

INCLUDING
A MACRO-
ECONOMIC
EVALUATION

ADEME ENERGY TRANSITION SCENARIOS

2030 2050

ADEME



French Environment &
Energy Management Agency

SUMMARY

Preamble

ADEME, the French Environment and Energy Management Agency, is a public agency reporting to the Ministry of Ecology, Sustainable Development and Energy and the Ministry of Higher Education and Research. In 2012 the agency drew up a long-term scenario entitled “ADEME Energy Transition Scenarios 2030-2050”. This document presents a summary of the report. The full version can be viewed online on the ADEME website.

With this work ADEME offers a proactive energy vision for all stakeholders – experts, the general public, decision-makers, etc. – focusing on two main areas of expertise: managing energy conservation and developing renewable energy production using proven or demonstration-phase technologies.

These scenarios identify a possible pathway for the energy transition in France. They are based on two time horizons and two separate methodologies. One projection, applicable from the present day, seeks to maximise potential energy savings and renewable energy production in an ambitious but realistic manner, up to 2030. The second exercise is a normative scenario that targets a fourfold reduction in greenhouse gas emissions generated in France by 2050, compared to 1990 levels.

The analysis presented in this document is primarily based on an exploration of different scenarios that allow for the achievement of ambitious energy and environmental targets under technically, economically and socially feasible conditions. This analysis is supplemented by a macroeconomic analysis.

These projections, particularly for 2030, do not rely on radical changes in lifestyle, lower comfort levels or hypothetical major technological breakthroughs. They show that by using technologies and organisational changes that are currently within our reach, we have the means to achieve these long-term goals. The scenarios are based on assumptions of significant growth, both economic (1.8% per year) and demographic (0.4% a year). The 2050 scenario shows that with sustained growth, a fourfold reduction in greenhouse gas emissions is achievable.

By supporting the green economy, which embraces business activities of the future such as renewable energy production, energy recovery from waste, recycling and eco-design – “resources” that are all available within France – we can move towards robust and sustainable growth.

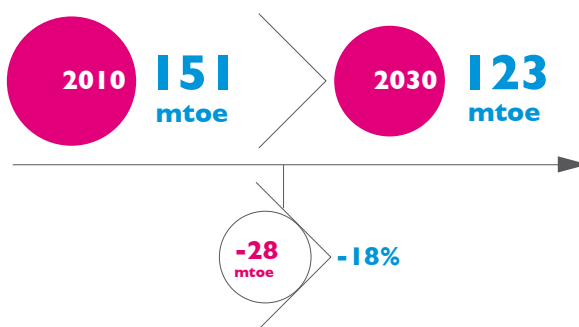
The present economic crisis should not halt our efforts. Greater energy efficiency means higher employment. Breaking our dependency on fossil fuels is the way to anticipate future economic conditions – fossil energy prices will inevitably rise during the coming decades – and to reduce our vulnerability to imports that have become a significant burden (€69 billion in 2012) and comply with our international commitments to reduce our greenhouse gas emissions. Acting now clearly has a cost, especially during the first years, but the macroeconomic evaluation that accompanies the 2030-2050 Energy Transition scenarios show that in addition to environmental benefits, the energy transition could also have a beneficial impact on the French economy.

Energy scenario to 2030 at a glance

Maximising France's potential for saving energy and developing renewable energy sources

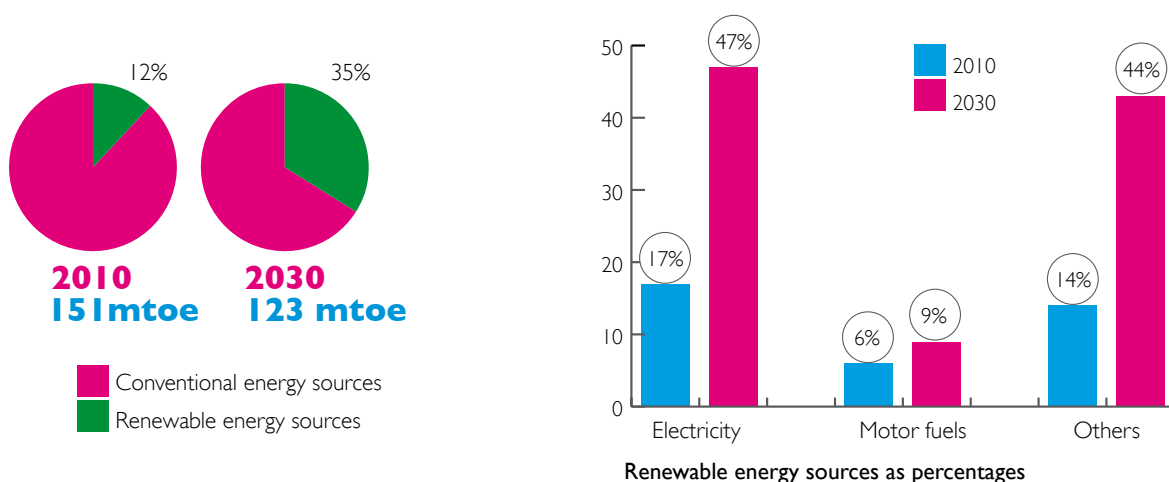
1. Energy demand: starting to reduce consumption

Up to 2030, the buildings sector (residential and tertiary) is the largest contributor to lower energy consumption, with 15 mtoe in savings (over 50% of anticipated savings) thanks to the renovation of an average of 500,000 dwellings per year. The transport sector contributes 8 mtoe (30% of total savings), as the greater structural changes required in this sector will take longer to establish.



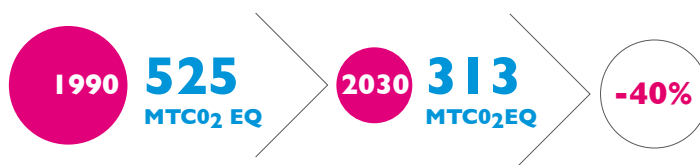
2. Towards a sustainable and diversified energy supply

Starting from the current situation in which nearly 90% of energy production is dependent on non-renewable energy sources, investments in renewable energy sources will lead to a more balanced situation in which renewables account for 35% of the energy mix.



3. Greenhouse gas emissions reduced by 40%

The 2030 scenario allows for a 40% reduction in greenhouse gas (GHG) emissions between 1990 and 2030. The decarbonising of energy supplies occurs in the residential and tertiary sectors in particular, but also in industry and in electricity and heat production.

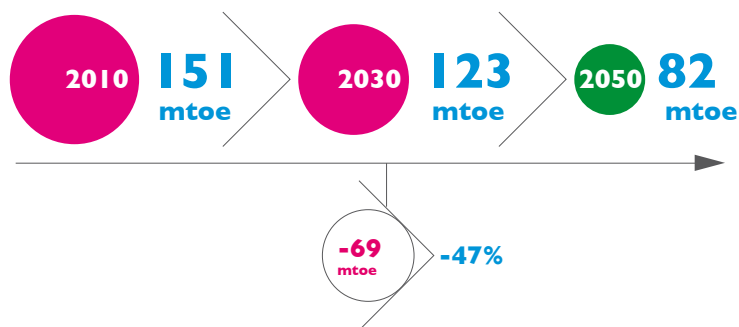


Energy scenario to 2050 at a glance

A vision of French society in which the country has achieved a fourfold reduction in its greenhouse gas emissions (compared to 1990) thanks to energy savings, greater efficiency and renewable energy.

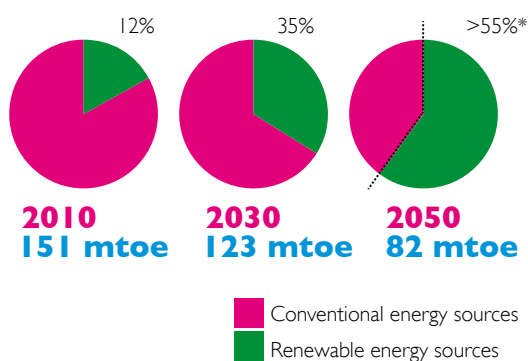
1. Total energy consumption nearly halved in relation to 2010

Between 2010 and 2050, the transport and buildings sectors each contribute 40% to the drop in energy consumption. By 2050, mobility services account for 30% of urban passenger travel, thanks to car-sharing and car-pooling.

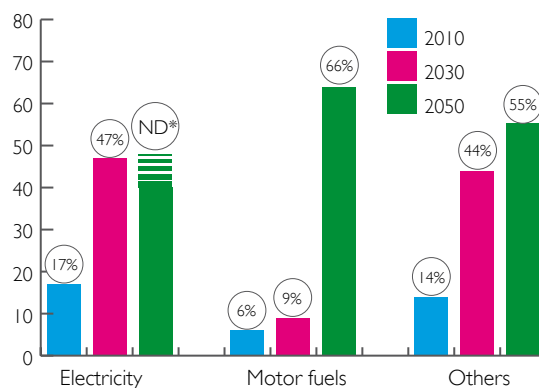


2. Sustainable energy resources

With over 55% of renewable energy sources in the energy mix, the increase in renewable electricity (wind and photovoltaic energy), in addition to biogas (for transport and in the supply grid) will reduce the carbon content of energy produced and consumed. The available quantities of biogas and the development of electric vehicles allow us to envisage energy independence from oil for transport.



*3 proposed scenarios: see page 41 or the full document on the ADEME website



Renewable energy as percentages

*3 proposed scenarios: see page 41 or the full document on the ADEME website

3. Fourfold reduction in greenhouse gas emissions

The shift to forms of mobility that no longer depend on carbonaceous resources, efforts to renovate and build housing that consumes less energy, and investment in renewable energy sources are the main ways to achieve the fourfold reduction in greenhouse gas emissions. These changes are accompanied by changes in diet (reduction of excessive carbohydrate and protein consumption and a more even balance between animal and plant proteins), and by the adoption of more sustainable practices in agriculture.



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SCENARIO TO 2030

Buildings and urban organisation

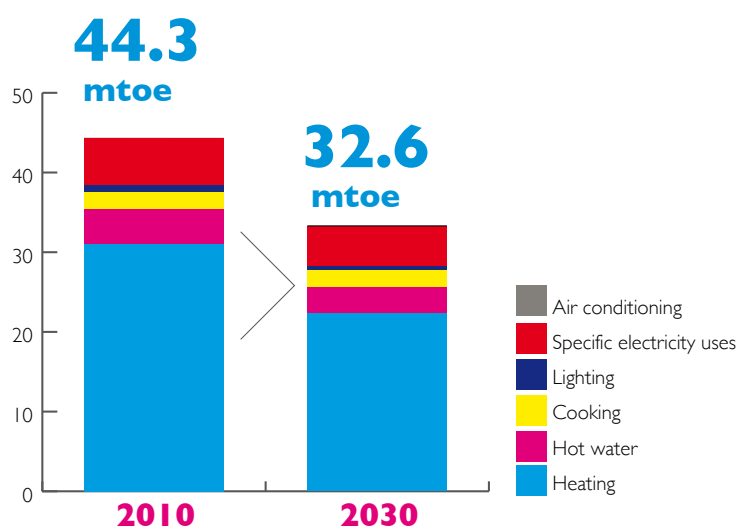
The buildings sector (comprising residential and tertiary buildings) accounts for over 40% of the delivered energy consumed in France today.

An ambitious construction and energy-efficiency renovation plan

To reduce consumption in this key sector, this scenario posits that an ambitious new building and energy-efficiency renovation plan for residential and tertiary buildings is implemented by 2030.

It is assumed that 350,000 new dwellings are built each year. It should be possible to balance construction of new multi-family housing and single-family houses in 2030 (compared to the current share of 58% for single-family houses and 42% for multi-family housing). These new buildings are intended to form part of a new system of urban organisation requiring less commuting, and limiting land area that is paved over; however, the system of urban organisation up to 2030 has already been largely determined by the current housing stock. On average, 500,000 dwellings per year would be retrofitted to be more energy-efficient.

By 2030, the entire social housing stock built before 2005 could thus be renovated, in addition to 5 million single-family houses (over half of which were built before 1975), which amounts to one-third of all single-family houses.



ENERGY CONSUMPTION IN RESIDENTIAL CONSTRUCTION IN 2010 AND 2030, BY TYPE OF USE

More efficient equipment and facilities for at least the same level of comfort

With regard to the two main categories of consumption in residential buildings, the level of comfort is assumed to remain the same, i.e. temperature in buildings and volumes of domestic hot water used. Overall energy needs diminish due to insulation retrofits and are met by more energy-efficient technologies than with current appliances.

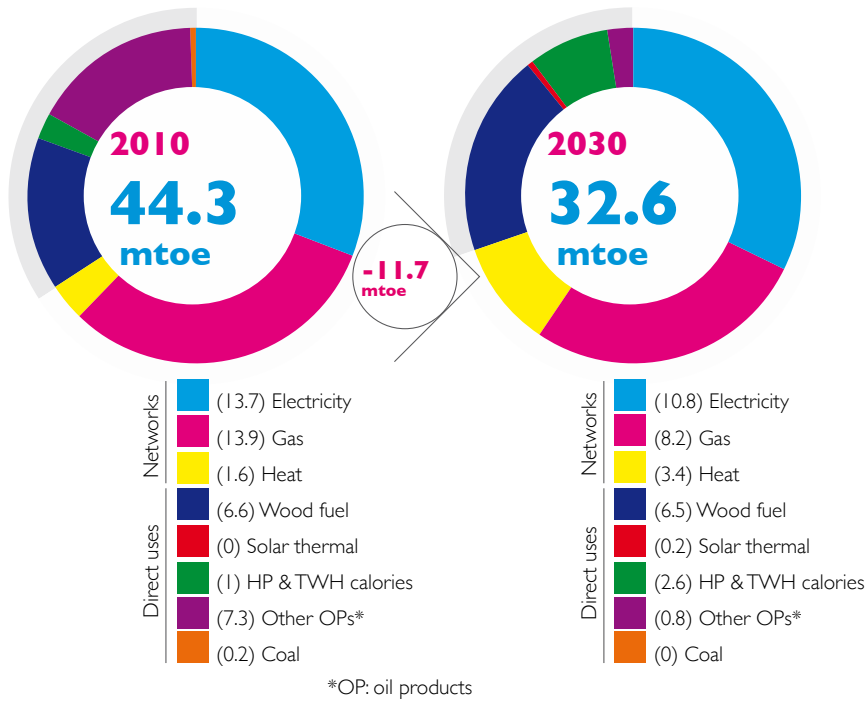
- **For space heating, heat pumps (HP)**, particularly reversible air-source heat pumps, equip 20% of total housing stock, especially electrically heated homes. These HPs will have a performance coefficient of 4 in 2030, compared to an average of 3 today. The widespread prevalence of this equipment is also linked to the ongoing trend to use air conditioning in certain regions. Gas-heated dwellings are increasingly equipped with condensing boilers. Towards the end of the period, hybrid and micro-cogeneration systems are progressively installed in the housing stock.

- **For domestic hot water, electric water heaters (joule-effect heaters)** are increasingly replaced by thermodynamic water heaters (TWH), which can halve household hot water consumption and, to a lesser extent, by individual solar water heaters (ISWH).

However, without major breakthroughs in terms of costs and performance in France, developments which are not yet foreseeable, ISWHs will spread slowly throughout the housing stock, with an estimated penetration rate of 10% of dwellings in 2030.

Average electricity consumption per square metre in housing thus drops by nearly a third between 2010 and 2030, from 190 kWh/m² of final energy* per year to 130 kWh/m² per year, for all uses.

* To avoid confusion, changes in electricity consumption are expressed in terms of final energy, rather than in primary energy, as the energy mixes for electricity and heating will evolve over time.



ENERGY CONSUMPTION IN THE RESIDENTIAL SECTOR IN 2010 AND 2030, BY ENERGY VECTOR

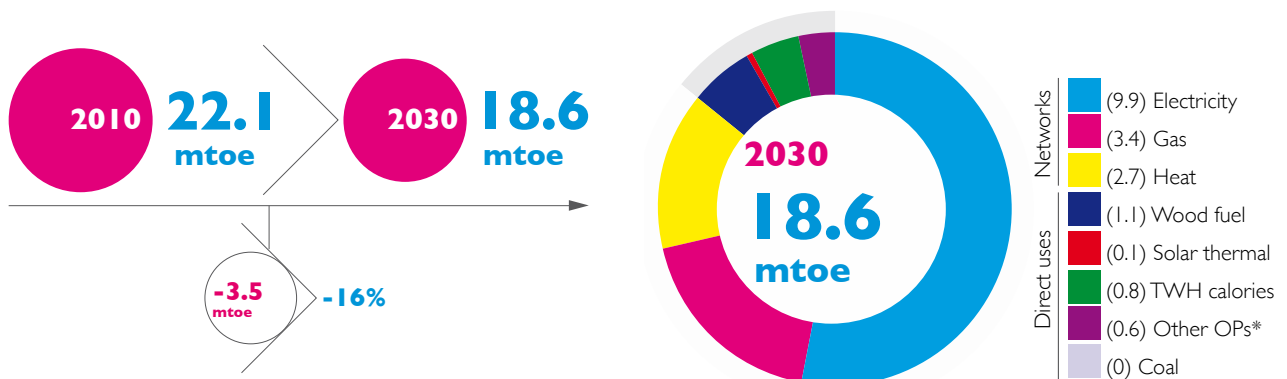
Ambitious targets to reduce energy consumption: 350,000 new dwellings built per year and 500,000 old dwellings renovated each year

Specific uses at best remain stable

With regard to specific uses of electricity, the average housing stock in 2030 is assumed to be equipped with the best technologies available today. The equipment rate per household for each category of white goods (domestic appliances) and brown goods (televisions, etc.), has increased. The emergence of consumption for new uses is also accounted for, and becomes the fastest growing item among specific uses. Overall, technical progress, combined with the proliferation of uses, means that the best we can expect is for specific electricity consumption to remain stable.

Tertiary buildings

The assumptions made concerning the structural growth of GDP have an impact on business activity and thus on energy consumption in the tertiary sector. The increase in building surface area is considered to be related to the rise in the number of employees: the surface area per employee is assumed to be constant between now and 2030. Airconditioned surface area increases while heating requirements diminish due to building renovations. In addition, equipment becomes more efficient, as in the residential scenario.



ENERGY CONSUMPTION IN THE TERTIARY SECTOR IN 2010 AND 2030 (FINAL MTOE)

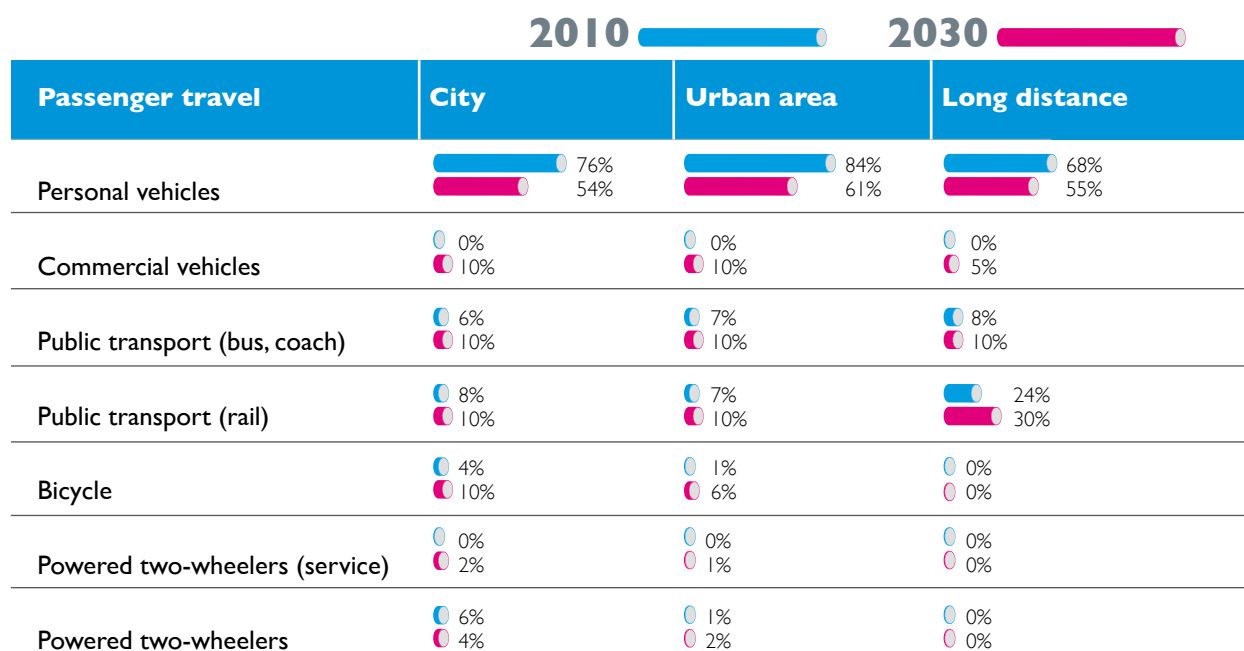
ENERGY CONSUMPTION OF TERTIARY BUILDINGS IN 2030 (MTOE), BY VECTOR

Transport and mobility

Travelling just as much, but differently

Today, travelling by personal car is the rule for all types of journeys: city, urban area and long-distance. Yet, although the average distance travelled is 13,000 km per vehicle and per year, personal cars are unused for 95% of the time and are often occupied by a single person.

In 2030, it is assumed that people travel the same distances as today, but in a different manner. Mobility services – vehicles (especially electric vehicles) owned by service vendors and made available to users via self-service schemes, for example – start developing on a large scale from 2020, eventually accounting for 10% of city and urban area travel in 2030. Carpooling continues to develop. A large proportion of the modal transfer also occurs towards public transport and non-motorised modes of travel.



Mobility and travel	2010	2030
Travel (billions of vehicles*km)	450	450
Overall mobility (billions of trips*km)	711	790

PASSENGER FLOWS AND TRAVEL IN 2010 AND 2030

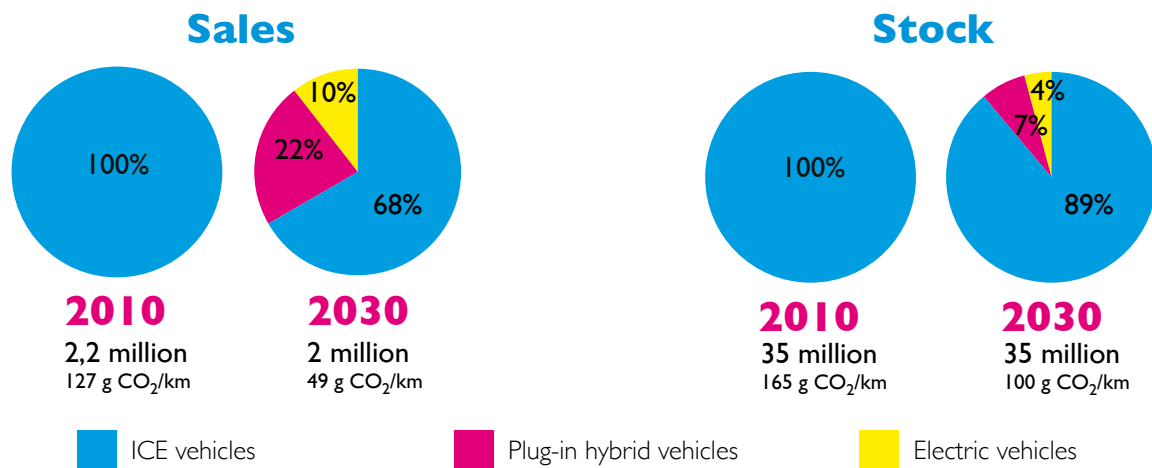
More efficient vehicles

From a technological standpoint, internal combustion engines continue to improve and the number of non-rechargeable hybrid vehicles in circulation keeps increasing. New engine types appear on the market: mainly rechargeable plug-in hybrid vehicles (PHV) with two engines, that can be recharged on the electricity mains, in addition to electric vehicles which are bought mainly by professionals and deployed by mobility services.

The average emissions of the national vehicle fleet will thus decrease from the current level of 167 g CO₂/km to 100 g CO₂/km in 2030. Whereas in 2010 new vehicles on average emitted 127 g CO₂/km, the weighted average emissions for new vehicles in 2030 will be 49 g CO₂/km (electric vehicles do not emit CO₂ in use, PHVs will emit approximately 30 g CO₂/km, and vehicles with internal combustion engines will emit between 50 and 100 g CO₂/km).

The land area cultivated for biofuels will not increase, but the proportion of second-generation biofuels will increase at the expense of first-generation biofuels, to attain 0.9 mtoe of second-generation biofuels out of a total 3 mtoe of biofuels in 2030.

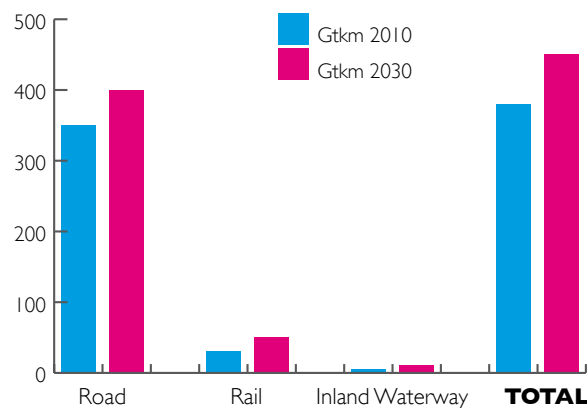
**More efficient vehicles: from average emissions of 127 g of CO₂/km
for new vehicles today, to 49 g CO₂/km in 2030**



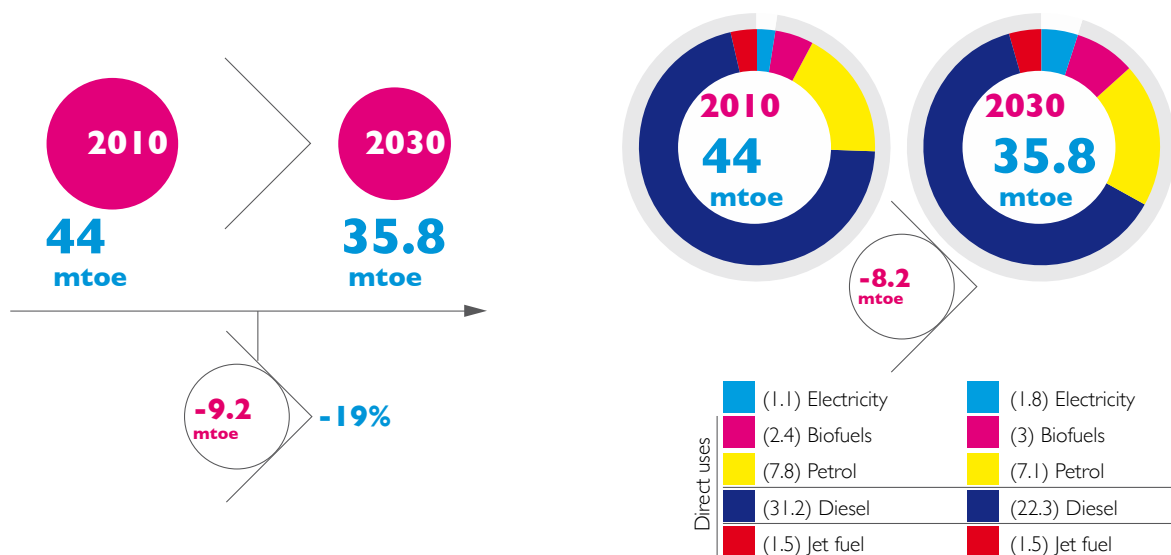
VEHICLE SALES AND FLEETS

Road haulage still predominates for freight transport

Growth in GDP has a strong impact on freight transport. Our hypothesis is that freight transport will be partly decoupled from GDP, and will be rising by 0.8% per year in 2030 (compared to 2.1% per year today). We also posit significant modal transfers to rail transport (which returns to its 1990 level) and inland waterway transport. Road haulage will continue to increase, however, and freight transport requirements (in tonne.kilometres) will continue to grow up to 2030.



FREIGHT TRANSPORT IN GTKM BY MODE IN 2030



ENERGY CONSUMPTION IN THE TRANSPORT SECTOR (FINAL MTOE) FROM 2010-2030

ENERGY BALANCE FOR THE TRANSPORT AND MOBILITY SECTOR (EXCLUDING INTERNATIONAL AIR TRANSPORT) BY VECTOR

Food, agriculture and land use

Although the agricultural sector consumes little energy (accounting for less than 3% of final energy), it is responsible for significant quantities of greenhouse gas emissions (almost 18% of national emissions) linked mainly to agricultural practices and the size of livestock herds.

Diet

The 2030 scenario does not assume any significant changes in the French diet. However, an ambitious policy makes it possible to cut avoidable food wastes in half, in accordance with European targets. Import and export volumes of agricultural products and foodstuffs are considered to be stable. Current trends to lower meat consumption continue to prevail.

Agricultural practices and productions

Agricultural practices evolve gradually with the development of “integrated” production techniques on 10% of usable agricultural land (UAL), which limit the use of inputs, optimise the effects of organic amendments and employ minimal soil tillage techniques whenever possible, while making greater use of crop rotation.

The Grenelle (French environmental consultation process and legislation) target for organic farming to be established on 20% of UAL is attained.

The other main changes are:

- a decrease of approximately 25% in the energy consumption of buildings, equipment and machinery
- a reduction of approximately 20% in the consumption of synthetic nitrogen fertilisers
- greater autonomy where the protein content of animal feed is concerned (fewer imports of soybean oil cake), associated with the reintroduction of dedicated crops.

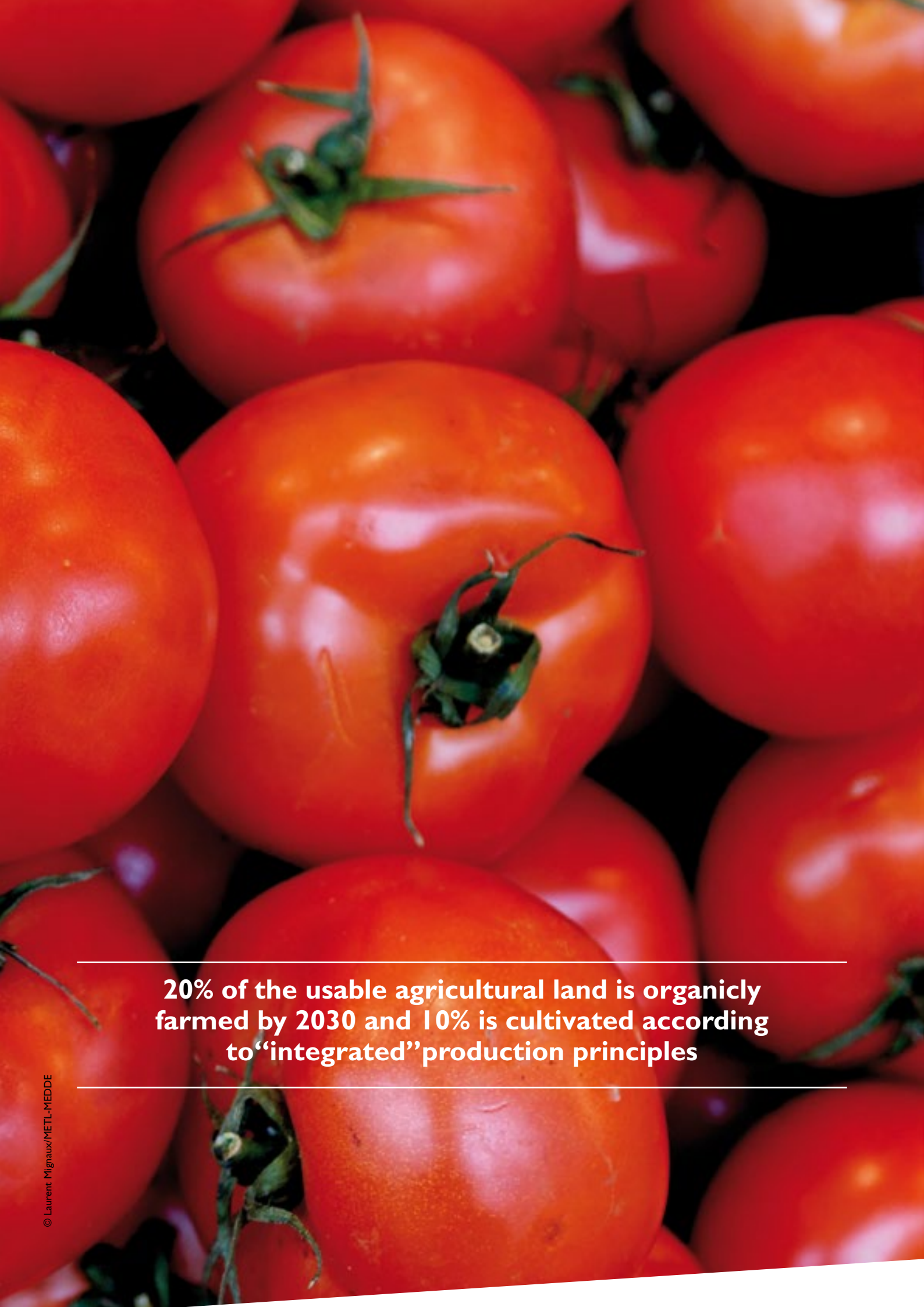
The aforementioned changes concerning wastes and excessive consumption lead to an 11% decrease in livestock-related impacts.

Energy consumption in the agricultural sector (tractors, greenhouses and agricultural buildings) decreases from a total of 4 mtoe in 2010 to 3 mtoe in 2030.

Land use

Very little land is released. Afforestation (planting of trees in areas long devoid of trees) continues, with a slight increase of 0.2 M ha of forested land between 2010 and 2030.

The current rate of soil sealing (62,000 ha per year) is halved by 2030.



20% of the usable agricultural land is organically farmed by 2030 and 10% is cultivated according to “integrated” production principles

Industry and industrial processes

After a period of significant increases, energy consumption in industry levelled off in the middle of the 2000s. It fell in 2009 and 2010 due to the economic situation. In our scenario, energy-intensive industrial activities are assumed to recover to the levels of physical production recorded in 2005, while other industries will grow at the same pace as GDP. To establish the 2030 scenario, industry was divided into sub-sectors (iron and steel, primary metals, chemicals, minerals, agri-food industry, materials goods and equipment, etc.), and the potential to increase recycling (between 60% and 100% depending on the sub-sectors) and energy efficiency (average of 19.6%) were assessed for each sub-sector:

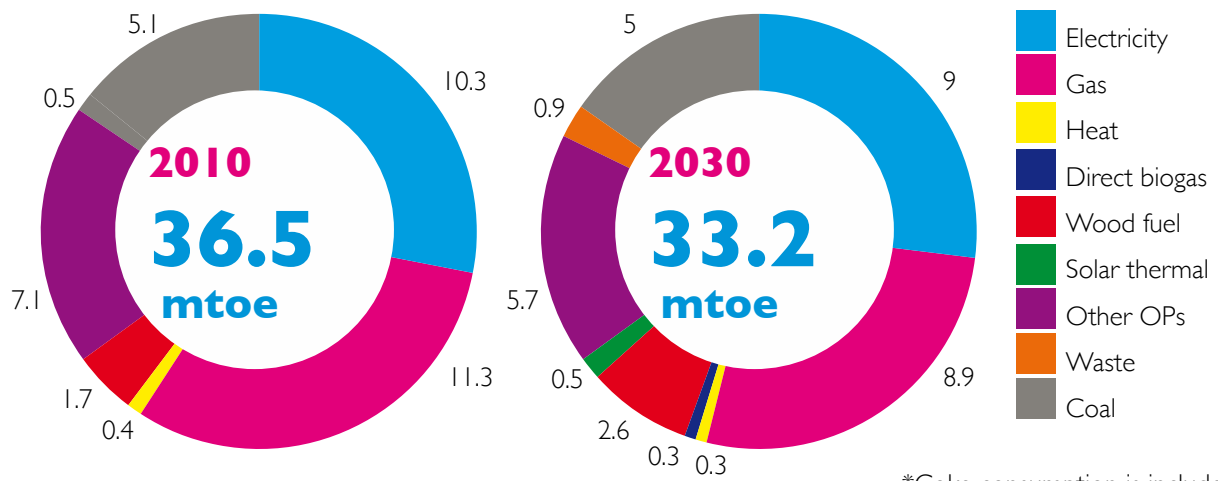
Reincorporation rate	2010	2030	Comment
Aluminium	78.3%	90.0%	Limitations of exports
Zinc	44.5%	60.0%	
Steel, including oxygen process	114 kg/ tonne of cast iron	~150 kg/ tonne of cast iron	Maximum threshold: 160 kg/tonne of cast iron
Steel, including electric process	100%	100%	Consisting of scrap only
Container glass	63.1%	70%	Limited by collection rate

REINCORPORATION AND RECYCLING RATES

The potential energy efficiency gains in each of these sub-sectors have been categorised according to whether they are based on proven technologies (currently available and with a known return on investment time), innovative technologies or organisational measures. Industrial co-products (residual heat, energy recovered from waste, etc.) are itemised in the energy supply section.

Industry	Gains	Distribution according to type of gain (percentages are not summable)	● Organisational ● Innovation ● Proven
Metal	-7.5 %	● 0.7 % ● 3.2 % ● 3.7 %	
Primary metals	-12.7 %	● 1.8 % ● 0 % ● 11.5 %	
Chemical	-18.0 %	● 2.6 % ● 6.5 % ● 11.2 %	
Non-metallic minerals	-14.3 %	● 2.9 % ● 3.0 % ● 10 %	
Food industry	-29.4 %	● 5.5 % ● 5.8 % ● 20.8 %	
Equipment	-27.7 %	● 6.9 % ● 4.0 % ● 20.1 %	
Others	-25.2 %	● 4.5 % ● 5.5 % ● 17.3 %	
Total	-19.6 %	Gains per unit produced	

ENERGY EFFICIENCY GAINS BY SECTOR

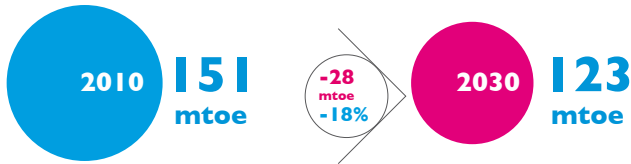


*Coke consumption is included in the coal figure

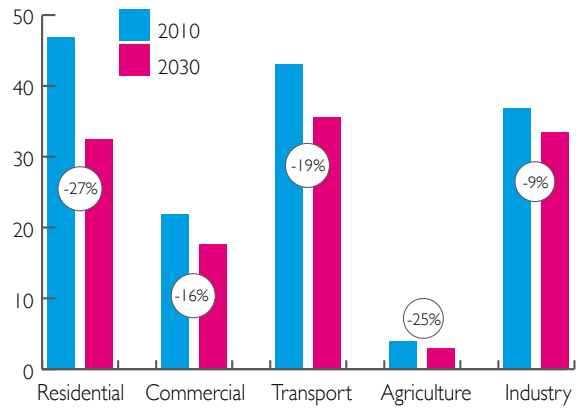
ENERGY CONSUMPTION IN INDUSTRY IN 2010 AND 2030 (FINAL MTOE)



Total energy consumption

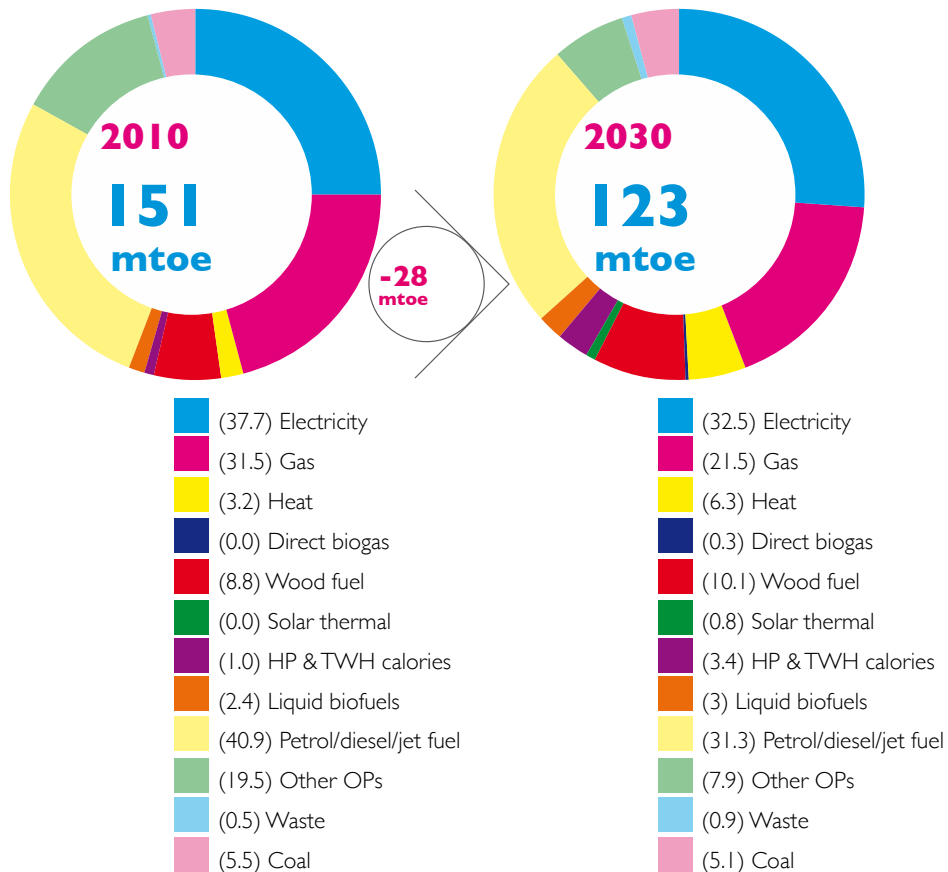


ENERGY CONSUMPTION IN 2010 AND 2030
(FINAL MTOE)



ENERGY CONSUMPTION FROM 2010-2030
BY SECTOR

In 2030, there is a total drop in final energy consumption of 28 mtoe, a decrease of nearly 18% compared to 2010. The buildings sector (residential and tertiary) accounts for 54 % of this reduction (15.2 mtoe) and the transport sector accounts for 30% (8.2 mtoe).



ENERGY CONSUMPTION BY VECTOR (FINAL MTOE)

Renewable energy production

The resources available for each renewable energy source (RES) have been analysed and detailed information about each resource is provided in the full report. The resources listed are the potential amounts that can be exploited under given technical and economic conditions. The partial exploitation of certain resources in the scenario is explained by diversification of the energy mix or the existence of local constraints.

I. Biomass

An ambitious plan to exploit forestry resources is assumed to be implemented, boosting the harvest rate of natural forest growth from 48% at present to 75% in 2030.

Solid biomass fuels	2010	2030
Forest		
Natural growth (including branchwood)	115 Mm ³ /year	122 Mm ³ /year
Forest harvesting rate	48 %	75 %
Harvesting rate (Mm ³)	55	92
- Timber for building in Mm ³	22	30
- Wood for industry (Mm ³)	12	12
- Fuelwood and stumps (Mm ³)	21 (4.7 mtoe)	50 (11.3 mtoe)
Other biomass		
Waste wood (mtoe)	1.2	3.4
Agricultural residues, hedges, agroforestry, trees in urban environments	0	3.3
TOTAL biomass solid fuels (mtoe)	5.9	18
SOLID BIOMASS FUELS		

The assumptions underlying these results include the increased use of timber forestry resources in the building industry (construction and renovation) and the exploitation of non-forest resources.

Total accessible resources for combustion biomass thus rise to 18 mtoe by 2030.

Biomass for methanation constitutes a significant and still largely unexploited resource. Assuming the installation of 600 biogas plants per year (which is half the German rate), **there will be an accessible resource of 6 mtoe of primary energy in 2030**, with approximately 50% for final use in the gas grid, 30% for cogeneration and 20% for direct use as heat.

2. Wind power

At an installation rate of 1.5 GW per year there are 34 GW of exploitable onshore wind resources by 2030 (the existing capacity in Germany today). There are 12 GW of offshore resources in 2030.

3. Photovoltaic (PV)

There are 33 GW of exploitable PV resources in 2030, at an average installation rate of 1.55 GW per year. Groundmounted plants are operated only at sites without land-use conflicts.

4. Hydroelectricity

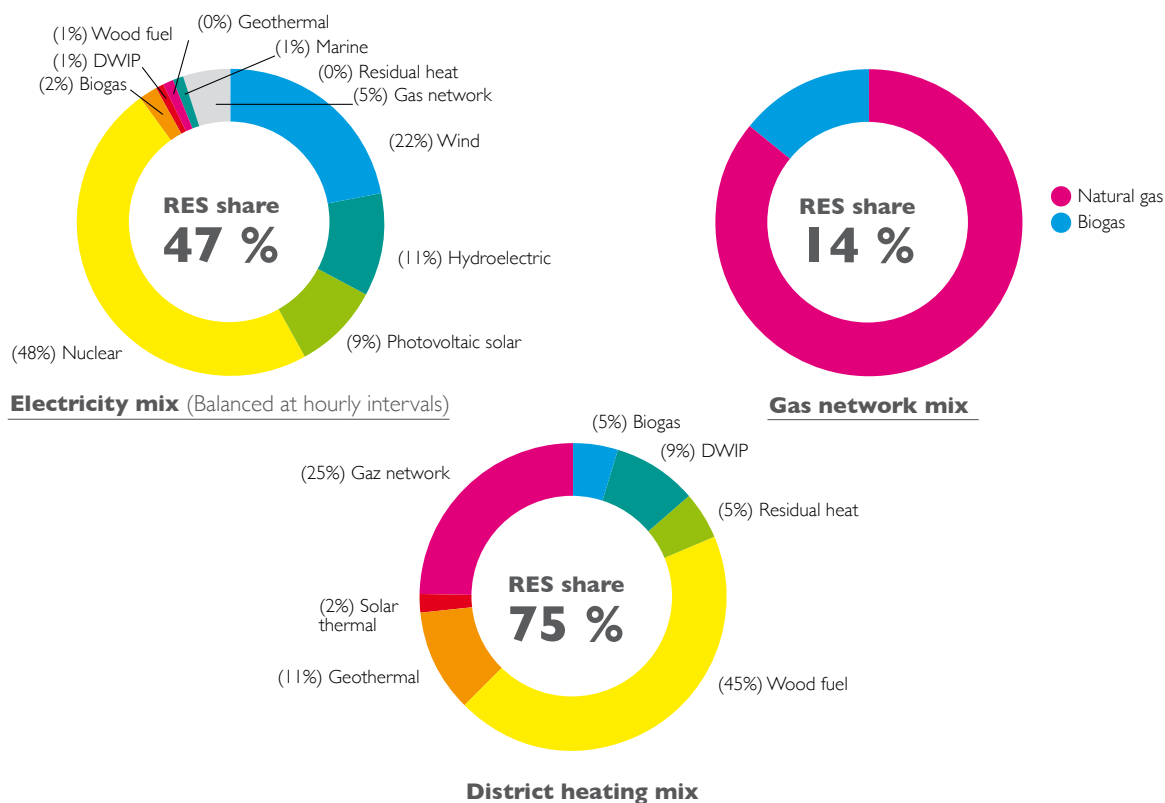
The growth potential for hydroelectricity is relatively limited. By 2030, the potential electrical power storage capacity of Energy Transfer Pumping Stations (ETPS) increases from 5.5 GW to 7 GW.



By 2030, we can harness 34 GW of onshore wind power resources (the same as in Germany today)

	Vector	2030
Renewable Energy Sources (RES)	Solid biomass fuels	16
	Wind	8.6
	Biogas	5.8
	Geothermal	3.5
	Hydroelectric	4.1
	Photovoltaic	3.4
	Biofuels excluding wood	7.9
	Ambient air calories	1.8
	Solar thermal	1.0
	Waste	1.4
	Marine	0.4
	Total RES	
Non-renewable	Nuclear	56.1
	Natural gas	23.7
	Oil	42.2
	Coal	5.1
	Waste	1.4
Grand total		182

PRIMARY ENERGY SOURCES IN 2030 (MTOE)



PROPORTION OF RES IN EACH NETWORK IN 2030

Final energy consumption by source

Sources		mtoe	
Electricity grid	Wind	7.2	32.5
	Hydroelectric	3.4	
	Photovoltaic	2.9	
	Nuclear	15.6	
	Methanation	0.6	
	DWIP	0.3	
	Wood fuel	0.3	
	Geothermal	0.1	
	Marine	0.4	
	Residual heat	0.1	
Gas network	1.7		
Gas network	Methanation	3.0	21.5
	BtG	0.0	
	Hydrogen	0.0	
	Natural gas	18.5	
District heating	Methanation	0.3	6.3
	DWIP	0.5	
	Residual heat	0.3	
	Wood fuel	2.8	
	Geothermal	0.7	
	Solar thermal	0.1	
	Gas network	1.6	
Direct gas	Methanation	0.3	
	Wood fuel	10.1	
	Solar thermal	0.8	
	HP and rotary heat exchanger calories	3.4	
	Liquid biofuels	3.0	
	Petrol/Diesel/Jet fuel	31.3	
	Other OPs	7.9	
	Waste	0.9	
	Carbon	5.1	

Environmental impacts

The scenario described in the preceding pages leads to a 40% reduction in French greenhouse gas emissions by 2030. Great care has also been taken to avoid causing additional emissions in other countries.

Total greenhouse gas emissions in MtCO₂eq

	1990				2030			
	CO ₂	CH ₄	N ₂ O	Total GHGs	CO ₂	CH ₄	N ₂ O	Total GHGs
Industry								
Combustion	79.9			79.9	49.8			49.8
Process	25.2		23.6	48.8	21.2		2.6	23.8
Residential <small>(primary residence)</small>								
Combustion	67.2			67.2	20.8			20.8
Others		4.3	0.9	5.2		5.5	1.0	6.5
Tertiary sector								
Combustion	28.7			28.7	9.0			9.0
Others				0,0				0,0
Transport								
Combustion	113.3			113.3	96.8			96.8
Autres				0,0			1.0	1,0
Agriculture								
Combustion	8.7			8.7	5.5			5.5
Others		51.6	36.6	88.2		33.8	30.3	64.1
Energy production	62.1	6.8		68.8	19.4	0.1181	0.5254	20.0
Waste	1.7	11.3	1.4	14.4	1.4	12.5	1.2	15.2
Solvents	1.8			1.8	1.0			1.0
Total	388.7	73.9	62.6	525	225.0	51.9	36.7	313 (-40%)

CHANGES IN GREENHOUSE GAS (GHG) EMISSIONS 1990-2030

Air quality

The impact of this scenario on atmospheric emissions (pollutants, pollutant precursors) and on air quality in highly urbanised areas was evaluated in collaboration with the Centre for Teaching and Research on the Atmospheric Environment (CEREA), the Inter-University Laboratory for Atmospheric Systems (LISA) and the Inter-Professional Technical Centre for Atmospheric Pollution Studies (CITEPA).

On the basis of changes in pollutant emission factors (mass of pollutants and precursors emitted per km travelled or kg of biomass burned) and using the most efficient technologies currently known, the projected emissions for nitrogen oxide (NO_x), de PM_{2.5}, SO₂, and non-methane volatile organic compounds (NMVOC) point towards a significant drop in pollutant emissions by 2030 in the framework of the ADEME energy scenario. NO_x emissions from district heating networks will require special attention, and call for specially designed solutions.

Pollutants	Emissions in 2010 (t)	Emissions in 2030 (t)	Change in emissions (%)	Change in emissions by sector (%)	
NO _x	779 393	263 987	-66%	District heating: residential and tertiary use	-29%
				Agriculture	-97%
				Electricity production: Refineries – Industries	-47%
				Road traffic (+ abrasions) and non-road mobile machinery	-82%
PM _{2,5}	144 655	50 248	-65%	District heating: residential and tertiary use	-64%
				Agriculture	-98%
				Electricity production: Refineries – Industries	-43%
				Road traffic (+ abrasions) and non-road mobile machinery	-76%
SO ₂	255 252	73 681	-71%	District heating: residential and tertiary use	-74%
				Agriculture	-75%
				Electricity production: Refineries – Industries	-67%
				Road traffic (+ abrasions) and non-road mobile machinery	-99%
COVNM	282 347	90 334	-68%	District heating: residential and tertiary use	-68%
				Agriculture	-98%
				Electricity production: Refineries – Industries	-17%
				Road traffic (+ abrasions) and non-road mobile machinery	-78%

POLLUTANT EMISSIONS

With regard to air quality, sensitivity analysis for 2030 shows that the reduction in pollutant emissions from road transport has a positive impact. However, this positive effect is not proportional to the drop in emissions, given the non-linear relationships between pollutant emissions and precursors on the one hand, and air quality on the other. Additional work is required to assess the impact on air quality of the emission projections for all energy and non-energy sectors. Finally, in light of ongoing climate change, these analyses will be extended to include photochemical ozone, a pollutant induced by solar radiation.

A photograph of a modern tram with a white and teal livery traveling on tracks. The tracks are set on a slight incline, surrounded by lush green trees and vegetation. In the background, a city skyline is visible under a blue sky with scattered white clouds. The overall scene is bright and sunny.

SCENARIO TO 2050

Buildings and urban organization

Specific features of a normative approach

By 2050, the housing stock consists of two main types of buildings: new low-energy and positive-energy buildings (LEB/PEB), and renovated buildings. Energy consumption for the entire stock of 36,000,000 dwellings is thus divided into two main categories:

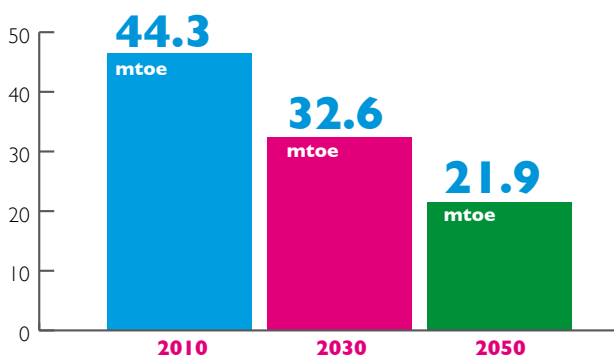
- “old renovated” buildings, a stock of 27,000,000 dwellings built before 2020
- “new” buildings, comprising 9,000,000 dwellings.

Average consumption per square metre in housing thus decreases by over 60% between 2010 and 2050, dropping from 191 kWh/m² of final energy (*) per year to 75 kWh/m² per year, all uses included.

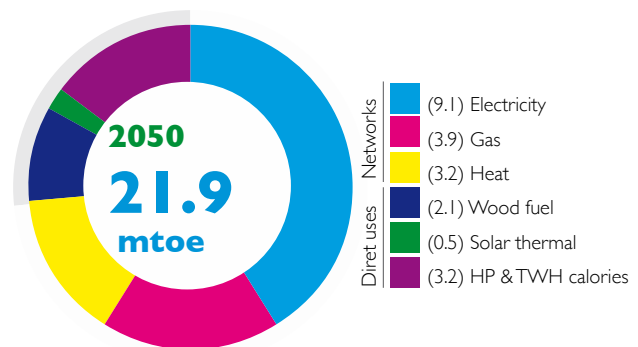
There is a sharp drop in average consumption associated with heating and domestic hot water due to energyefficiency renovation and the extensive introduction of HPs (50% of housing), ISWHs (20% of housing) and TWHs.

Specific uses of electricity are generally stable, but there is a significant rise in consumption for air conditioning, an indirect consequence of climate change.

Residential construction – a sector with widely accessible resources



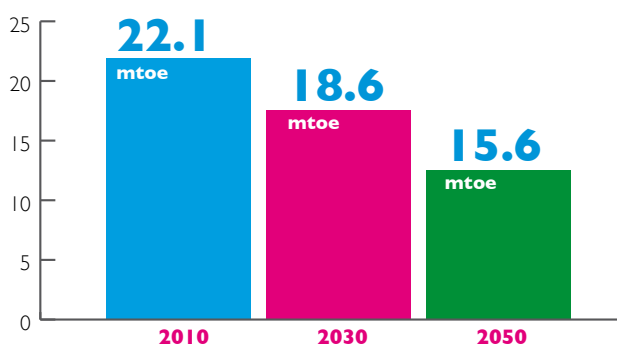
ENERGY CONSUMPTION IN THE RESIDENTIAL SECTOR IN 2010, 2030 AND 2050 (FINAL MTOE)



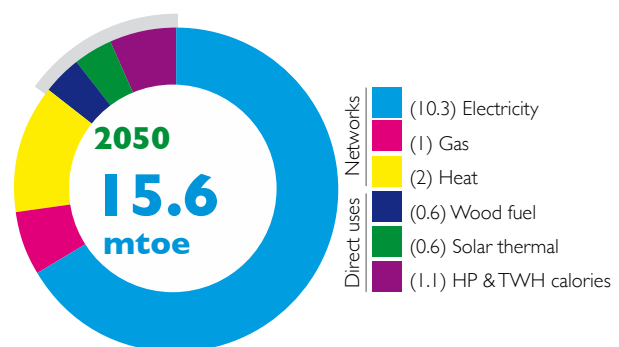
ENERGY CONSUMPTION IN THE RESIDENTIAL SECTOR IN 2050, BY VECTOR

Tertiary buildings and changes in types of employment

For 2050, we assume a 20% decrease in surface area per employee, due to the development of personal assistance services (especially in relation to the ageing of the population), a greater proportion of telecommuting (mainly due to the digitisation of communication) and the rationalisation of land use (associated with our assumption concerning land sealing).



ENERGY CONSUMPTION IN THE TERTIARY SECTOR IN 2010, 2030 AND 2050, BY VECTOR



ENERGY CONSUMPTION IN THE TERTIARY SECTOR IN 2050, BY VECTOR

A more efficient system of urban organisation

The active population works in residential buildings or in telecentres close to their homes on a more regular basis. From a “buildings” standpoint, this is merely a transfer of energy consumption, but it has a significant impact on transport. As the energy consumption cycles of residential and tertiary buildings are not synchronised, the creation of positive energy islands (physical or virtual via smart grids) may be envisaged, thus reducing the demand on the national electricity grid (impact not accounted for in the sizing of the electricity grid).



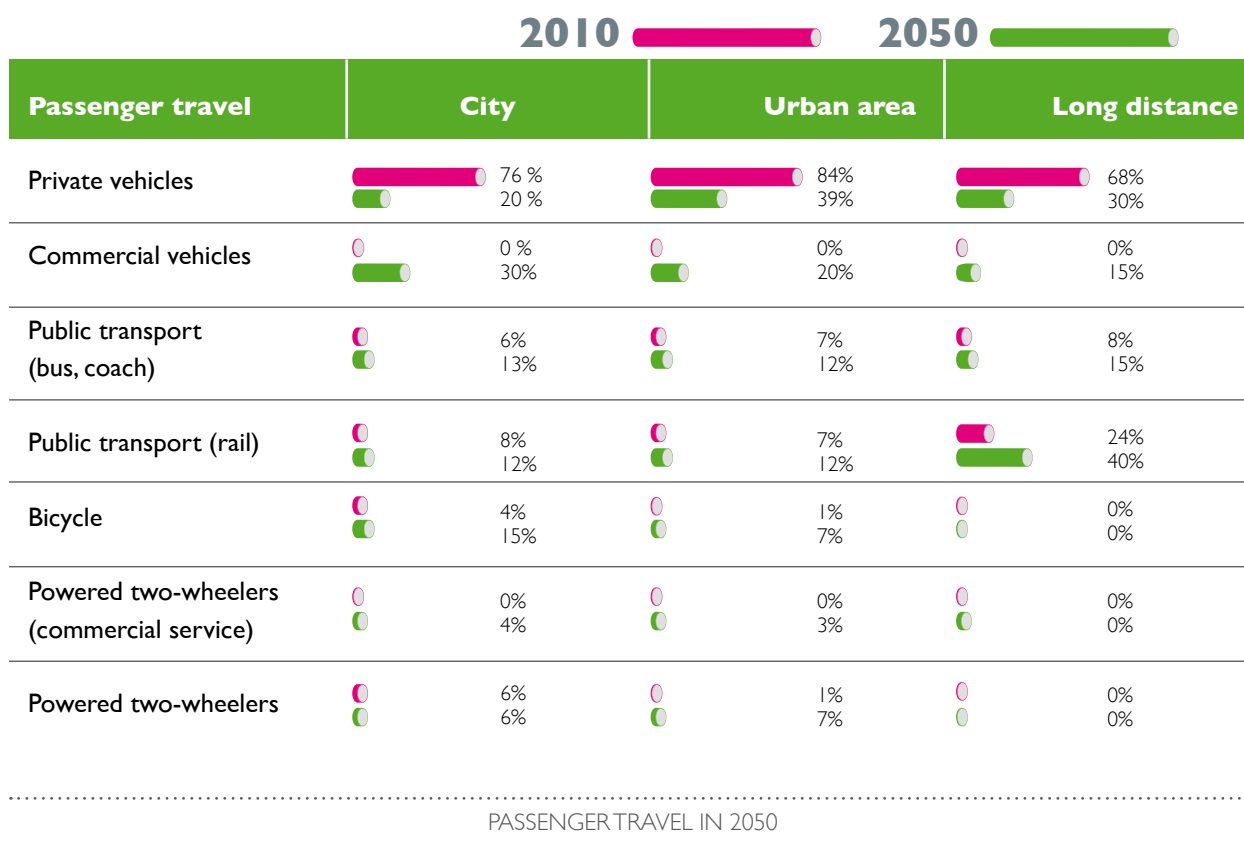
In our 2050 scenario, average energy consumption per square metre of housing will decrease by over 60% between 2010 and 2050

Transport and mobility

By 2050, individual mobility decreases by 20%, a change which can be mainly attributed to an increase in telecommuting, the significant ageing of the population, and improved systems of urban organisation.

More fluid and efficient mobility

In 2050, mobility services account for 30% of passenger travel in urban areas. There are twice as many passengers using public transport as today, while transport by powered two-wheelers and bicycles has quadrupled.



A very different national vehicle fleet, allowing for oil independence in 2050

To satisfy mobility needs in 2050, the vehicle fleet would be smaller, numbering 22 million vehicles compared to 35 million today. This ambitious assumption implies that cars cease to be commodities purchased mainly by private individuals, and become a mode of transport integrated into a much broader system: vehicles are pooled, used several times a day, and carry more passengers. They are also better designed for each type of journey with greater differences between urban and long-distance vehicles, resulting in improved energy efficiency. The national fleet would consist of 1/3 internal combustion engine vehicles, 1/3 plug-in hybrid vehicles and 1/3 electric vehicles.

Vehicles (including personal cars and light utility)	2050 sales	2050 stock
Internal combustion engine vehicles	34%	34%
Plug-in hybrid vehicles	38%	38%
Electric vehicles	28 %	28%
Total	1.2 million	22 million

.....
VEHICLE SALES AND FLEET IN 2050

Of these 22 million vehicles, 12 million would be privately owned and 5 million used in vehicle-sharing schemes with the remaining 5 million being light utility vehicles.

Our research shows that a significant reduction in heating requirements for the buildings sector would release potential renewable energy sources that could be transferred to the transport sector via the natural gas network. This would allow for a gradual transition from oil as the fuel source for internal combustion engine vehicles to natural gas, a major proportion of which is renewable. Combined with the development of second-generation or even third-generation biofuels, France could thus become independent of oil resources by 2050. However, this change in the fuels used will not be the key factor for achieving the target of a fourfold reduction in emissions – the decisive changes will be a modal transfer towards carpooling, public transport and non-motorised modes of transport, and the growing prevalence of electric and plug-in hybrid vehicles. If the energy vector used continues to depend on oil products, the average emissions from the vehicle fleet may amount to 49 g CO₂/km in 2050.

By 2050, mobility services account for 30% of urban passenger travel

A systems approach to freight transport

The normative scenario for 2050 assumes a radical change compared to past trends, with freight transport, measured in tonne-kilometres, returning to 2010 levels. This change calls for the implementation of a systemic policy and significant efforts focusing on logistics, packaging and the correlation of production sites and consumption zones. There is a substantial increase in the modal shares of rail, inland waterway and maritime transport.

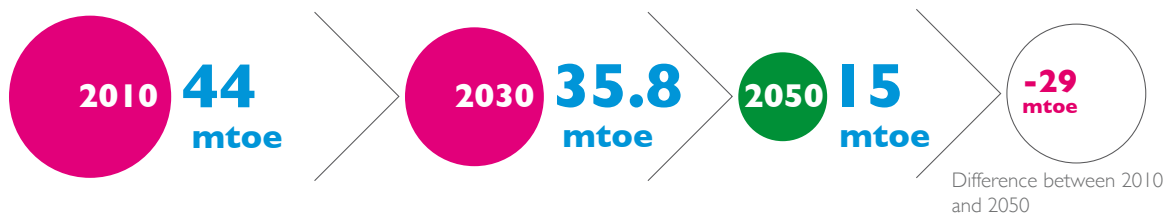
Heavy goods vehicles stay outside of towns and cities, dropping off their goods in logistics centres which then use lighter vehicles for final deliveries in city centres.

Mode of transport	Freight traffic 2010, in Gtkm	Freight traffic 2050, in Gtkm
Road	340	262
Rail	34	100
Internal navigation	8	20
Total	382	382

* Gtkm is the conventional unit of measurement for freight transport, equal to 1 billion tonnes of freight transported over 1 km.

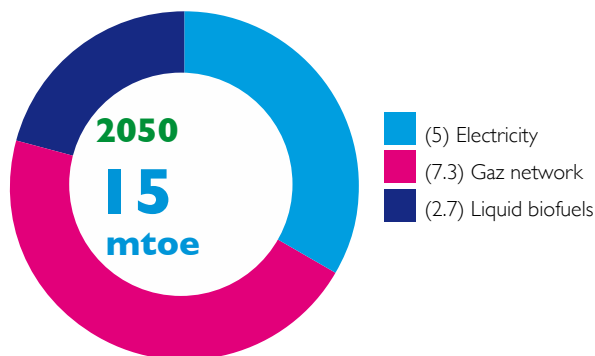
FREIGHT TRANSPORT BY MODE IN 2050 (GTKM)

Energy consumption in the transportation sector



ENERGY CONSUMPTION IN THE TRANSPORT SECTOR IN 2010, 2030 AND 2050 (FINAL MTOE)

Assuming that internal combustion engine vehicles are powered by natural gas, there will be the following energy mix in the transport sector:



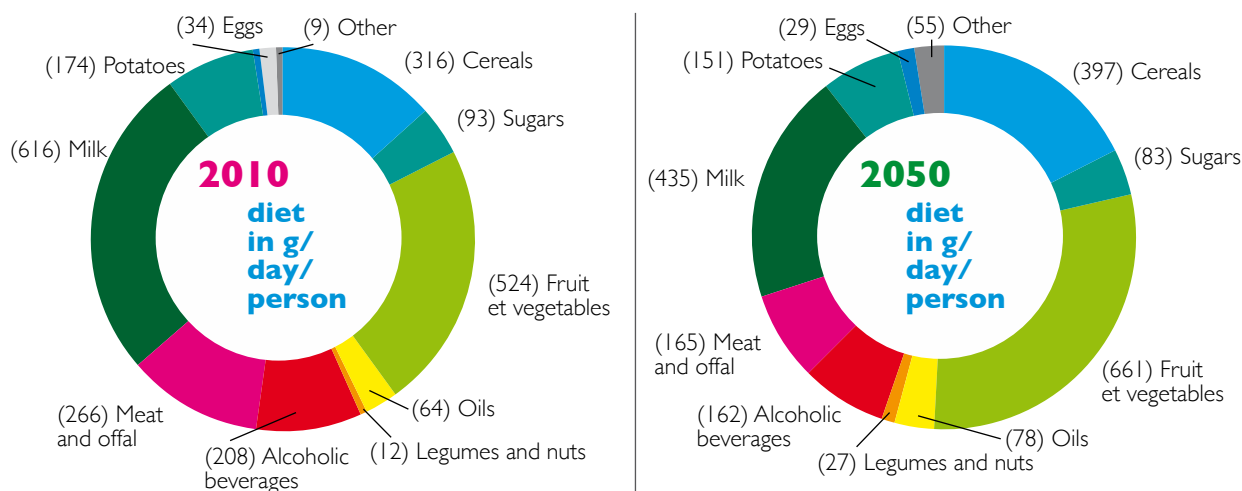
ENERGY CONSUMPTION IN TRANSPORTATION IN 2050, BY VECTOR

Food, agriculture and land use

The scenario assumes that there is no change to the 2010 energy balance between imports and exports. Additional research will be required for a more detailed analysis of the place of French agricultural production within Europe and in the global agricultural landscape.

Food consumption

For 2050, changes in diet are posited, moving towards the FAO (Food and Agriculture Organization) recommendations, without fully attaining them. The scenario assumes a reduction in the excessive consumption of simple carbohydrates and proteins, and a more equal balance between animal and plant proteins. A drastic reduction (-60%) in food wastage is assumed to take place. The nutritive potential of French farming is improved due to the drop in individual protein and energy consumption. Consumption of dairy products is reduced by 25%, offset by diversified sources of calcium.



	2010	2050
Total proteins	113 g/day/person (including 40 g plant-based)	86 g/day/person (including 43 g plant-based)
Energy	3324 kcal/pers/day	3270 kcal/pers/day
Nutritive potential (in number of people fed)	Energy 140 million / million proteins 95 / Animal proteins 65 million	Energy 136 million / million proteins 113 / Animal proteins 79 million

DIET IN 2010 AND 2050

Agricultural practices and production

Agricultural production systems are moving towards more sustainable practices, while maintaining high levels of productivity. “Integrated” production occupies 60% of the usable agricultural area, with organic farming accounting for 30% and conventional farming the remaining 10%.

The main determining factors of the scenario concern:

- A significant reduction in the consumption of mineral nitrogen fertilisers (-37 %) by rationalising practices, extending rotations and increasing leguminous crop cultivation;
- Ploughless or minimal tillage of the soil (fuel savings, preservation of soil quality, etc.);
- Substantial reduction in energy consumption for the heating of buildings and greenhouses;
- Shifting of the focus in cattle farming towards grassland farming systems that promote the maintenance of permanent pastures and carbon storage;
- Protein self-sufficiency target of 75% for animal feed;
- Massive increase in methanation (50% of manure processed);
- Increase in intercropping (improved biodiversity, fewer inputs, etc.);
- Systematic planting of intermediate crops to preserve soil quality;
- Large increase in land areas covered by hedgerows (+1.7 Mha compared to 2010) and agroforestry.

The proposed agricultural models are characterised by their greater diversity, the increased exploitation of natural resources and the quest to achieve a balanced ecosystem.

The 2050 scenario takes climate change effects into account (assumptions derived from the INRA Climator project). These effects are growing irrigation needs -- +30%, attaining 4 billion m³ of water annually. This increase is attenuated, however, compared to a business-as-usual scenario.

Livestock populations for white meat production remain fairly constant between now and 2050. The downward trend in bovine meat consumption observed over the last three decades continues. Cereal, fruit and vegetable production increase.

**GHG emissions from the agricultural sector are halved between 2010 and 2050,
while energy consumption decreases from 4 mtoe to 3 mtoe**

Land use

It is assumed that the currently rising rate of soil sealing will fall under the impetus of public policies from 2015, ceasing entirely in 2030. Moreover, afforestation continues.

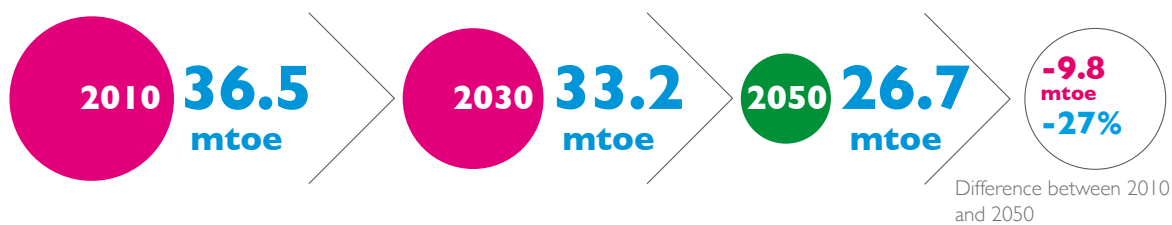
Energy consumption in the agricultural sector falls by 25% from 4 mtoe in 2010 to 3 mtoe in 2050.



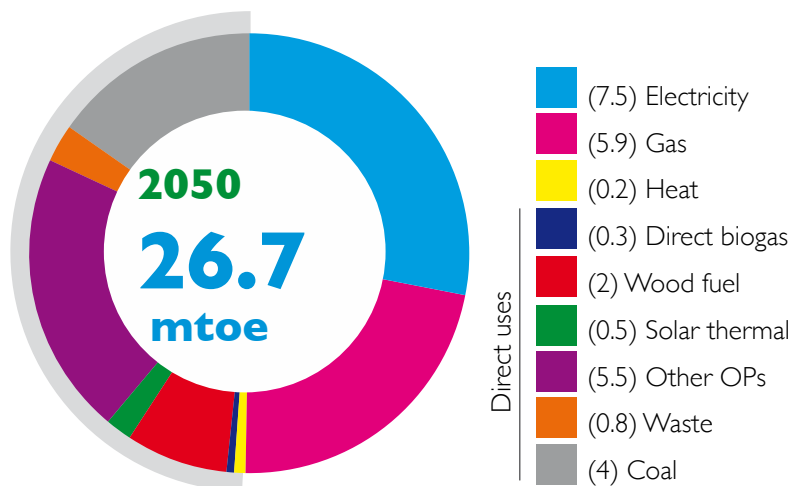
ENERGY CONSUMPTION IN THE AGRICULTURAL SECTOR IN 2010, 2030 AND 2050 (FINAL MTOE)

Industry and industrial processes

In the scenario projected for 2050, the structural changes undertaken up to 2030 continue and the efficiency gains between 2030 and 2050 are assumed to be the same as between 2010 and 2030. Energy consumption is consequently reduced by over 25%, despite the growth in business activity (the sector's share in GDP is maintained and physical production is stabilised at the levels achieved in the 2030 scenario). This is a preliminary approach which must be supplemented by additional work.



ENERGY CONSUMPTION IN THE INDUSTRIAL SECTOR IN 2010, 2030 AND 2050 (FINAL MTOE)



ENERGY CONSUMPTION IN THE INDUSTRIAL SECTOR IN 2050, BY VECTOR



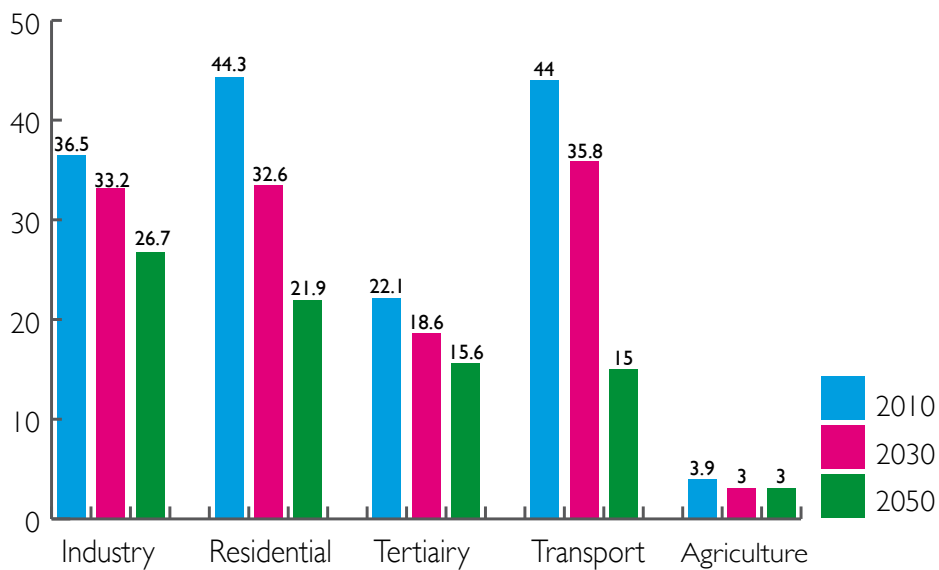
The 2050 scenario envisages a 25% reduction in energy consumption, despite the growth of industrial activity, the share of industrial production in GDP remaining stable.

Total energy consumption



ENERGY CONSUMPTION IN 2050 (FINAL MTOE)

To achieve the target of a fourfold reduction in greenhouse gas emissions, our scenario is based on French energy consumption decreasing by almost 50% between 2010 and 2050. The buildings sector (residential and tertiary) and transport sector will be mainly responsible for this drop in consumption. The agriculture and forestry sector plays a key role in the scenario, via its impact on changes in greenhouse gas emissions and its decisive contribution to renewable energy (RES) production.



ENERGY CONSUMPTION IN 2050 BY SECTOR (MTOE)

Renewable energy production

Each individual renewable energy source (RES) has been assessed, and detailed information about each resource is provided in the full report. The available resources mentioned are the potential amounts that can be exploited under given technical and economic conditions.

The partial exploitation of certain resources in the scenario can be explained by the diversification of the energy mix or the existence of local constraints.

1. Biomass

By Maintaining a 75% harvest rate of natural annual forest growth, a yearly **21 mtoe** of wood fuel are made available by 2050. In accordance with the agricultural scenario, the total accessible resource for methanation can be increased to 9 mtoe of primary energy in 2050.

2. Wind power

The exploitable potential for onshore wind power in 2050 is **40 GW**. The exploitable offshore potential in 2050 is **30 GW**.

3. Photovoltaic (PV)

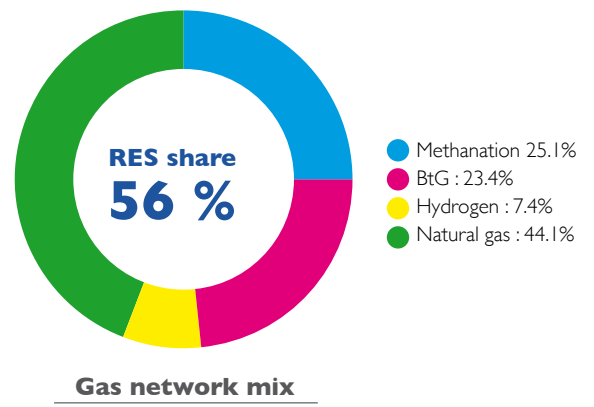
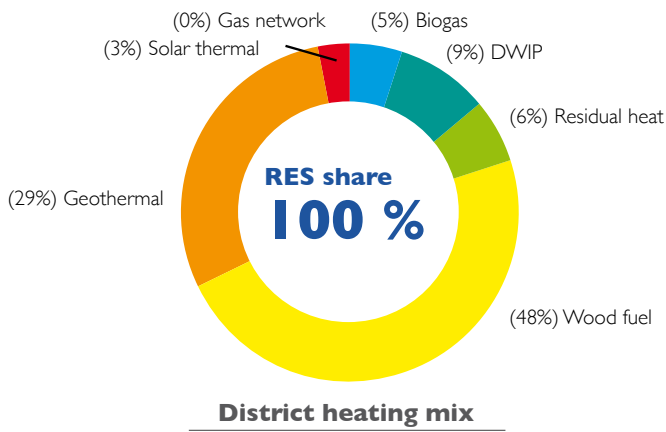
The exploitable potential for photovoltaic power rises to **65 GW** in 2050.

4. Hydroelectricity

A marine ETPS may be built by 2050.

Three electricity mix scenarios have been developed (see the full document for detailed descriptions). The “High” scenario sees the share of nuclear power in electricity production remaining stable at approximately 50% in 2050, as in 2030. The “Median” scenario assumes that the share of nuclear power in energy production continues to fall, to 25% in 2050. The “Low” scenario envisages an 18% share for nuclear power in electricity production in 2050, implying the maximum exploitation of potential RESs. The ranges shown in the table below cover the values for the three alternative scenarios.

	Vectors	2050
RES	Solid biomass fuels	17.1
	Wind	9.1 - 13.9
	Biogas	8.8
	Geothermal	5.1 - 6
	Hydroelectric	4.3 - 5.8
	Photovoltaic	3.6 - 6
	Biofuel materials excluding wood	5.6
	Ambient air calories	2.4
	Solar thermal	1.8
	Waste	1.3
	Marine	0.5 - 3.9
Non-renewable	Nuclear	21.6 - 57.6
	Natural gas	11.9
	Oil	5.9
	Coal	4.0
	Waste	1.4
Grand total		117 - 140



PROPORTION OF RESS IN EACH NETWORK IN 2050



Final energy consumption per source

Sources		mtoe			
		High	Medium	Low	
Electricity network	Wind	7.3	9.9	11.1	32.8
	Hydroelectric	3.4	4.6	4.7	
	Photovoltaic	2.9	4.8	4.9	
	Nuclear	15.7	8.2	5.9	
	Methanation	0.6	0.6	0.6	
	DWIP	0.2	0.2	0.2	
	Wood fuel	0.2	0.2	0.2	
	Geothermal	0.1	0.1	0.2	
	Sea-based energy	0.4	2.3	3.1	
	Residual heat	0.1	0.1	0.1	
Gas network		1.8	1.8	1.8	
Gas network	Methanation			5.6	19.3
	BtG			2.6	
	Hydrogen			1.2	
	Natural gas			9.9	
District heating	Methanation			0.3	5.4
	DWIP			0.5	
	Residual heat			0.3	
	Wood fuel			2.6	
	Geothermal			1.6	
	Solar thermal			0.1	
	Gas network			0.0	
Direct use	Methanation			0.3	
	Wood fuel			4.7	
	Solar thermal			1.6	
	HP and & TWHs calories			4.3	
	Liquid biofuels			3	
	Petrol/Diesel/Jet fuel			0	
	Other OPs			5.5	
	Waste			0.8	
	Coal			4.0	

Environmental impacts

Our 2050 scenario analysis shows that the target of a fourfold decrease in greenhouse gas emissions is achievable. Indeed, further reduction is possible, because the scenario does not take into account breakthrough technologies or technologies which are currently being developed (carbon capture, storage and recovery). Carbon storage by soils, which is not included in the official data, is positive in the ADEME scenario (in contrast to a business-as-usual scenario).

Total greenhouse gas emissions in MtCO₂ eq

	1990				2050			
	CO ₂	CH ₄	N ₂ O	Total GHGs	CO ₂	CH ₄	N ₂ O	Total GHGs
Industry								
Combustion	79.9			79.9	35.5			35.5
Process	25.2		23.6	48.8	17.1		1.8	18.8
Residential (primary residence)								
Combustion	67.2			67.2	4.8			4.8
Others		4.3	0.9	5.2		0.1	0.0	0.1
Tertiary								
Combustion	28.7			28.7	1.3			1.3
Others				0.0				0.0
Transport								
Combustion	113.3			113.3	8.5			8.5
Others				0.0			0.0	0.0
Agriculture								
Combustion	8.7			8.7	3.9			3.9
Others		51.6	36.6	88.2		22.0	24.9	46.9
Energy production	62.1	6.8		68.8	3.1	0.0		3.1
Waste	1.7	11.3	1.4	14.4	0.7	6.3	0.6	7.6
Solvents	1.8			1.8	10.5			0.5
Total	388.7	73.9	62.6	525	75.4	28.4	27.3	131 (-75%)

CHANGES IN GREENHOUSE GAS (GHG) EMISSIONS 1990-2050

Our 2050 scenario shows that the target of a fourfold decrease in greenhouse gas emissions is achievable.

MACROECONOMIC
EVALUATION
2030
2050

The identification and quantification of the resources released following the adoption of more energy-efficient practices, and of the technical potential for energy efficiency and the development of renewable energy sources, were supplemented by a macroeconomic evaluation of scenarios envisaging the exploitation of these technical possibilities and resources. What are the expected impacts on gross domestic product (GDP), employment and the trade balance? Are these technical proposals for achieving the target of a fourfold reduction in greenhouse gas emissions economically viable, and do they represent an opportunity for growth?

Changes in macroeconomic indicators under different scenarios

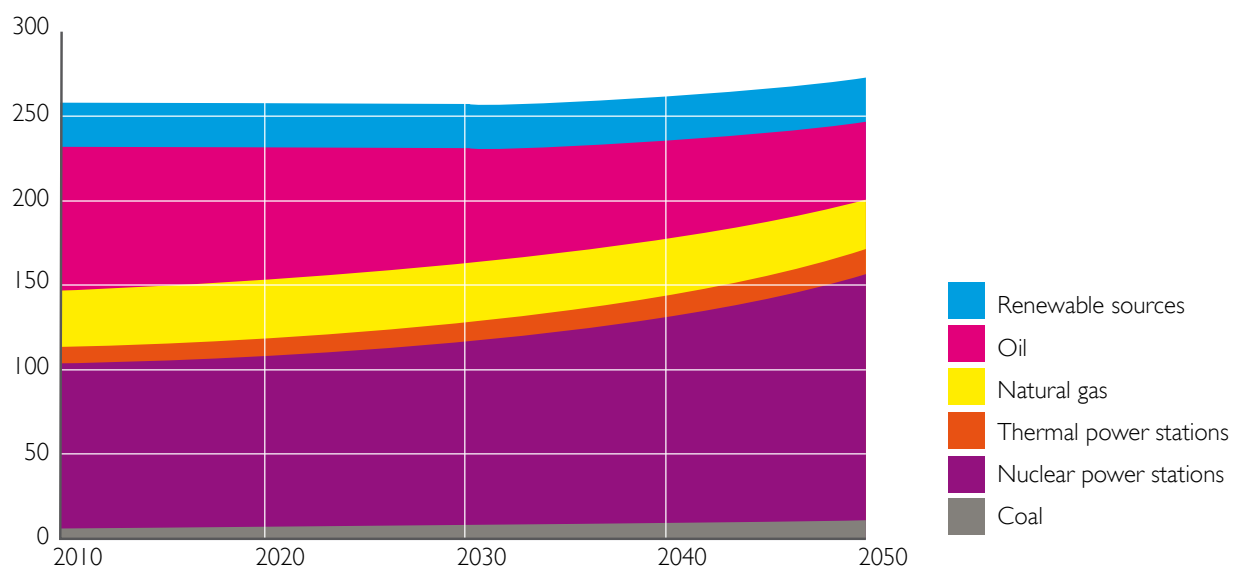
To perform this evaluation, ADEME used a “Multisectoral Macroeconomic Model for Evaluating Energy and Environmental Policies (ThreeME), which the agency has been developing since 2008 in conjunction with the French Economic Observatory (OFCE), an economic research centre at the Institute of Political Studies. ThreeME is an economic forecasting model used to assess the effects of public policy measures on business production and employment, and the repercussions for consumption, the trade balance, public accounts, and national income (GDP).

The macroeconomic evaluation carried out using the ThreeME model reveals the gains or losses generated by the implementation of our scenarios for 2030 – 2050, compared to a business-as-usual scenario. Changes in energy prices for the different economic operators and the relative proportion of the energy bill in their spending can also be simulated. The results depend on the modelling principles used (which, in this case, are comparable to other macroeconomic forecasting models used by INSEE), the calibration of the baseline year and certain other assumptions.

One trend-based scenario and three alternative energy scenario analyses

In the business-as-usual scenario used as a baseline, the shares of the different energy sources remain stable in the energy mix, the instruments currently used to combat climate change are not modified, the economy is growing at a rate of 1.8% and fossil fuel prices change according to IEA forecasts. Final energy consumption amounts to 170 mtoe in 2010, 156 mtoe in 2030 and 138 mtoe in 2050.

BASELINE SCENARIO

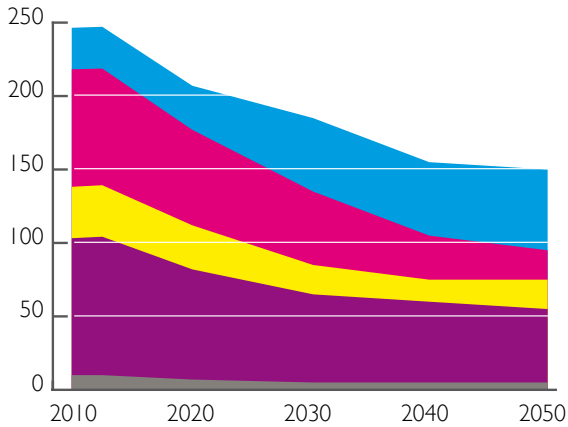


Scenarios

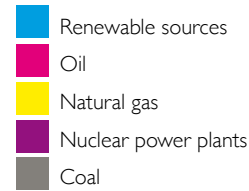
The ADEME 2030 scenario has the following main characteristics: final energy consumption reduced by nearly 30 mtoe to 123 mtoe FE, renewable energy sources accounting for 35% of the energy mix and 50% of electricity generated by nuclear power. By 2050, final energy consumption amounts to 82 mtoe.

Three energy mix scenarios are proposed:

ADEME HIGH SCENARIO

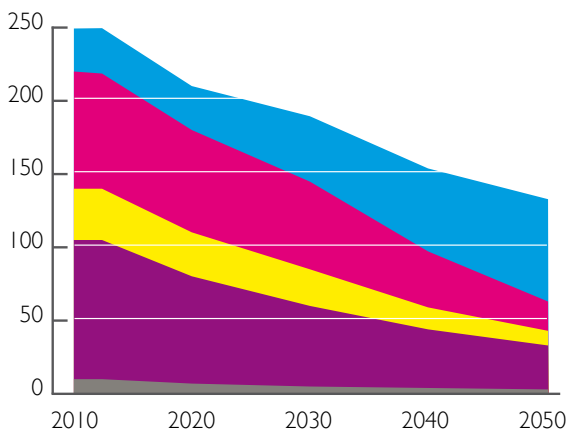


The «High» scenario sees **nuclear power maintaining a 50% share in electricity generation in 2050**, as in 2030

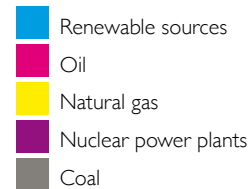


CHANGES IN THE ENERGY MIX IN MTOE OF PRIMARY ENERGY - SOURCE:THREEME 2013

ADEME MEDIUM SCENARIO

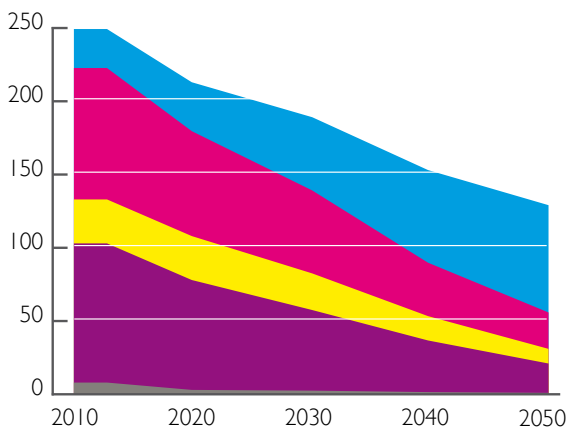


The «Medium» scenario sees **the share of nuclear power in electricity generation continuing to decline to 25% in 2050**

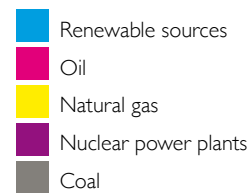


CHANGES IN THE ENERGY MIX IN MTOE OF PRIMARY ENERGY - SOURCE:THREEME 2013

ADEME LOW SCENARIO



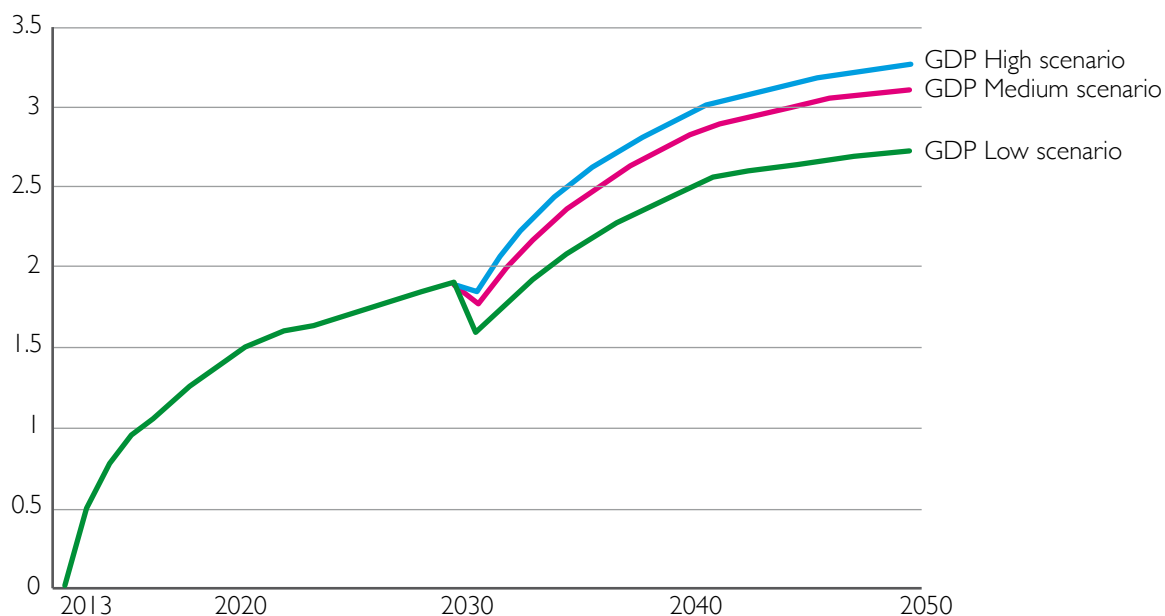
The «Low» scenario sees **nuclear power accounting for 18% of electricity generation in 2050**, which implies the maximum exploitation of potential RES.



CHANGES IN THE ENERGY MIX IN MTOE OF PRIMARY ENERGY - SOURCE:THREEME 2013

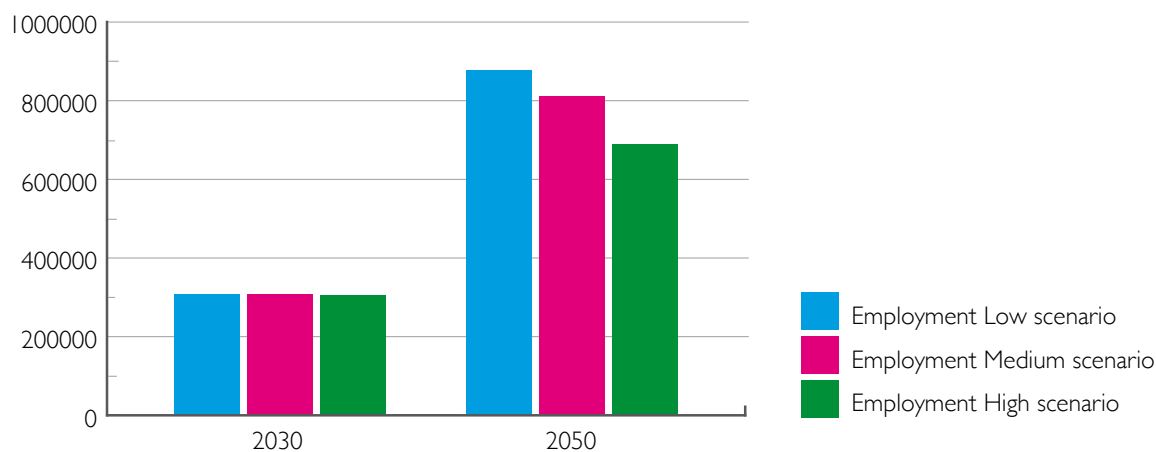
A long-term improvement in macroeconomic indicators

This evaluation focused solely on conventional macroeconomic indicators such as GDP, which take into account only recorded financial transactions. Losses or gains in well-being, associated with changes in behaviour (decrease in individual mobility, other modes of energy consumption, etc.) and changes in climate and environment trends, are not evaluated due to the lack of consensus concerning their definitions and measurement tools.



DEVIATION FROM THE BASELINE SCENARIO IN INDEX POINTS – SOURCE:THREEME 2013

In 2030, the implementation of the ADEME scenario results in a 1.9-point increase in GDP compared to the baseline scenario.¹ In 2050, the projection leads to a rise of 3.3 GDP points in the Low scenario, 3.1 GDP points in the Medium scenario and 2.7 GDP points in the High scenario. In other words, the energy transition could generate gains equivalent to nearly two years of additional growth over the 2013-2050 period. This result can be attributed mainly to increased employment and the reduction of the trade deficit.



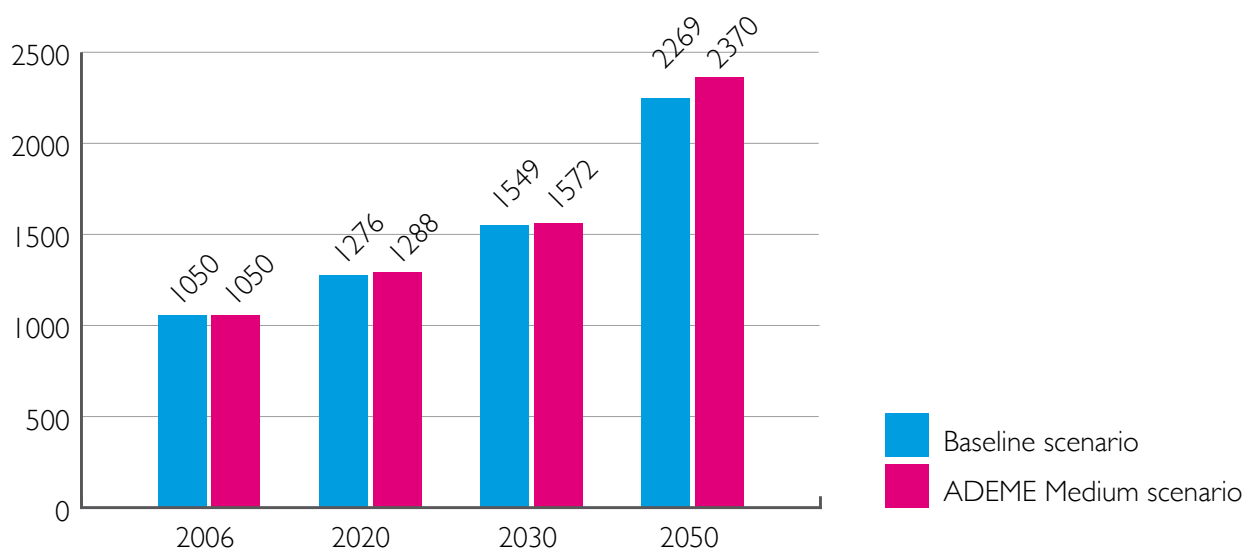
DEVIATION FROM THE BASELINE SCENARIO – SOURCE:THREEME 2013

(1) For a GDP index of 100 in the baseline scenario, the index rises to 101.8 in the ADEME projection for 2030

In 2030, job creation is boosted by 329,000 positions compared to the baseline scenario. In 2050, 825,000 jobs are created in the Medium scenario (+874,000 jobs are created in the Low scenario and +691,000 jobs are created in the High scenario). In the Medium scenario, the unemployment rate as a percentage of the active population decreases by 1.5 points in 2050, compared to the baseline scenario.

In the short term, the trade deficit rises by 0.4% of GDP compared to the baseline scenario, due to an increase in capital goods imports, which is linked to the development of renewable energy production and a slight drop in French exports, following a rise in energy prices. After 2010, the trade deficit gradually decreases in line with reductions in energy costs and also declines in relation to the baseline scenario, by 1% of GDP in the Low scenario, 1.1% of GDP in the Medium scenario and 1.2% of GDP in the High scenario, by 2050.

Between 2014 and 2030, household energy bills increase due to rising prices and higher energy taxes. They then decrease, despite the continuous rise in energy prices, due to lower energy consumption. The energy transition leads to increased household purchasing power, with a rise in gross disposable income of over €100 billion – excluding energy bills and minus household debt incurred for energy efficiency investments (in the housing and motor vehicle sectors) by 2050 compared to the baseline scenario. This is the result of job creation and the reduction in energy bills in the medium term.



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 GROSS DISPOSABLE HOUSEHOLD INCOME EXCLUDING ENERGY AND DEBT BURDEN REMAINS CONSTANT
 (BILLIONS OF EUROS)

This macroeconomic evaluation of the 2030-2050 scenario using the ThreeME model demonstrates that the recessionary impacts of public energy transition policies such as the drop in business activity linked to the decrease in energy production, the rise in the cost of electricity generation and the increase in environmental taxation, are offset by expansionary effects, such as increased employment associated with the development of new business activities (e.g. energy-efficiency renovation of buildings), the medium-term reduction in energy bills (allowing for increased consumption in other areas), the redistribution of environmental tax revenues to households (in the form of income tax reductions) and companies (in the form of lower charges) and a medium-term improvement in the trade balance (drop in imports, particularly of fossil fuels). In addition to its positive environmental aspects, the energy transition is thus also expected to be beneficial for the French economy in general.

APPENDICES

Two time horizons and two separate methodologies

In 2012, ADEME asked its technical and economic departments to develop forward-looking energy scenarios up to 2030 and 2050. The results, “ADEME Energy Transition Scenarios 2030-2050», are summarised here.

This in-house project has enabled the Agency to propose proactive energy and climate scenarios focusing on the management of energy consumption and the development of renewable energy supplies. These scenarios identify a possible pathway towards energy transition in France, address key environmental issues and identify green growth sectors and the changes that must be made to French energy production facilities.

	ADEME Vision 2030	ADEME Vision 2050
Méthodology	Exploratory	Normative
Target	Proactive trend-based	75% reduction in GHG emissions
Sectors considered	All sectors of energy consumption, excluding energy production	
Main indicators	Energy, GHGs (CO ₂ , CH ₄ , N ₂ O), pollutants emissions, air quality	
Economic indicators	GDP, employment, investments, trade balance, energy prices	
Consideration of the consequences of climate change	No	Yes for buildings and agriculture (AIB scenario of the IPCC report)
Results		
Primary energy (% 2010)	182 mtoe (-30 %)	Not available
Delivered energy (% 2010)	123 mtoe (-18 %)	82 mtoe (-46 %)
GHGs (% 1990)	313 Mt CO ₂ eq (-40 %)	131 Mt CO ₂ eq (-75 %)

SCENARIO UP TO 2030

Macroeconomic and demographic outlook

For both scenarios, the demographic changes in question are derived from the INSEE “high birth- rate” scenario i.e. 68,531,000 inhabitants in 2030 compared to 62,881,000 today. The INSEE assumption of a decrease in the number of people per household has also been adopted (2.17 people per household in 2030 compared to 2.31 today). The International Energy Agency’s (IEA) macroeconomic parameters have been used for oil, natural gas and coal prices in 2030, and the French Strategic Analysis Centre’s (CAS) parameters have been adopted for GDP growth, i.e. an average of 1.8% per year over the period.

Factors	2010 value	2030 value	Units	Source
Oil	78.1	134.5	\$ ₂₀₁₀ /baril	AIE WEO 2011
Gas	7.5	13	\$ ₂₀₁₀ /Mtu	AIE WEO 2011
Coal	99.2	115.9	\$ ₂₀₁₀ /tonne	AIE WEO 2011
Structural increase of the GDP	1.8 % per year over the period			CAS

SCENARIO UP TO 2050

Macroeconomic and demographic outlook

For the 2050 time horizon, the trends used for the 2030 scenario analysis have been extended. The demographic changes in question are derived from the INSEE “high birth-rate” scenario i.e. 74,130,000 inhabitants in 2050, compared to 62,881,000 today. The INSEE assumption of a decrease in the number of people per household has also been adopted (2.05 people per household in 2050 compared to 2.31 today). The significant ageing of the population has been taken into account. There are major alterations to the age pyramid, with an additional 9 million people over 65 years old, an age group that will constitute a quarter of the French population.

Factors	2010 value	2050 value	Unit	Source
Oil	78.1	231	\$ ₂₀₁₀ /barrel	Continuation of IEA WEO trend
Gas	7.5	22	\$ ₂₀₁₀ /Mtu	Continuation of IEA WEO trend
Coal	99.2	128	\$ ₂₀₁₀ /tonne	Continuation of IEA WEO trend
Structural	1.8 % per year over the period			Continuation of CAS trend

List of abbreviations and acronyms

INSEE: Institut National de la Statistique et des Etudes Economiques (French Institute for Statistics and Economic Studies)

IAE: International Energy Agency

BtG: Biomass to Gas

CAS: Centre d'Analyse Stratégique (Strategic Analysis Centre)

ISWH: Individual solar water heater

TWH: Thermodynamic water heater

GHG: Greenhouse gas

INRA: Institut National de la Recherche Agronomique (French National Institute for Agricultural Research)

kWh: kilowatt hour

mtoe: 1 million toe

HP: Heat pump

GDP: Gross Domestic Product

OP: Oil products

PV: Photovoltaic

toe: tonnes of oil equivalent

DWIP: Domestic Waste Incineration Plant

Units, definitions and conversion factors

toe: Quantity of energy contained in one tonne of oil

Common energy conversions

	Diesel (t)	Gasoline (t)	Biomass (t)	Electricity (MWh)	Natural gas (MBTU)	Coal (t)
1 toe	0.95	1.05	0.22	11.63	36.7	0.62

ABOUT ADEME

Having played a central role in environmental issues for two decades, ADEME – the French Environment and Energy Management Agency – is active in the implementation of public policies in the areas of the environment, energy and sustainable development. ADEME provides expertise and advisory services to businesses, local authorities and communities, government bodies and the public at large, enabling them to establish and consolidate their environmental action. As part of this work, the agency helps finance projects, from research to implementation, in the following areas: waste management, soil conservation, energy efficiency and renewable energy, air quality and noise abatement.

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