Determining Future Energy Efficiency Potential Across Sectors –

A Case study for Germany

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Enerdata: a global energy intelligence company

- **Independent** energy research & consulting company since 1991
- Spin-off of CNRS research center
- **Expert** in analysis and forecasting of global energy & climate issues
- **In-house** and globally recognized databases and forecasting models
- Headquartered in the Grenoble (French Alps) research cluster
- Offices in Paris, London and Singapore + network of partners Worldwide
- **Global reach**: clients in Europe, Asia, Americas, Africa

Energy Efficiency Scenarios

Case study on Germany

Germany

1st largest energy consumer in Europe

+5 GW of wind capacity installed in 2016

-27% in GHG emissions between 1990 and 2015

- 2010: **« Energy Concept »** :
  - Comprehensive strategy, long term pathway to 2050
  - Goal: « becoming one of the Worlds most energy efficient and environmentally friendly economies »
  - Renewable energy: cornerstone of future supply
  - Postpone the nuclear power phase-out agreed by former Government
- 2011 (after Fukushima Daiichi nuclear accident) –
  - Phase out of Germany's nuclear fleet by 2022
  - 9 nuclear power plants have already been shut down since 2011

2011 second energy package: « Energiewende »

- Seven legislative measures to support:
  - Renewable energy
  - Grid expansion
  - Promote Energy Efficience
  - Fund the reforms
  - Phasing out of Nuclear by 2022

Energy efficiency targets

- Primary energy demand
  - 20% reduction by 2020
  - 50% reduction by 2050

- Electricity demand
  - 10% reduction by 2020
  - 25% reduction by 2050

(Compared to 2008)

Sectoral Targets

- Building sector
  - doubling the building renovation rate from about 1% to 2% per year,
  - 2020: 20% reduction in heating requirements
  - 2050: 80% reduction in heating requirements

- Transport sector:
  - 2020: 10% reduction in the consumption of transport by 2020
  - 2050: 40% by 2050

  (compared to 2005).

- The Government provides €2bn/year (2016) for the CO2 Building Renovation Programme
  financed by KfW's "energy-efficient building and refurbishment" funding programmes.

- The 2009 and 2014 amendments of the building regulation (Energy Saving Ordinance, Energieeinsparverordnung, EnEV) :
  - reinforced the thermal standards for new buildings by approximately 30% and 25% (as from 2016), respectively.

- The new regulation also introduced:
  - the obligation to replace from 2015 oil and gas boilers more than 30 years old, and
  - the Climate-neutral Building Standard for all new buildings by 2020.

Country Energy Demand Forecasts Service description

Country Energy Demand Forecasts - service description

- Service offering **energy demand forecasts** by country up to **2035**
- **Bottom-up** modelling methodology with high level granularity (by sector and end-use) using **Medpro** model

- **2 scenarios** : reference scenario and energy efficiency scenario
- **6 EU countries** covered : Germany, France, Spain, UK, Italy and Belgium
- **Sensitivity analysis** on key drivers : macro-economy, demography, energy prices, modal shift, energy efficiency in buildings, etc.

MedPro : a techno-economic (bottom-up) simulation model of energy demand

- MedPro is a **techno-economic model**, which is the latest version of the MEDEE models used under different versions since the mid-70's.
- **Used in 60 countries worldwide** to provide energy demand forecasts and analysis by various actors of the energy sector (industry, governments, policy-makers…).

Energy demand long-term forecasting

- Energy demand forecasting by **sector** and **end-use** until 2040
- **Calibration of scenarios**

Energy efficiency policies evaluation

- Impact of energy efficiency **policies** and **measures**
- Calculation of **energy indicators**

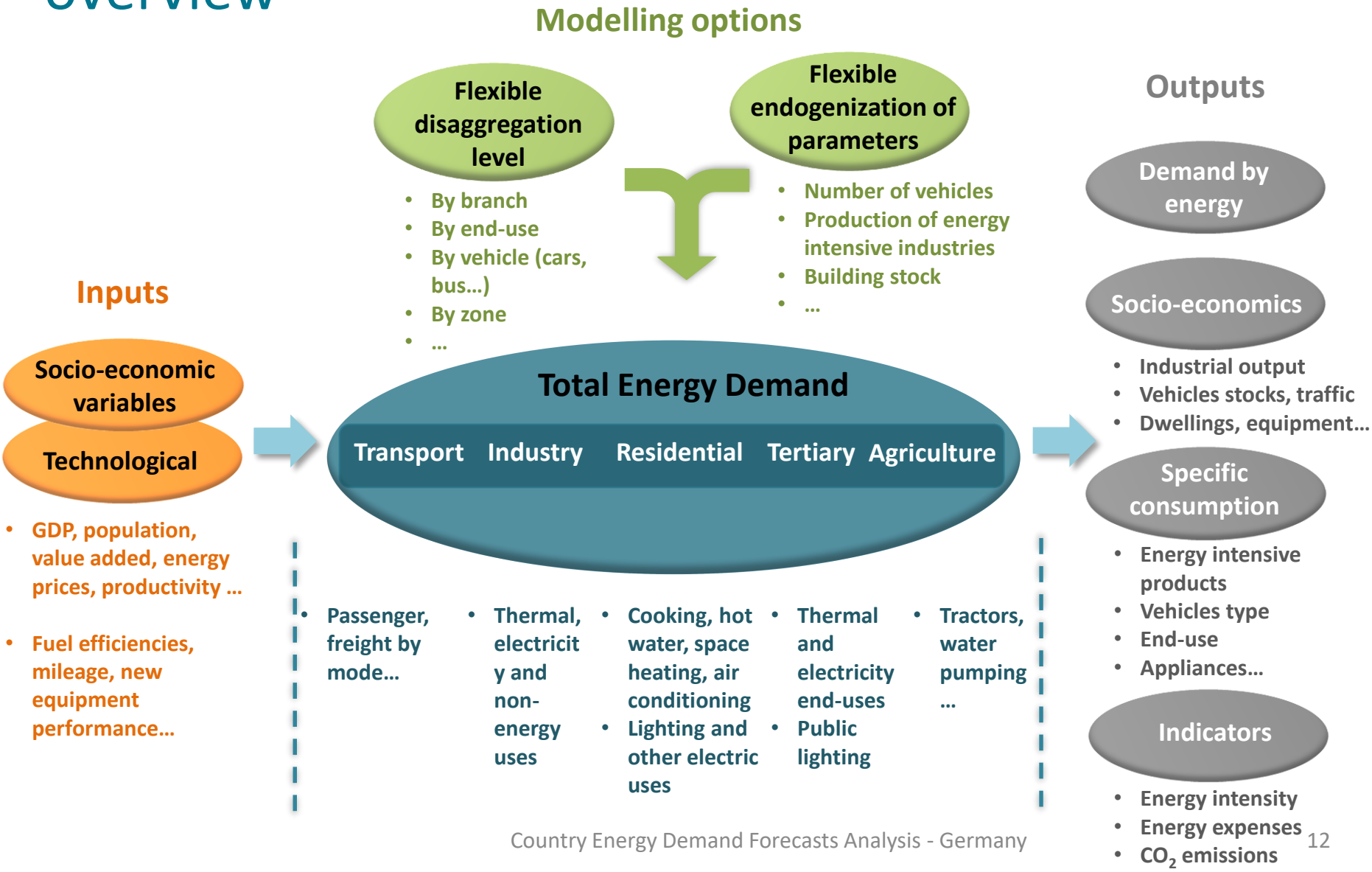
GHG emissions forecasting

- Simulation by **sector** and by **end-use**
- Evaluation of **strategies to reduce GHG emissions**

Recent references…

- France :
  - Ministry of Environment (2008-ongoing)
  - ADEME – French Energy Efficiency Agency (2016)
- Tunisie : ANME – Tunisian Energy Efficiency Agency (2012 & 2017)
- Morocco : Ministry of Energy, Mines, Water & Environment (2015)
- Turkey : Ministry of Energy (2005-2007, 2015)

MEDPRO bottom-up energy demand model: overview



Country Energy Demand Forecasts
Scenario definitions

Reference

Outlook of national energy demand **based on current trends and existing policies**.

Macroeconomic context : end of the global recession.

Continuous but limited improvements in energy efficiency due to technological progress.

Energy efficiency

Improvements in energy efficiency driven by **more ambitious policies**.

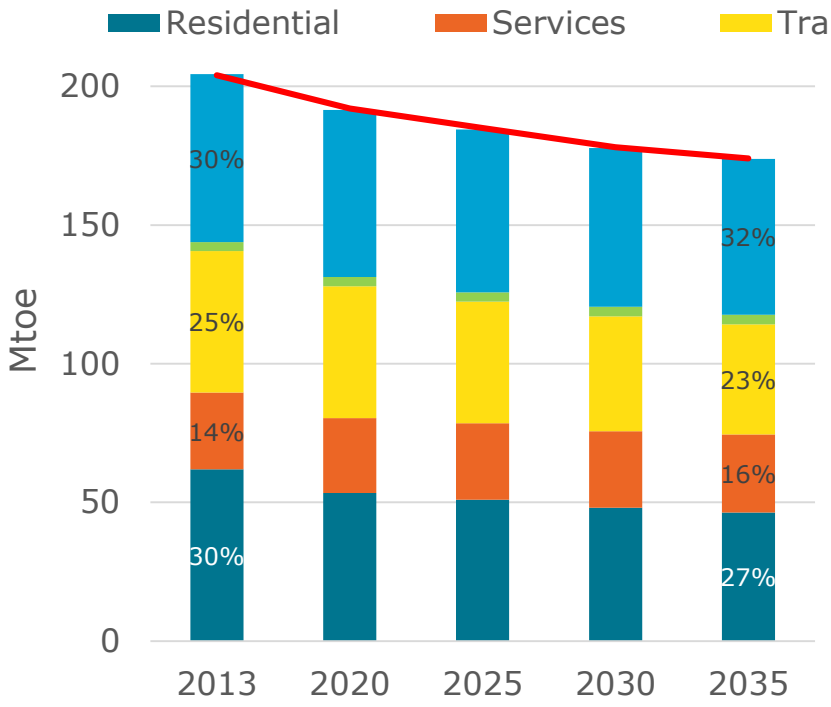
Same macroeconomic assumptions as the Reference scenario.

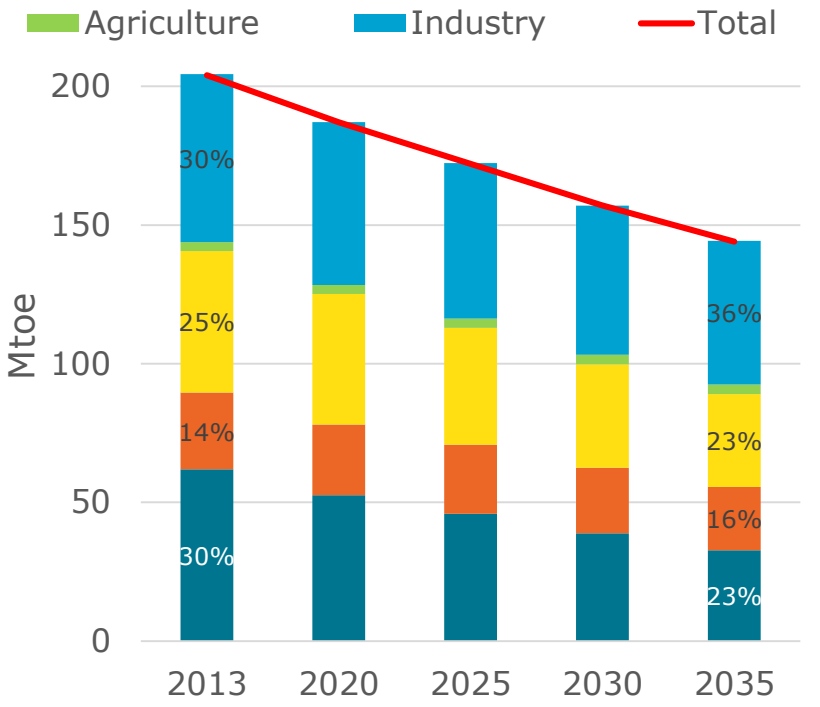
Main drivers include:

- ✓ Reinforcement of buildings codes, renovation rate, more efficient appliances;
- ✓ Improvement in industrial processes;
- ✓ Modal transfer and greater improvements in energy performance of road vehicles.

Cross sectoral analysis

Final energy consumption by sector





Reference scenario

Final energy consumption growth: **-0.7%/year over 2013-2035**

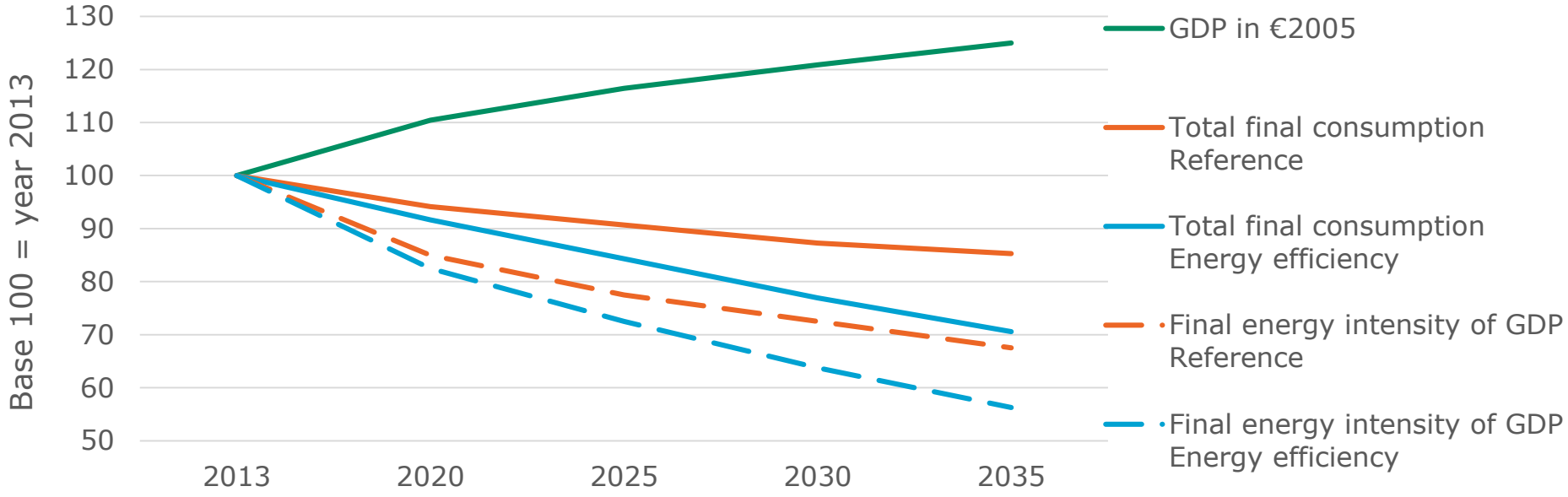
Stronger decrease in **residential and transport**: -1.3%/year and -1.1%/year respectively over 2013-2035 (shares dropping by 2 percentage points minimum)

Energy efficiency scenario

Final energy consumption growth **: -1.6%/year over 2013-2035**

Faster decrease in residential (-2.9%/year over 2013-2035) (decreasing **share** in final consumption from 30 to 23%)

Global trends in final energy consumption and intensity



With an average GDP growth of 1%/year and a final consumption decreasing faster in the energy efficiency scenario (-1.6%/year vs -0.7%/year), the final energy intensity is decreasing by 0.8%/year faster than in the reference scenario

Reference scenario

Final energy intensity decrease over 2013-2035: -**1.8%/year**

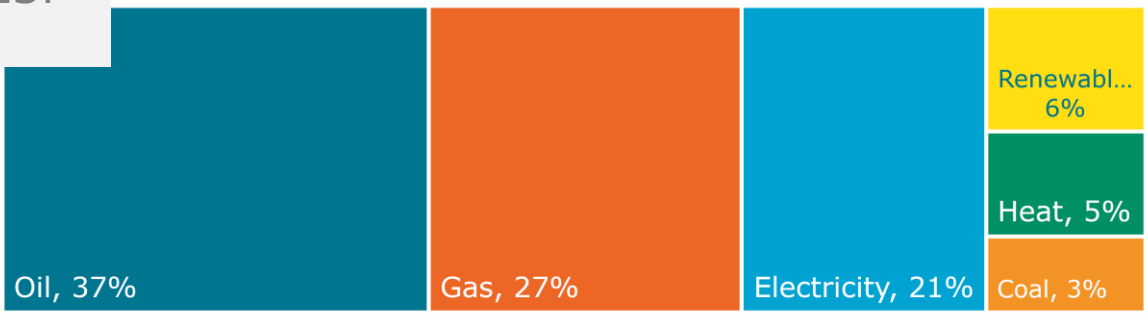
Energy efficiency scenario

Final energy intensity decrease over 2013-2035: -**2.6%/year**

Strong dependence on **fossil fuels in 2013**: 68%

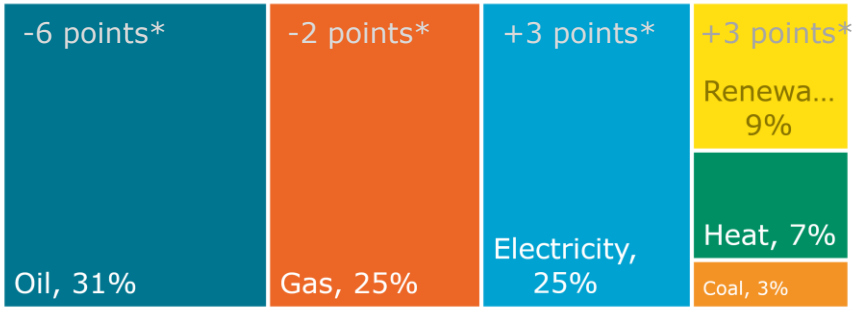
Final energy consumption by energy

Year 2013



Reference scenario

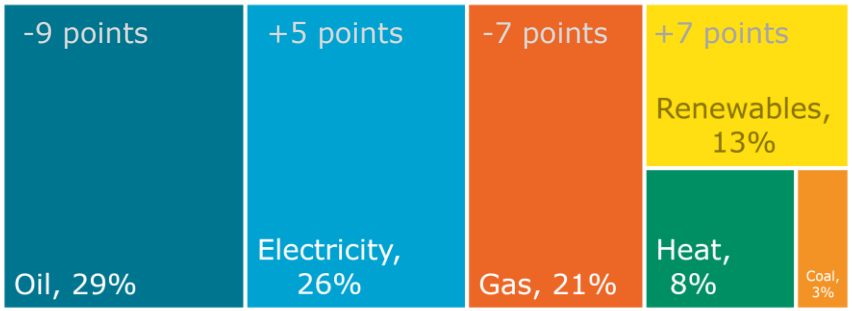
Year 2035



* Market shares variations between 2013 and 2035

Energy efficiency scenario

Year 2035



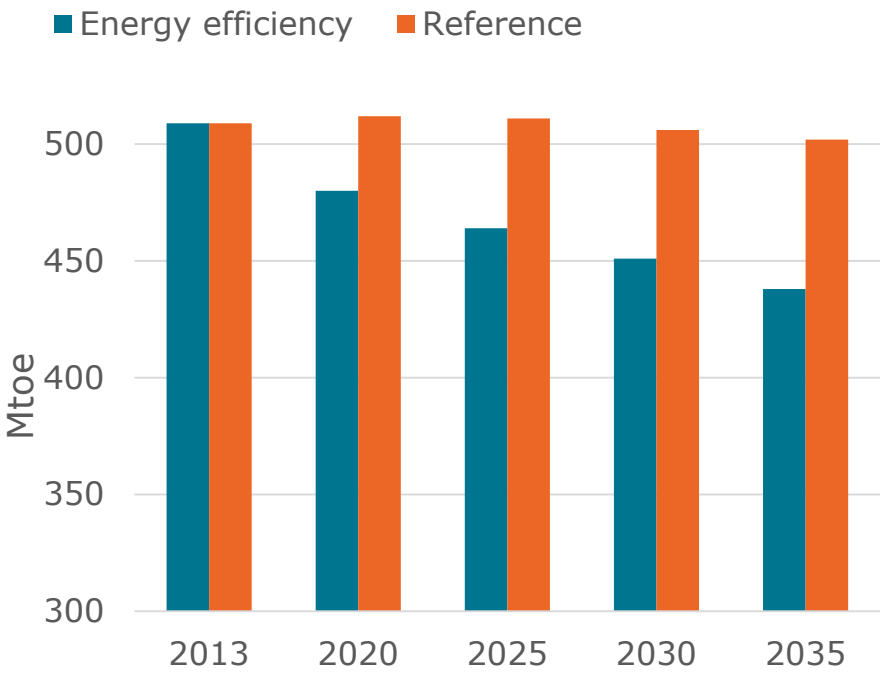
Even if **renewables**** represent a higher share (9%), **60% of energy still come from fossil fuels in 2035.**

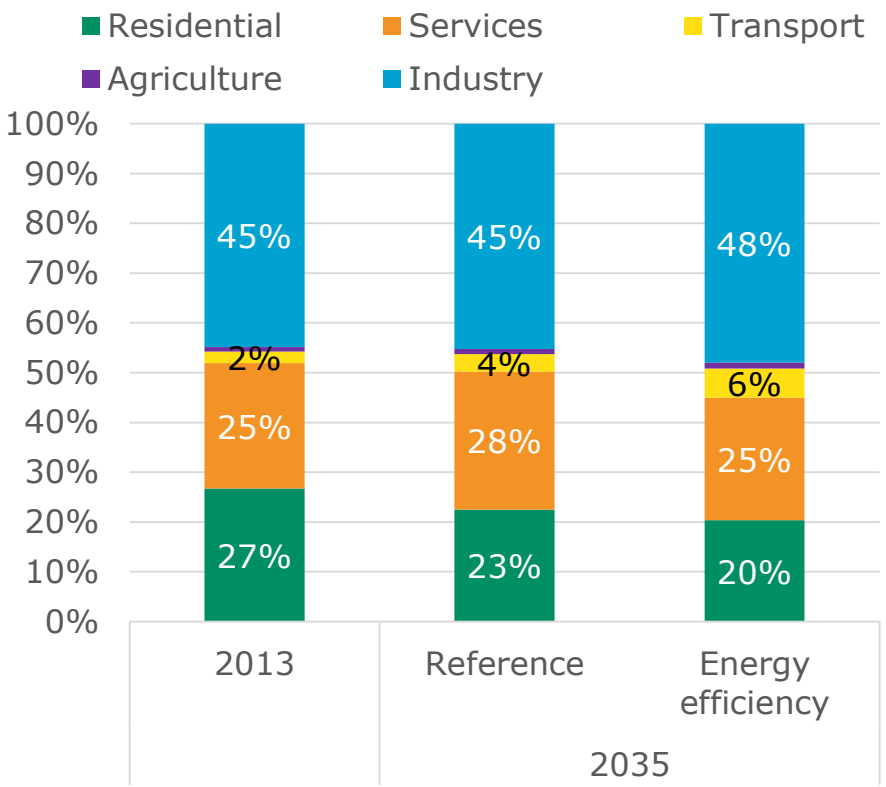
Decreasing role of fossil fuels (52%); oil still remains the first fuel in 2035.

Renewables** represent up to 13% in 2035.

** Direct use of renewables

Electricity consumption





Reference scenario

Electricity consumption growth: **-0.1%/year over 2013-2035**, with a **peak consumption in 2020**

Steady electricity mix by sector over time

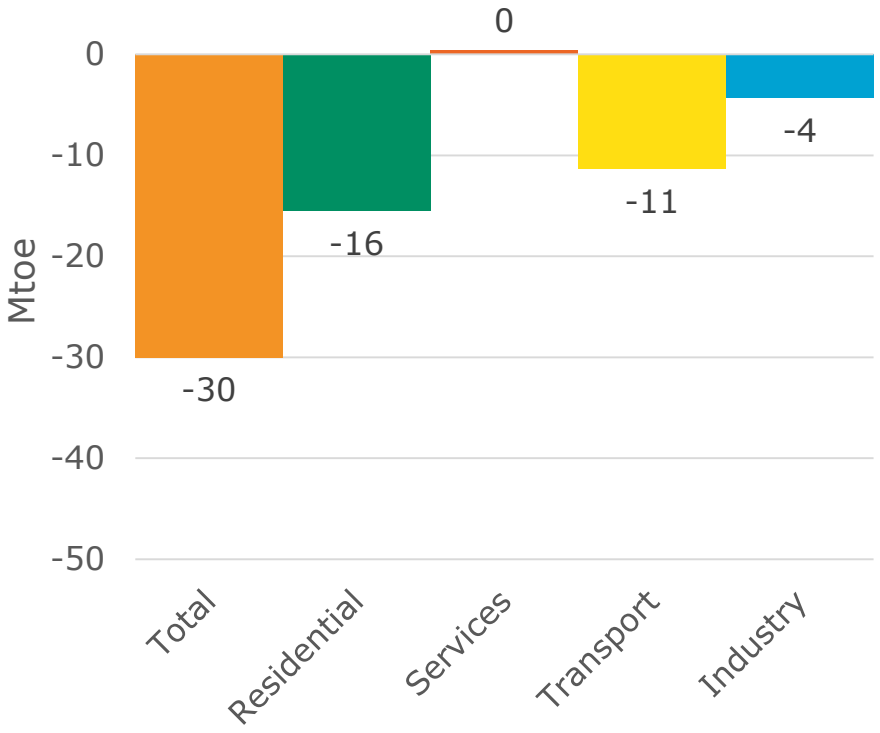
Energy efficiency scenario

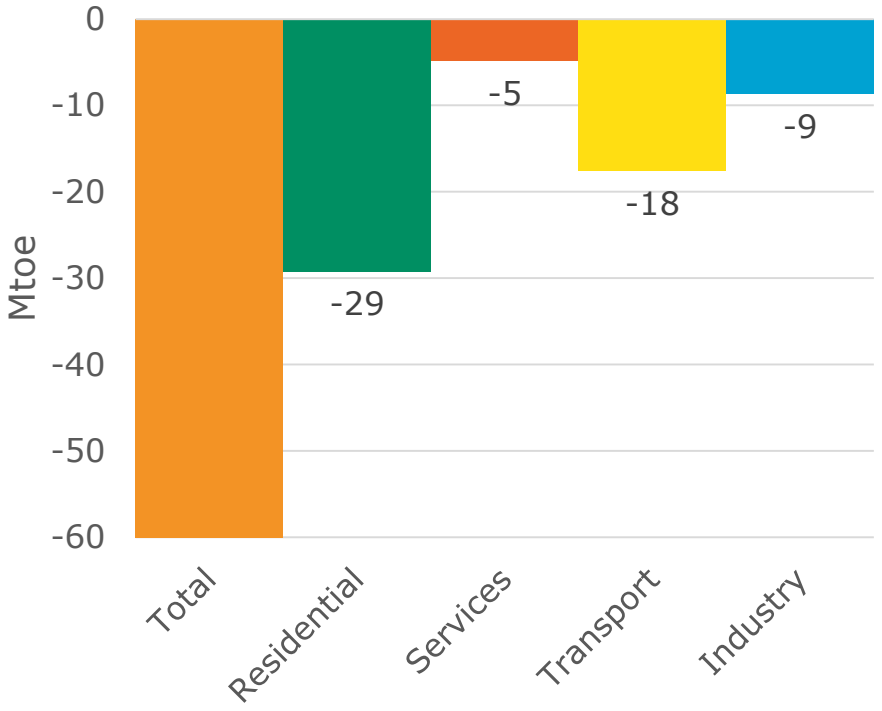
Electricity consumption growth: **-0.7%/year over 2013-2035**

Increasing share of **transport** due to the diffusion of electrical vehicles

Strong decrease in residential sector (-1.9%/year)

Energy consumption variation by sector (2013-2035)





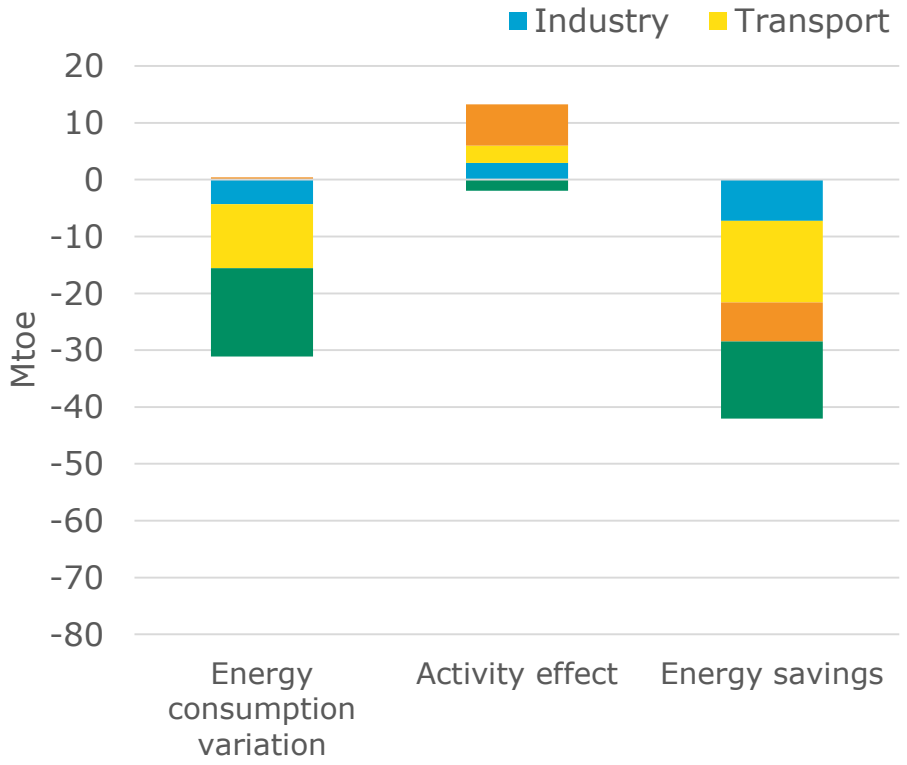
Reference scenario

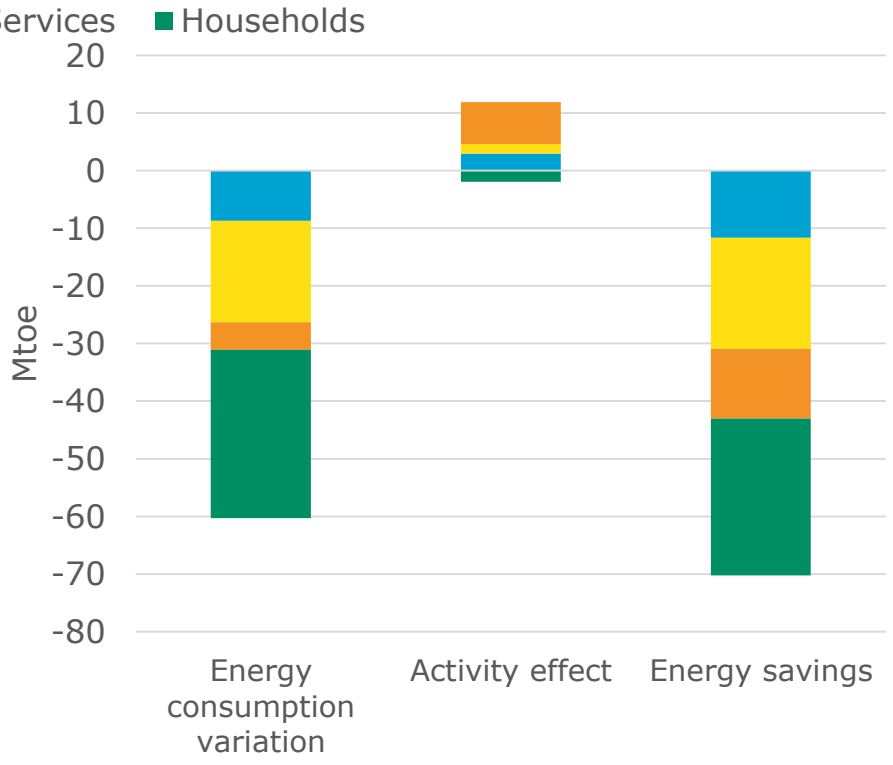
Total decrease by **30 Mtoe** over 2035 and 2013, with **transport** contributing for 36% of this decrease, and **residential** 53%.

Energy efficiency scenario

Total decrease by **60 Mtoe,** with **residential** contributing for 48% of this decrease, and **transport** 30%.

Decomposition of energy consumption variation by main drivers (2013-2035)





Reference scenario

Energy consumption variation is decreasing by 30 Mtoe over 2013-2035 mainly thanks to energy savings gained in household and transport sectors, and to industry at a less extent.

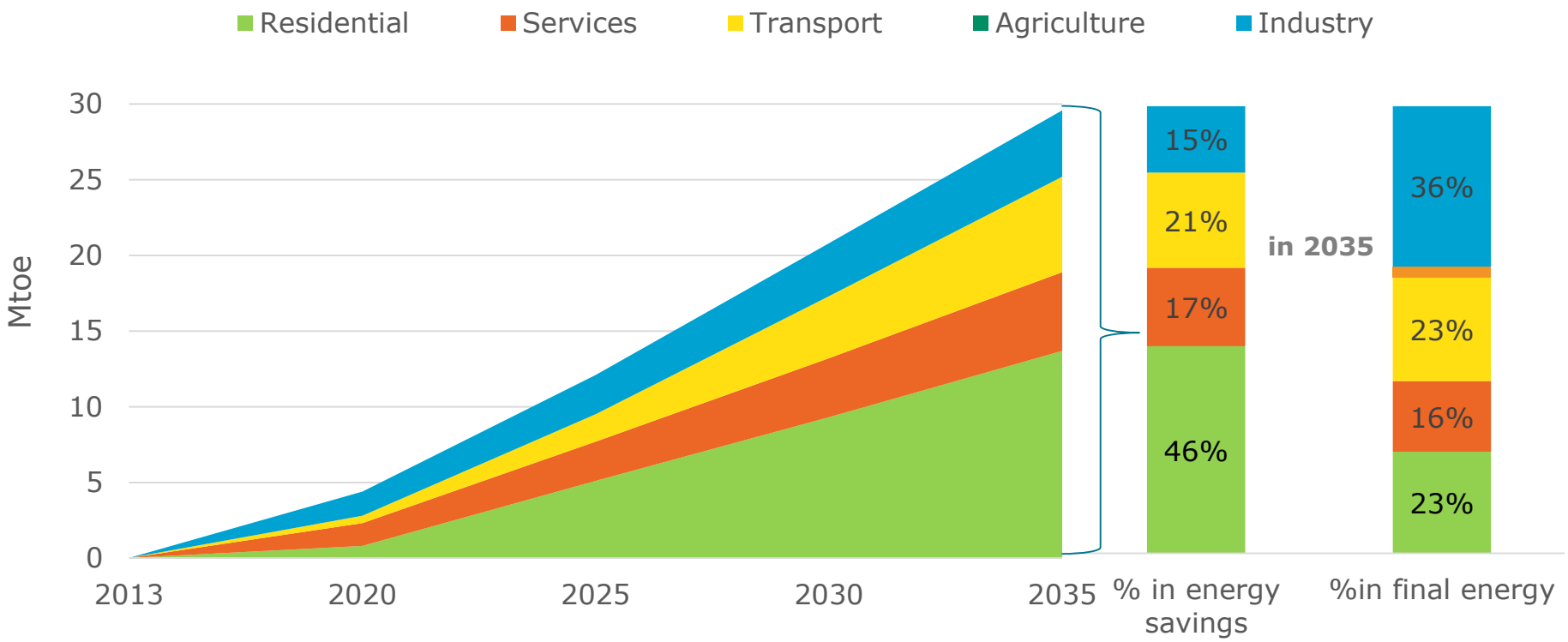
Energy savings achieved in services are compensated by an increase in activity.

Energy efficiency scenario

Energy consumption variation is decreasing twice faster (60 Mtoe) compared to **reference scenario:**

- The impact of activity on consumption level is the same in both scenario
- But savings are significantly higher in all sectors in **energy efficiency scenario**

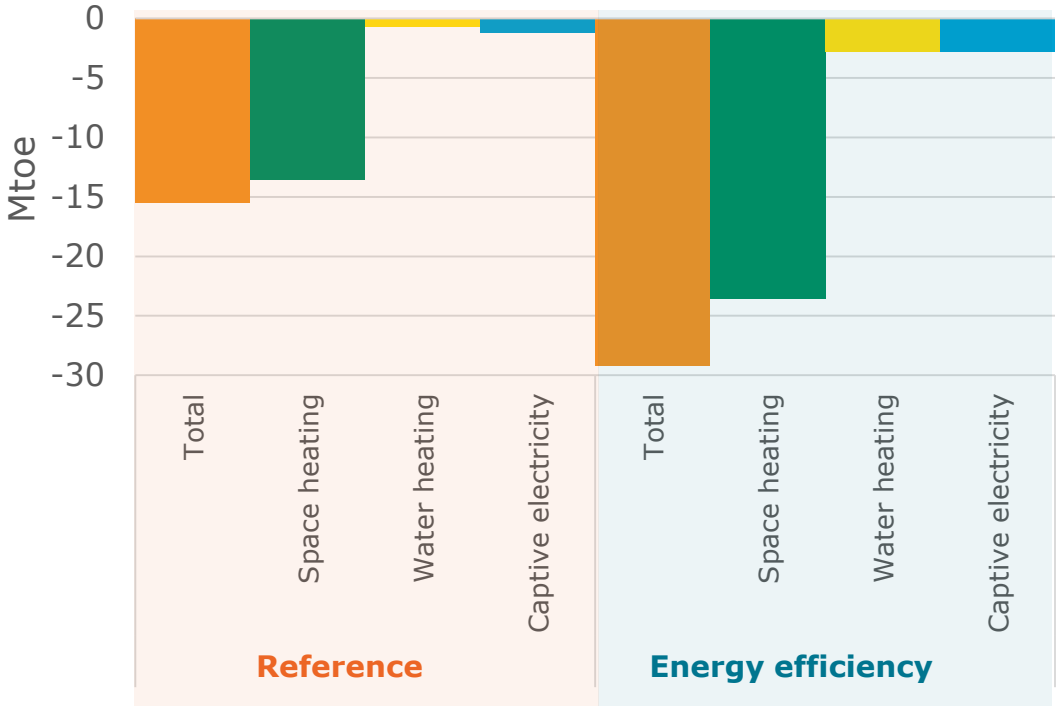
Additional energy savings in Energy Efficiency scenario compared to Reference scenario



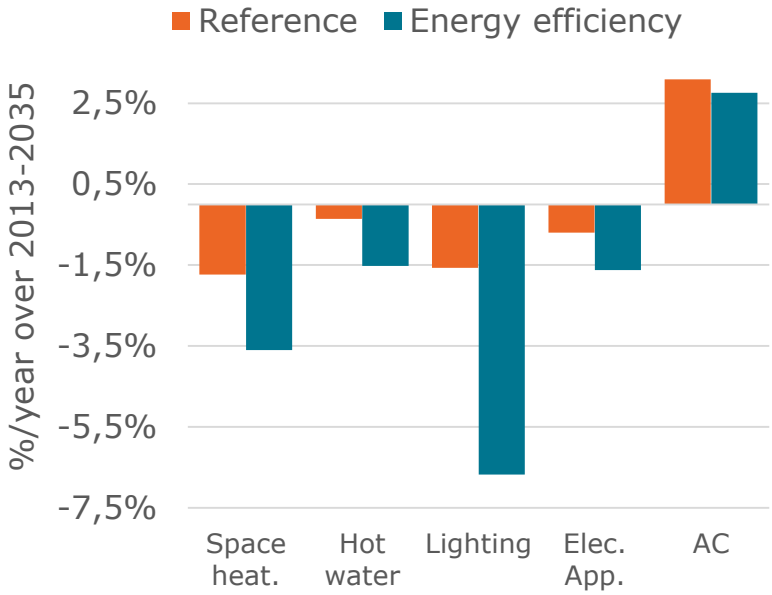
The residential sector contributes to the bulk of the additional energy savings in the energy efficiency scenario in **2035 (46%), which is tremendous relatively to its relative share in final energy consumption in 2035 (23%).**

Sectoral analysis

Decomposition of energy consumption variation (2013-2035)

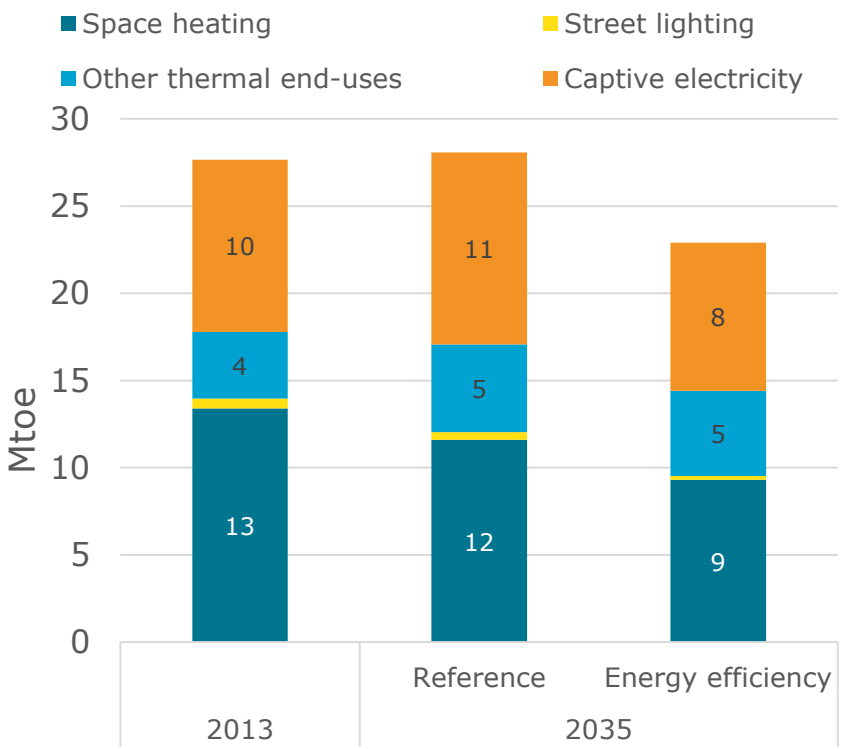


Trends in unit consumption

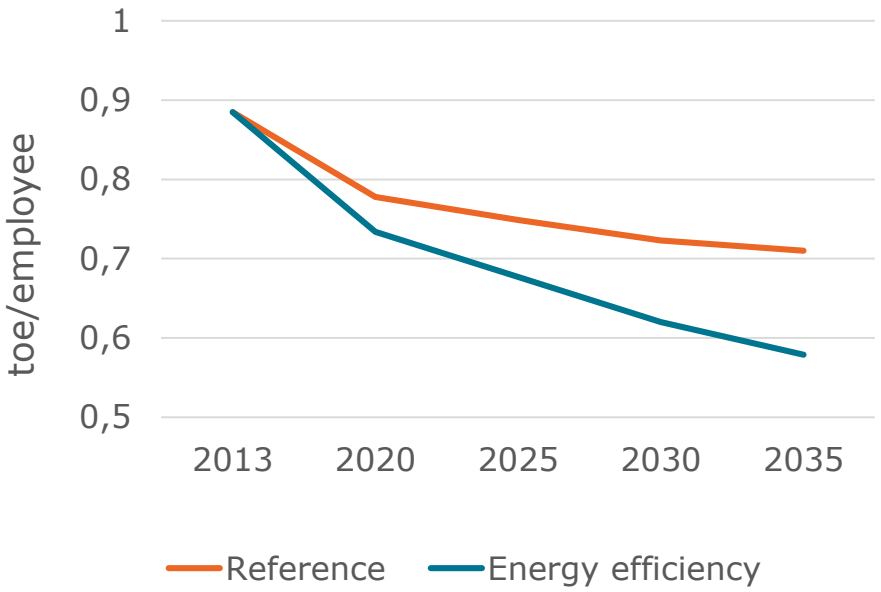


Thanks to significant energy efficiency improvements for space heating (-3.6%/year for the unit consumption per m2) and lighting (-6.7%/year), the energy consumption of residential decreases much faster (-29 Mtoe, or -2.9%/year) in the energy efficiency scenario, compared to reference scenario (-16 Mtoe, or -1.3%/year).

Trends in final consumption of service sector

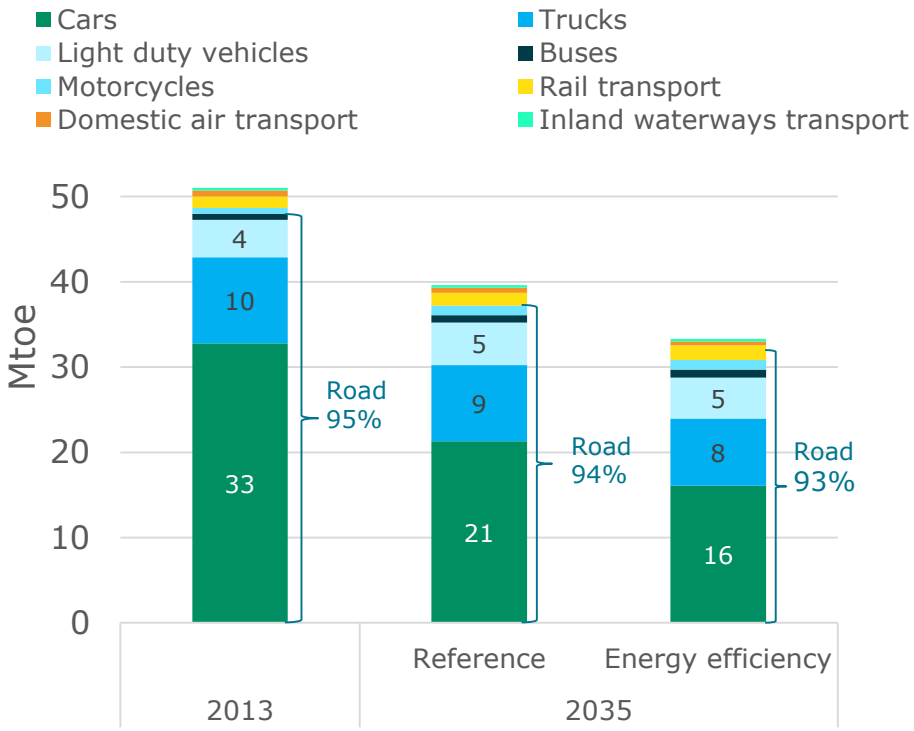


Unit consumption per employee

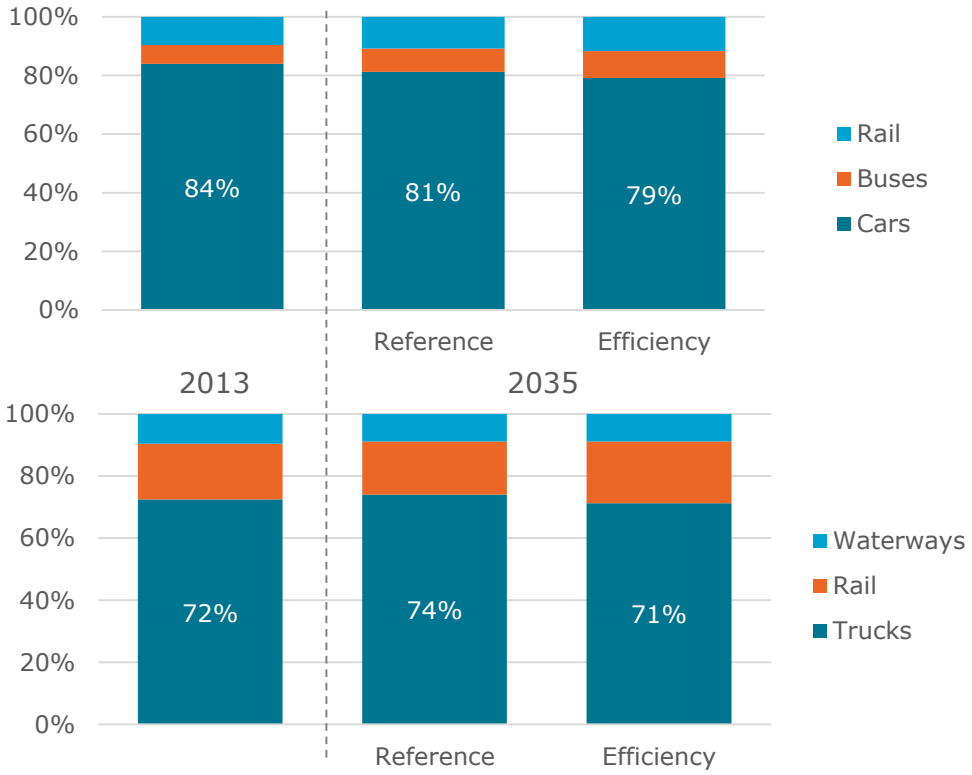


Even if the consumption per employee decreases slightly in the reference scenario, the total energy consumption is higher in 2035 than in 2013 (increase in equipment rate and employment). However, in the energy efficiency scenario, total consumption decreases significantly thanks to energy efficiency gains for space heating in particular.

Trends in final consumption



Share of modes in passengers and freight traffics

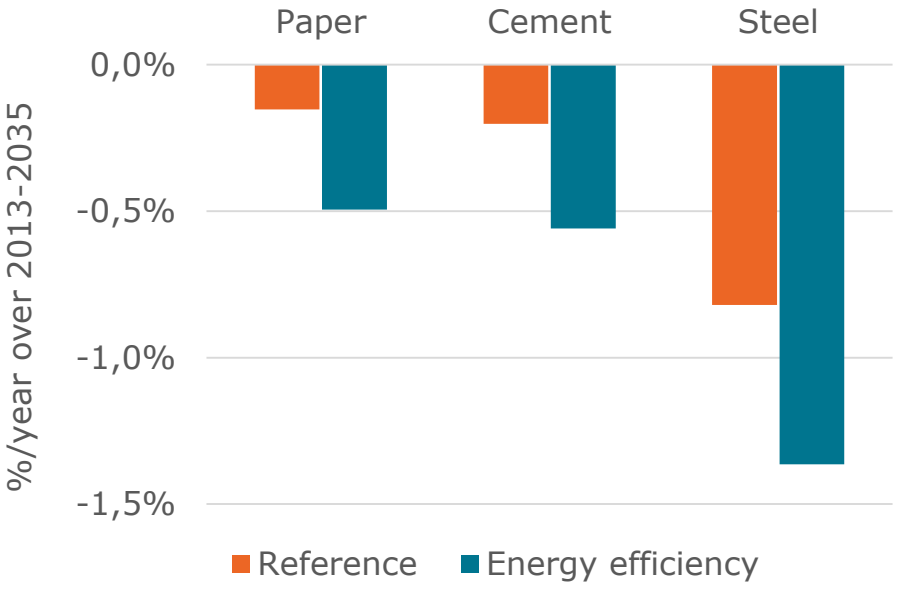


The consumption of cars is decreasing by 35% in the energy efficiency scenario and by 22% in the reference scenario.

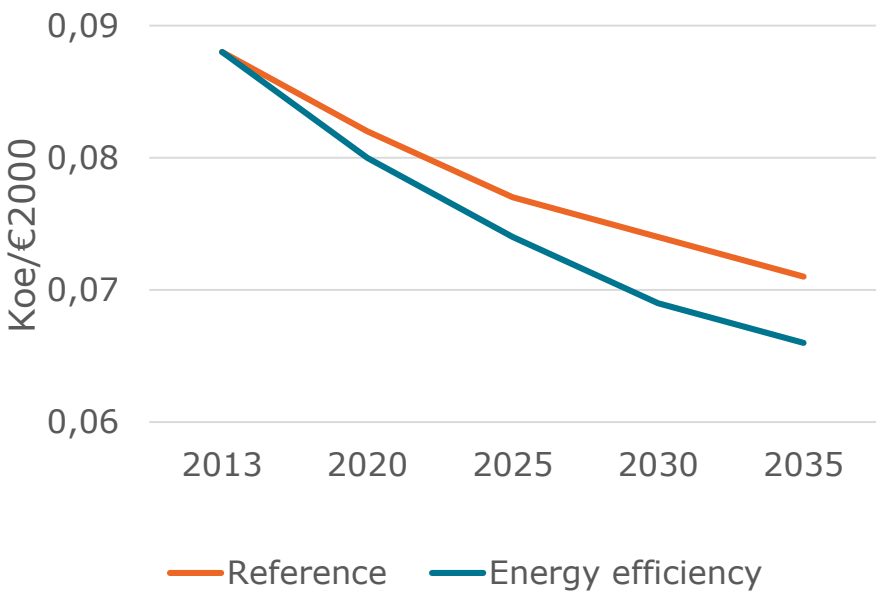
This improvement is mainly explained by large energy savings of cars (decrease in unit consumption).

The modal transfer to public transport for passengers and to rail and waterways for freight also contributed to decrease faster consumption in the energy efficiency scenario.

Trends in unit consumption



Energy intensity of industry



Significant greater improvements in unit consumption of intensive branches in the energy efficiency scenario compared to the reference.

As a result energy intensity is decreasing faster in the energy efficiency scenario (-1.3%/year compared to -1%/year in the reference scenario)

Sensitivity analysis

Sensitivity analysis features to assess the impact of key drivers on energy demand

Examples of drivers linked to the final energy consumption

Macro-Economy

	⇊	↓	-	↑	⇈
GDP annual rate of growth	-0.4 point	-0.2 point	**0**	+0.2 point	+0.4 point
Yearly new dwellings	-20%	-10%	**0**	+10%	+20%
Dwellings with air cond' in 2030	-20%	-10%	**0**	+10%	+20%
Yearly replacement rate of service buildings	-10%	-5%	**0**	+5%	+10%
Saturation of car ownership	-10%	-5%	**0**	+5%	+10%

Demography

	⇊	↓	-	↑	⇈
Population annual rate of growth	-0.2 point	-0.1 point	**0**	+0.1 point	+0.2 point
Average household size 2030 (pers/hh)	-0.01	-0.005	**0**	+0.005	+0.01

De-materialization of the economy

	⇊	↓	-	↑	⇈
Share of industry in the GDP in 2030	+2 points	+1 point	**0**	-1 point	-2 points
Share of services in the GDP in 2030	- 2 points	- 1 point	**0**	+1 point	+2 points

Energy prices

	⇊	↓	-	↑	⇈
Average energy price, industry	-40%	-20%	**0**	+20%	+40%
Average energy price, residential	-20%	-10%	**0**	+10%	+20%
Average energy price, motor fuels / transport	-20%	-10%	**0**	+10%	+20%

Decomposition of energy consumption variation for industry and services (2013-2035)

Energy efficiency scenario

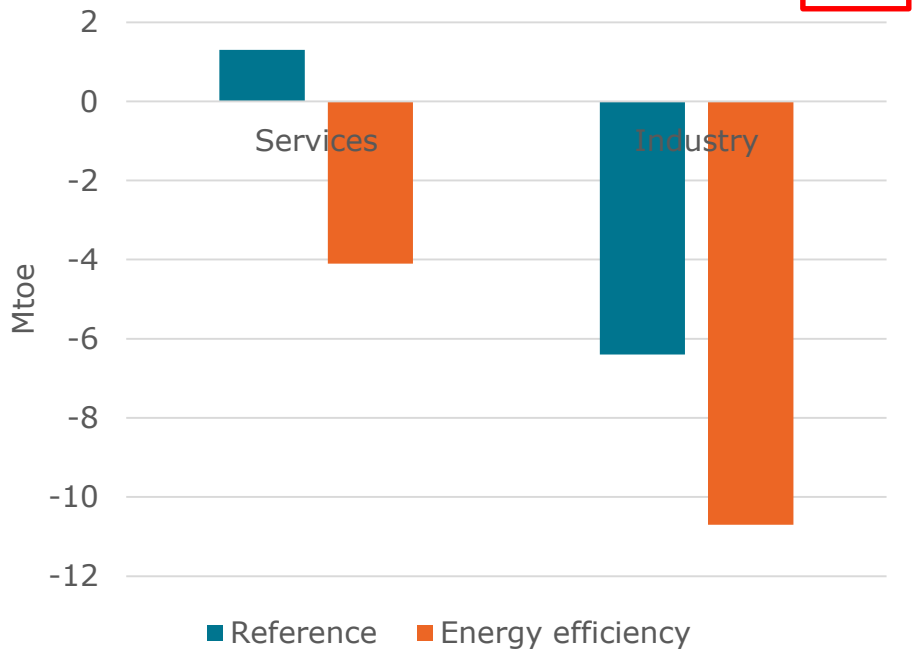
De-materialization of the economy

	↓↓	↓	-	↑	↑↑
Share of industry in the GDP in 2030	+2 points	+1 point	0	-1 point	-2 points
Share of services in the GDP in 2030	- 2 points	- 1 point	0	+1 point	+2 points

Energy efficiency scenario with significant de-materialization of the economy

De-materialization of the economy

	↓↓	↓	-	↑	↑↑
Share of industry in the GDP in 2030	+2 points	+1 point	0	-1 point	-2 points
Share of services in the GDP in 2030	- 2 points	- 1 point	0	+1 point	+2 points



The de-materialization of the economy (-2 points of industry share in GDP, +2 points of services share in GDP) accelerates the energy consumption decrease in the services sector (by 23% in the energy efficiency scenario) and contributes to lower the consumption decrease in the industry sector (by 0.7 Mtoe in the energy efficiency scenario).

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