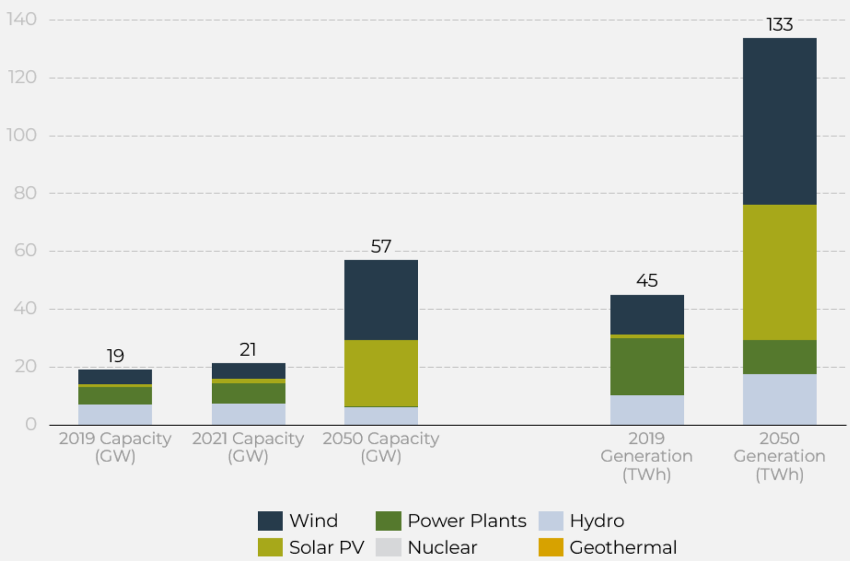
- The Energy Efficiency First Principle can reduce the final energy demand by 38% from 2019 to 2050
- Primary energy supply can be reduced by around 37% from 2019 to 2050
- The bioenergy consumption per capita is 13 GJ per person which is significantly lower than the EU sustainable level of 22

Primary and final energy demand



Electricity demand

Electricity capacity and generation

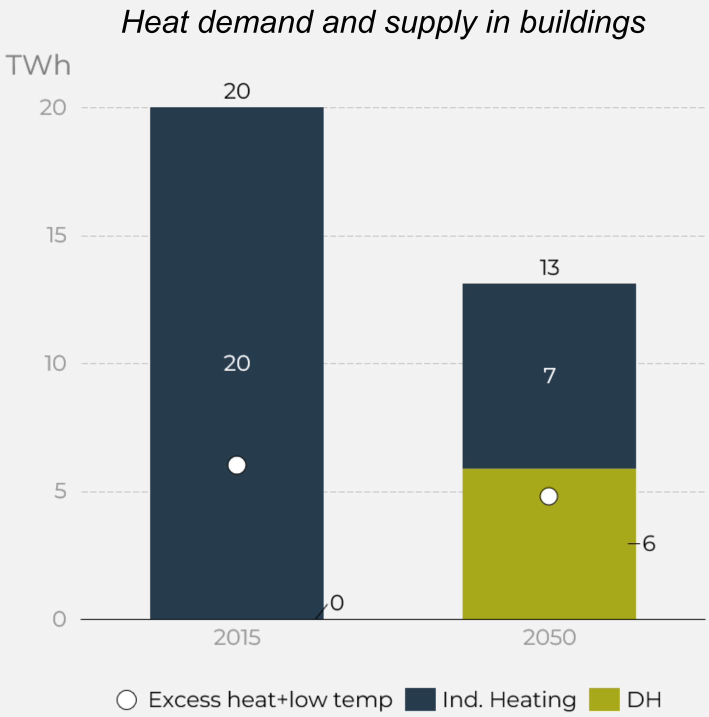


- Total electricity demand increases by 159% to 133 TWh in 2050 as compared to 2019
- New investment in wind and solar PV is 28 billion euros from 2019 to 2050
- Renewable electricity capacity is within the low potential of 64 GW for wind (onshore and offshore) and 92 GW for solar photovoltaics
- The energy system is balanced with high security of supply where new demands are situated with new supply and short-term thermal storages balance the district heat supply and demand
- Hydrogen production, heat pumps and electric vehicles are used to balance the electricity supply and demand

Heating in buildings

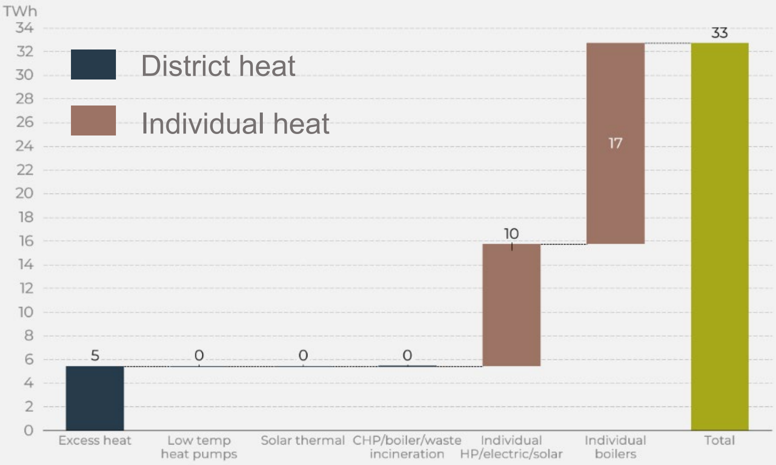
Click here for the Future Heat Demand, Efficiency Potentials and Supply Story Map

- The total heat demand in the residential and service building stock can be reduced cost effectively by 34% at a cost of 18 billion euros by 2050
- District heating share of the heat supply for the residential and service building can cost-effectively be increased from 1% to 45%
- Excess heat from industry and low temperature heat can supply over 81% of the district heating

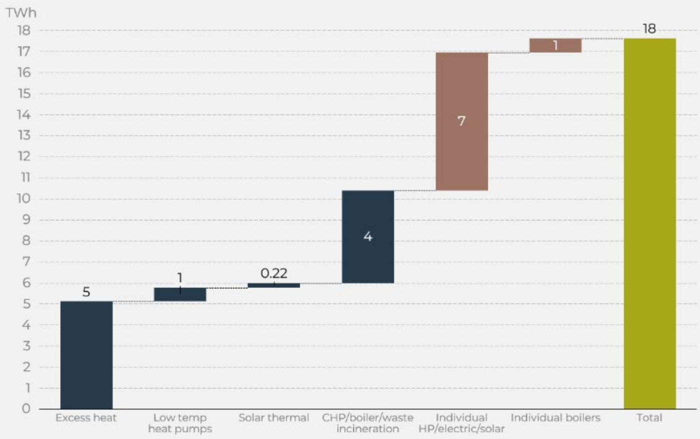


Heat supply for buildings

2015



2050

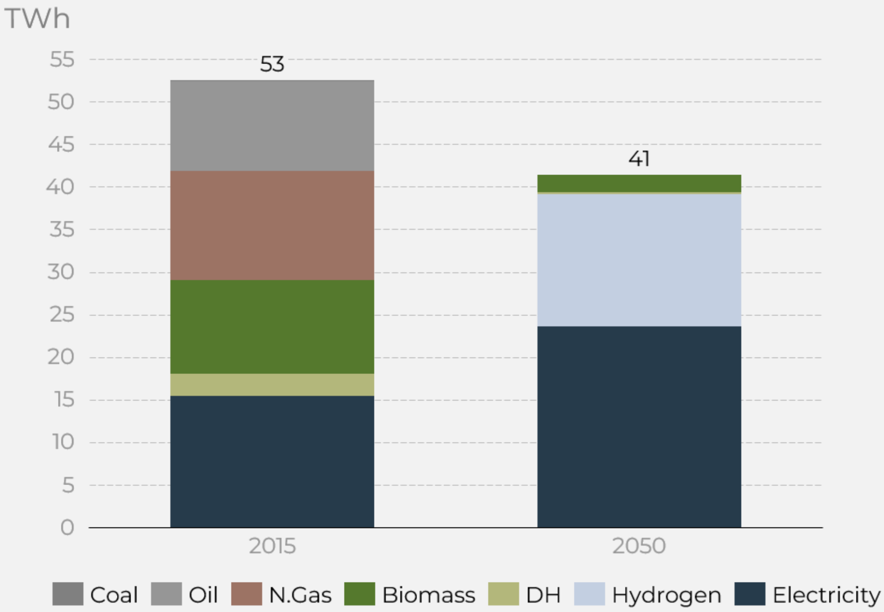


*District heat supply for industry is also included in these charts. In 2050 the majority of heat supply is for buildings (97%)

- District heat sources become more diversified in 2050 due to less electricity and heat from combined heat and power plants
- Individual heat pumps and solar thermal replace the majority of boilers in buildings

Industry final energy

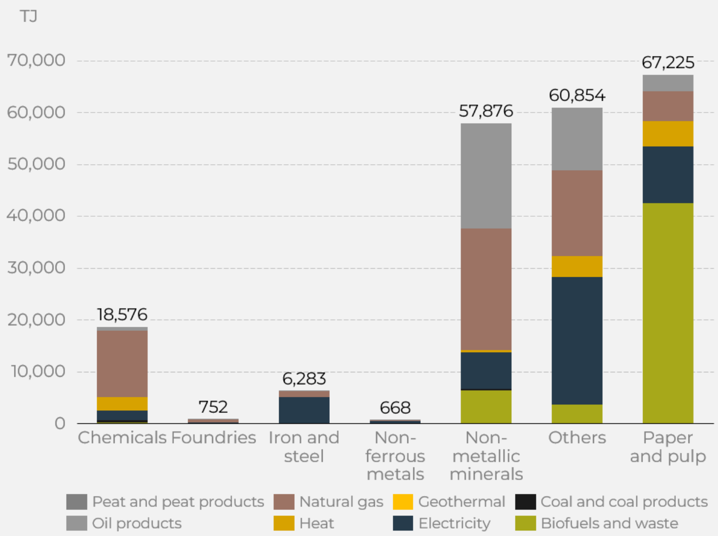
Click here for the Industrial Energy Efficiency Potentials Story Map



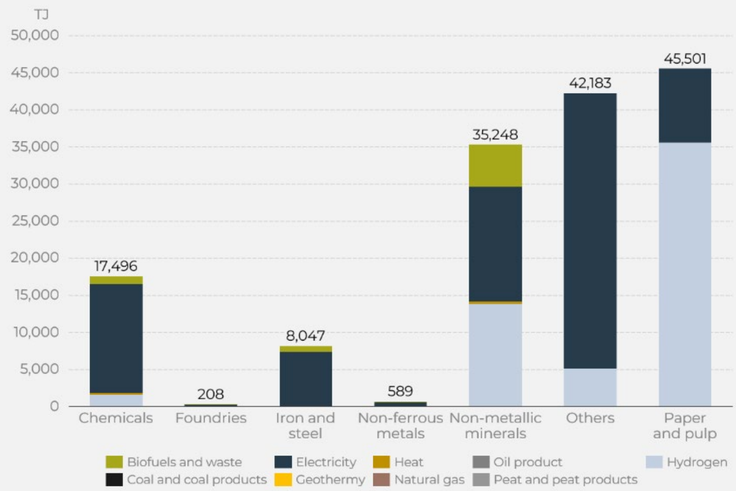
- Energy supply in industry can be transitioned from 2015 to 2050 at a cost of 6 billion euro
- 57% of the industrial final energy in 2050 can be electrified
- A mix of bioenergy and hydrogen can supply the majority of the remaining 43% of final energy demand

Industry fuel types by sector

2015



2050

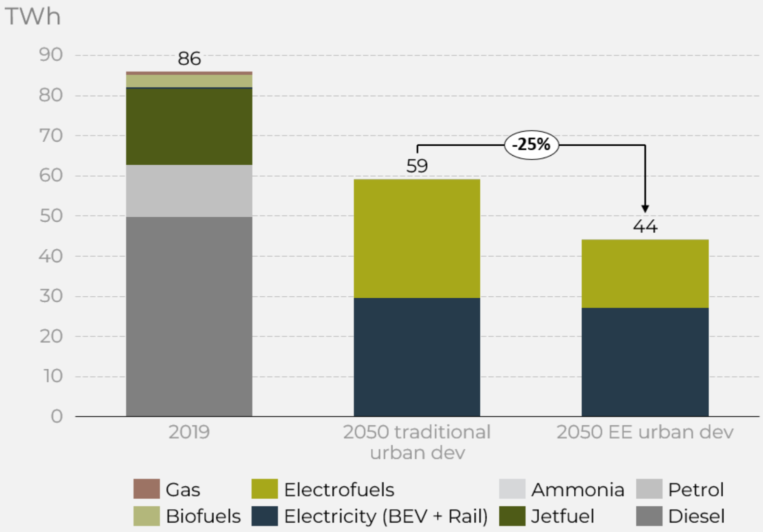


- The others sub-sector is a grouping of the food/drink, engineering, textiles

Transport final energy

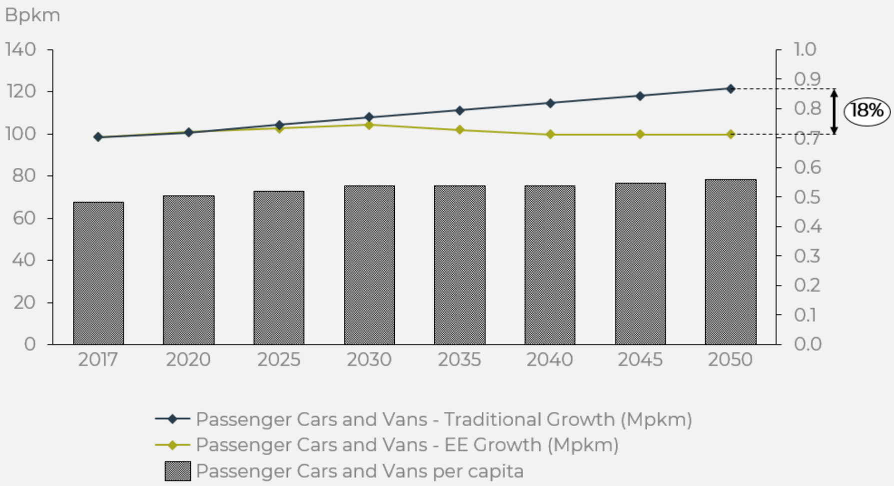
Click here for the Transport Sector Energy Efficiency Potentials Story Map

- The final energy demand in 2050, can be reduced by around 49% via a combined effect of electrification and energy efficient urban development as compared to 2019
- Energy efficient urban development such as densification and modal shifts contribute to a reduction of around 25% as compared to traditional urban development in 2050
- Direct electrification of heavy-duty trucks via e-roads can decrease the overall transport energy demand by 13% as compared to electro-fuels



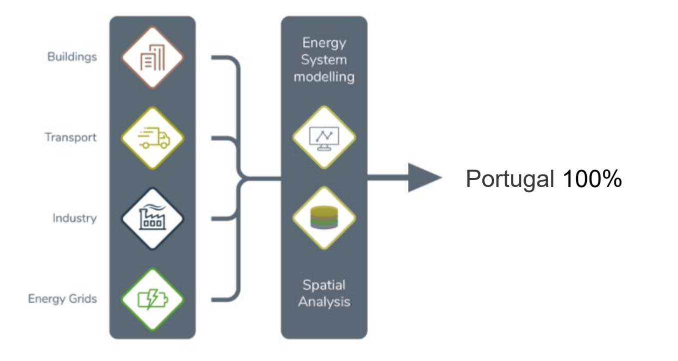
Light vehicle transition

- The number of passenger cars increase from 5.0 million to 5.1 million from 2017 to 2050 but 1.1 million are avoided in the energy efficient urban planning scenario as compared to traditional development
- The per capita passenger cars increase from 0.48 to 0.56 from 2017 to 2050
- The energy efficient growth trajectory reduces the pkm travelled by passenger cars by around 18% as compared to traditional growth trajectory in 2050
- The modal shifts from passenger cars and aviation cause the pkm travelled by rail to an increase by 600% in 2050 as compared to 2017



Methods

Eight separate analyses developed bottom-up results for Portugal



Buildings

Aggregated investment cost curves for building envelope measures per building type and building age class in Portugal for additional savings beyond the baseline

Single and multi-family houses

5 different age classes

Measures for 4 different building elements in building packages (1 to 16, mutually exclusive)

- Wall
- Window
- Roof
- Basement

Transport

Detailed decomposition of the entire transport sector in Portugal

Adjusted transport behaviour for each mode of transport related to trip distance

Quantified the energy efficiency potentials related to the implementation of alternative transport technologies, both in terms of energy consumption and costs

Industry

Energy efficiency potentials in every industrial sub-sector in Portugal, and the spatial location of industrial excess heat

Future material production per product in Portugal

Energy intensities per product, energy carrier and temperature level

Details on Best Available Technologies and Deep Decarbonisation Technologies

- Investment costs, Change in Operation & Maintenance costs, Current diffusion rates, Future Implementation rates

Waste heat availability from industrial flue gases per process and temperature level, with and w/o waste heat

Energy grids

Electric grid - Cost of reinforcing distribution grids for allowing low-carbon technologies integration in Portugal

Thermal grid - Potential for district heating and associated infrastructure cost in Portugal

Gas grid - Potential for power-to-gas and the transmission of new energy vectors (e.g. hydrogen) and associated infrastructure cost in Portugal

Electric grid - Computing the reinforcement cost per dwelling for representative grids

Thermal grid - Spatial modelling and assessment of thermal grids

Gas grid - Assessment of the role and costs of existing gas grids and future role of gas grids and types of gases

Spatial analytics

Combining spatially distributed information on energy efficiency to identify local synergies

Mapping of localised energy system data for the EU27+UK (including population change to 2050)

Highly detailed information down to the 1 -hectare level

Integration of building, industrial and transport sectors

Energy system analysis

100% renewable energy-efficient energy system in Portugal

Analysed energy supply system based on renewable electricity potentials, and thermal and bioenergy resource availability

Reports and outputs related to Portuguese results

Click here for WP1: Energy Efficiency and Refurbishment Strategies in Buildings

Click here for WP2: Comprehensive Energy Efficiency Potentials in Transport and Mobility

Click here for WP3: In-depth Quantification of Industrial Energy Efficiency Potentials

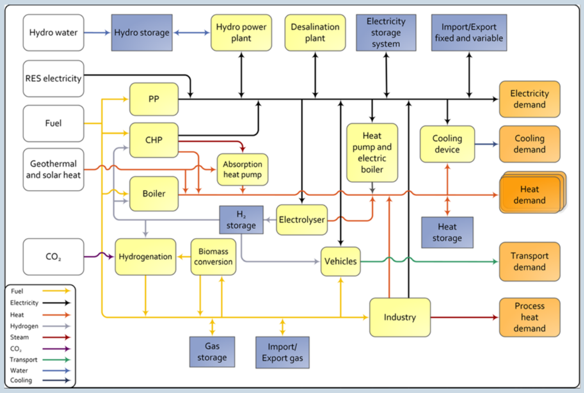
Click here for WP4: Assessment of the Role and Costs of Energy Grids

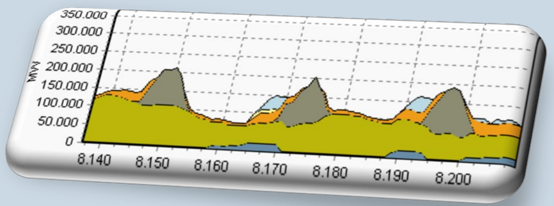
Click here for WP5: Spatial Analyses of Energy Efficiency potentials and Development of the GIS Visualisation Platform

Click here to access Peta5.2
Click here to access the Open Data

Click here for WP6: Modelling Energy System Synergies and Quantification of Energy Efficiency Impacts

Energy PLAN
Advanced energy system analysis computer model





Contributors
Andrei David Korberg
Baptiste Berthillot
Brian Vad Mathiesen
David Maya-Drysdale
Frederik Dahl Nielsen
Hamza Abid
Iva Ridjan Skov