Break it or make it

Long term impact of technology and policy developments on the global energy transition

ING Research – October 2020

Introduction

Covid-19 reduces fossil fuel demand for the wrong reasons

Fossil fuel use is the main cause of global greenhouse gas emissions that contribute to global warming. Therefore, the use of fossil fuels needs to be reduced tremendously to reach the Paris Agreement goals of keeping global warming to well below 2°C and to pursue efforts to limit the temperature increase to 1.5°C. In the short term the Covid-19 pandemic is doing just that, causing the strongest drop in fossil fuel demand in history. But Covid-19 is achieving this on the wrong premise, by temporarily shrinking the global economy as a result of government lockdown measures. Although significant, this in itself makes little difference to the world's efforts to progress towards the Paris Agreement goals. In fact, it may make things worse by lowering fossil fuel and electricity prices thereby worsening the business case for renewables.

Technology and policy developments determine the future of decarbonisation

We see the long term impact of Covid-19 on fossil fuel use dependent on how it will impact investments in green technology and policy support for the energy transition. But forecasting technology and policy developments is notoriously difficult. That is why ING Research started **scenario planning** in 2017 to better understand trends that drive the energy transition in energy intensive sectors.

Energy scenario planning

In this publication we look to share our experience and knowledge on scenario planning we have carried out. Firstly, our report explains **our scenarios** and how they are built, before considering the impact of Covid-19 on our scenario outcomes. Secondly, we present the impact of our scenarios on **transportation, manufacturing, the built environment** and the **power sector**. Lastly, we explore the implications for **fossil fuel demand**.

The aim of this report is to help corporate decision makers better understand the factors that drive opportunities and risks in the global energy transition. That knowledge helps to make better investment and lending decisions and to minimise the risk of stranded assets. It also provides decision makers guidance on whether to invest in mitigation or adaptation strategies. And here, we also urge our readers: support strong policy intervention, as that is what is needed to make low carbon investments profitable. It is the only way to prevent runaway climate change.

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Reading guide

In this publication we share our main insights from scenario planning with a larger audience. The structure of this report is as follows.

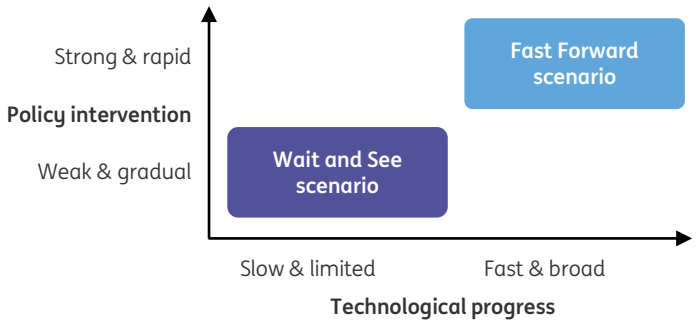
- **Chapter 1** describes why we use scenario planning, how we did it and what our main scenarios are. It turns out that policy and technology are our main scenario drivers and that the wide range of possible outcomes for fossil fuel demand can be narrowed down to two scenarios.
- **Chapter 2** describes the technology and policy developments in both scenarios.
- **Chapter 3** presents our scenario outcomes in terms of future coal, oil and gas demand. It also discusses the impact of the coronavirus pandemic on both scenarios. Lastly, chapter 3 also describes the most likely development of fossil fuels by presenting a baseline forecast. This forecast shifts the focus from the bandwidth of possible future outcomes to the most likely outcome.

Summary

This section describes the main findings from ING's scenario planning process. It concludes that the world needs a Fast Forward scenario to reach the Paris Agreement goals. At the same time there is a real risk that the Covid-19 pandemic pushes the world towards our Wait and See scenario. This leaves corporate decision makers in the dark: should they invest in mitigation or adaptation policies to future-proof their business? As a result they could apply a wait-and-see approach. Stronger climate policies can counter this self-fulfilling prophecy.

We focus on two scenarios to explore the wide range of future outcomes for fossil fuel demand

Energy transition scenarios based on technology and policy trends



Source: ING Research

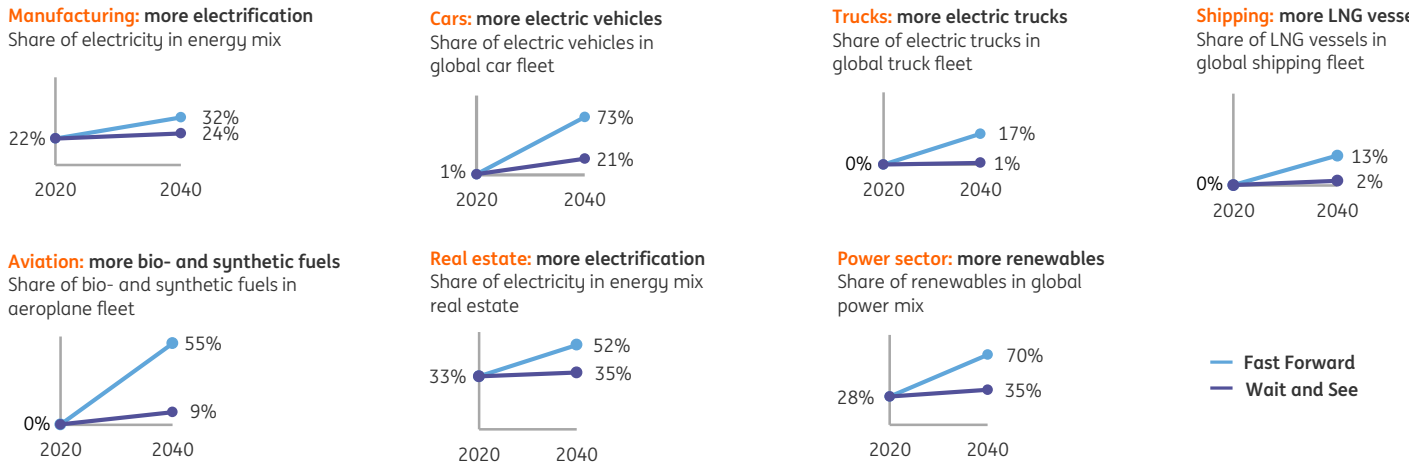
Two scenario that set the boundaries for fossil fuel demand

By applying a strict scenario-planning process we identify two crucial uncertainties for the energy transition: technological progress and policy measures to limit climate change. These are interdependent: policy drives the feasibility of technological progress. Either we end up in a world with a lot of policy that makes fossil fuels unattractive and technologies replacing fossil fuels profitable. In this **"Fast Forward"** world the energy transition will be in full swing and the physical risks from climate change are limited as global warming is contained. Transition risks are high though, as the world moves away from fossil fuels rapidly. Or we end up in what we are calling the **"Wait and See"** world with limited policy interventions and with the business case of many green technologies not being viable. In such a world, transition risks are low but the physical risks from runaway global warming are high as tipping points are crossed.

The speed at which energy intensive sectors become greener by investing in green technologies is what separates these two worlds.

Sectors get greener faster in the Fast Forward scenario

Main technology trend per sector in the Fast Forward and Wait and See scenarios



Source: ING Research

Summary *(continued)*

Technology can set us on the path towards the Paris Agreement goals

Technology will not be the constraining factor in achieving the Paris Agreement goals. Our Fast Forward world phases out coal and oil even faster than the IEA Sustainable Development Scenario* but it sees gas in line with this scenario until 2030 and continuing to grow afterwards as we do not believe renewables can compensate entirely for the coal phase out and increased power demand. While our Wait and See and Fast Forward scenarios set the boundaries of future fossil fuel demand, our **"Likely Tech"** scenario pictures a plausible path for technology and policy. It concludes that coal has already peaked, oil is not likely to reach its pre-coronavirus level and gas continues to grow until 2036.

Covid-19 is a drop in the ocean

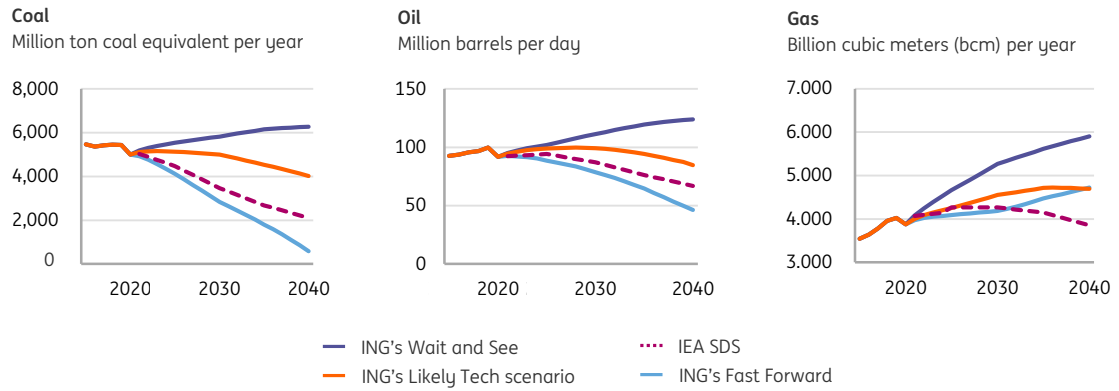
Despite Covid-19 causing the strongest drop in fossil fuel demand in history, it makes little difference on the world's efforts to progress towards the Paris Agreement goals. First, the size of the global economy is only reduced temporarily. By 2040 the economy is expected to be two-thirds bigger. Second, although Covid-19 is likely to have a long lasting impact on preferences, like airline business trips, its impact on total sector demand is relatively small. Third, Covid-19 has not yet led to a greening of policies and it could cause delay in this field. Lastly, many companies are currently in survival mode and cut back on green investments. Overall, the coronavirus dip is like a drop in the ocean.

Carbon pricing is needed to unlock corporate investments

If the chances of effective mitigation strategies diminish, it becomes rational to invest in adaptation measures to safeguard a business from supply chain disruptions from severe weather events. A shift in focus from mitigation to adaptation might put the energy transition at risk: a self-fulfilling prophecy. Uncertainty is amplified by the Covid-19 pandemic that rightfully put decision makers in survival mode. Stronger climate policies, notably on carbon pricing, clear the clouds from the future path of the energy transition and provide more viable business cases. That's a prerequisite to unlock the much needed corporate investments to set the world in Fast Forward gear.

Our scenario outcomes show a highly uncertain future for fossil fuels

Global demand of fossil fuels up to 2040

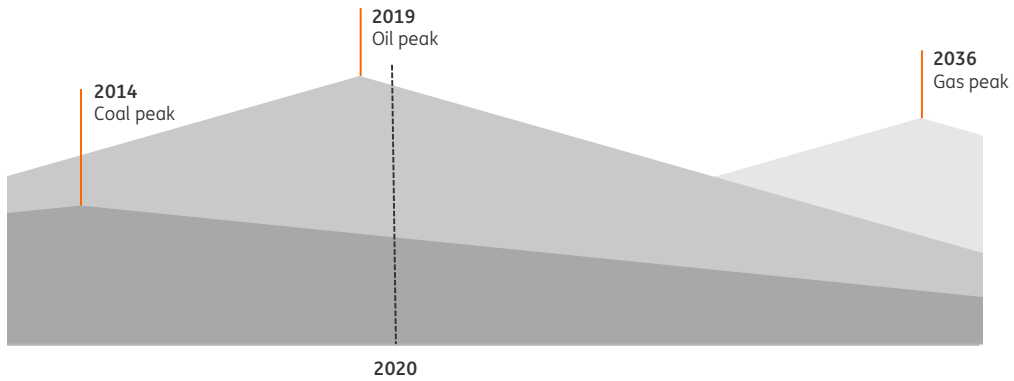


Source: ING Research

* A leading benchmark scenario for reaching the Paris Agreement goals.

We believe coal and oil have already peaked and gas will peak by 2035 in Likely Tech scenario

Schematic overview of fossil fuel use



Source: ING Research

Chapter 1

Why we use scenario planning and how the scenarios are built

1.1 The Paris Agreement goals require a significant reduction in the use of fossil fuels

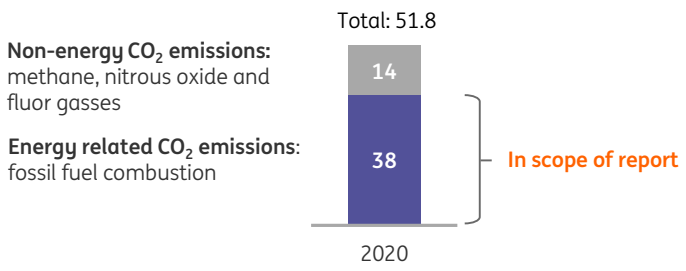
This section describes why it is of utmost importance to understand the future development of fossil fuels. It also provides a reading guide for this publication.

Reversing the upward trend in CO_2 emissions requires a phase out of fossil fuels

It is common practice to divide CO_2 emissions into energy related and non-energy related emissions. Currently, about two-thirds of global CO_2 emissions are energy related and stem from the use of fossil fuels. Research shows that limiting global warming to the Paris Agreement goal of 2.0°C maximum will require energy-related CO_2 emissions to be reduced by almost 67% up to 2050, or by 76% up to 2050 if the 1.5°C target is to be met [(1)]. That can only be achieved if the use of fossil fuels is phased out to a significant extent.

Scope of report: energy related CO_2 emissions

Global greenhouse gas emissions (gigaton CO_2-equivalent)



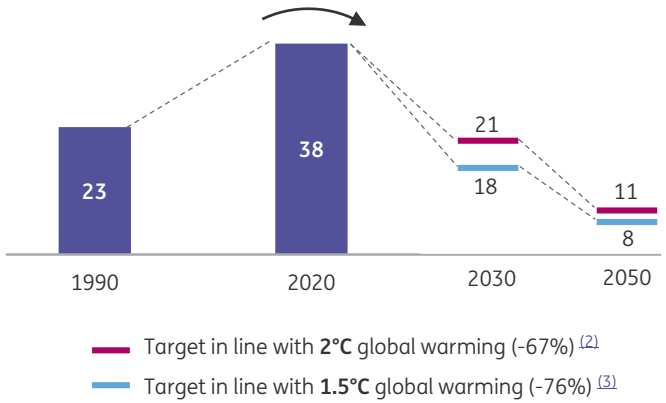
Source: ING Research based on IPCC for target values and IEA and PBL for past and current values

Can the phase-out of fossil fuels be achieved?

Peering into the future is notoriously difficult. The outcomes will critically depend on how the world evolves over the years. So, this study applies the framework of scenario planning to analyse possible ways the future might develop, in particular for fossil fuels.

Upward trend in emissions needs to be reversed

Global energy related greenhouse gas emissions (gigaton CO_2-equivalent)



1.2 Scenario planning: a tool to explore the unknown future of fossil fuels

This section describes why economists use scenario planning, what it is and how it is done.

Why we do it: preparing for an uncertain future

The world is changing rapidly and governments as well as companies are in need of a framework to consistently evaluate and respond to the ever-changing backdrop.

Scan of the future

Scenario planning provides decision makers with a tool to scan a highly uncertain future over which they have no, or very limited, control. However, the specifics of that future will determine the results of their decisions.

Shell's former Head of Scenario Planning, Arie de Geus:
"Nobody can predict the future, therefore, one should not try. The only relevant discussions about the future are those where we succeed in shifting the question 'whether something will happen' to the question 'what we will do if it happens". Scenario planning aims to do just that.

Scenario planning is not the same as forecasting

In analysing an unknown future it is helpful to explore the extremes. That gives decision makers a clear picture of what might happen if the future takes a course that is radically different from the current business environment. In doing so, **scenario planning** is a tool to explore the boundaries of the future. It is much more about the low probability, but high impact outcomes that sharpen our thinking and make us 'ready for the future'. But these extremes are often not the most likely outcomes, which is the focus of **forecasting**.

The benefits of scenario planning

Scenario planning has many benefits:

- helps to better understand the future;
- explores different futures, so one is not taken by surprise if a scenario materialises;
- helps to create a shared vision of the future;
- makes strategies robust for future developments;
- facilitates out-of-the-box thinking, dialogue, learning and engagement with internal and external stakeholders;
- facilitaties better decision making which helps companies to thrive.

How we do it: the eight steps of scenario planning

Our scenario planning follows a strict eight-step process, ranging from the creation of the scenarios all the way to implementing the scenario-outcomes in the strategy. This report focuses on steps 1 to 6 and leaves the strategy process conclusions up to the reader.

Report focus is on the scenarios, not the managerial implications for organisations

Scenario planning process

1.	Define the problem and the time horizon	**In focus of this report**
2.	Make a list of the trends that are quite certain to happen in the time horizon	
3.	Make a list of the things that are highly uncertain in the time horizon	
4.	Cluster the uncertainties in distinctive categories	
5.	Weighting of clusters based on degree of uncertainty and the size of the impact	
6.	Build scenarios around the two clusters that are most uncertain and have the highest impact	
7.	Define impact of scenarios on organisation and build strategic options	**Not in focus of this report**
8.	Implement the best strategic options in organisation	

Source: ING Research

1.3 Technology and policy developments are our main scenario drivers

This section considers steps 1-5 of our scenario planning process and describes how we picked 'technology and policy' as our main scenario drivers.

Step 1: define problem and time horizon

Fossil fuel use is the main cause of global greenhouse gas emissions that contribute to global warming. On the one hand, there are strong factors that support growth of fossil fuel demand, for example population growth or growth in transportation demand. On the other hand, there are strong factors that could reduce fossil fuel demand, such as electric vehicles and government policies to phase out fossil fuels. Mitigating global warming for a large part comes down to the question: **How will demand for fossil fuels like coal, oil and gas develop globally up to 2040?**

Steps 2-3: explore knowns and unknowns

In the process of scenario planning it is very helpful to set out what is known with near certainty as well as the things that are very uncertain up to 2040. For example:

- It is highly likely that the global **population** will grow from around 7.8 billion now to over 9 billion by 2040. It is highly uncertain though to what extent cultural differences and younger generations – that are generally more concerned about climate change – will impact climate policies
- In relation to the **economy**; it is very unlikely that markets themselves will bring about the required reductions in greenhouse gasses as long as the costs of climate change are not fully accounted for in market prices. On the other hand, it is very uncertain how and when any of the clean technologies will be cost competitive with fossil fuels.

A brainstorm of the certainties and uncertainties easily yields an extensive list of items. A list that needs **clustering**. We could cluster all our items under demography, economy, climate, policy and technology.

Steps 4-5: identify the two main scenario drivers

Demographic and economic trends are relatively stable in the long run

Up to 2040, demographic trends remain relatively stable, as do structural growth trend for the global economy. And although temperatures and sea levels are rising, 20 years is a relatively short time horizon that won't fundamentally change the way people live in many parts of the world. Without the crossing of hard-to-predict climate tipping points even vulnerable coastal areas are not expected to succumb to rising sea levels before 2040.

Policy and technology trends are more uncertain

Policy changes and technological inventions have the power to fundamentally change our lives. The one-child policy of China is a striking policy example, so are policies that restrict flying to reduce emissions from aviation. On the technology side, examples that have the potential to profoundly impact our lives include developments in artificial intelligence, 3d-printing, personalised medicines and climate tech. Hence, we define government policy and technology developments as our main scenario drivers, and their use as drivers is increasingly becoming common practice by institutes like the IEA, DNB, NGFS and McKinsey.

Technology and policy: uncertain factors with impact

Weighting of scenario drivers

Drivers with high uncertainty:

- Government policy
- Technology

Drivers with low(er) uncertainty:

- Ecology and climate
- Economy
- Demography

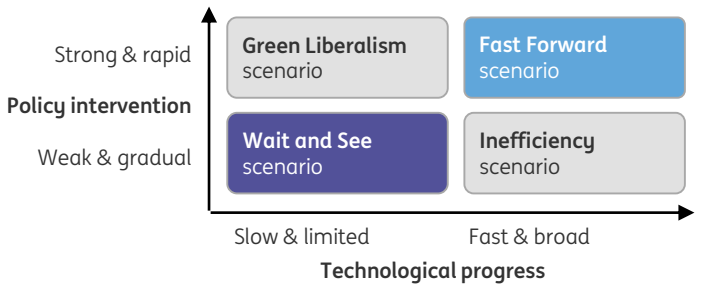
Source: ING Research

1.4 Two extreme scenarios set the boundaries for future fossil fuel use

This section describes our scenarios. They differ in the degree to which technological progress and government policies phase out fossil fuels.

In theory, our quadrant of policy and technology drivers can be used to identify four scenarios of energy transition, as shown below. In practice, we believe that it is most productive to focus on the extremes. One end of the spectrum we define as a world of fast and broad technological progress combined with strong and rapid policy intervention to mitigate global warming; our **Fast Forward scenario**. The other extreme is characterised by little innovation and limited policy intervention; our **Wait and See scenario.**

Four scenarios to explore the energy transition
Energy transition scenarios based on technology and policy trends



Source: ING Research

Fast Forward scenario: full speed ahead
Our Fast Forward scenario envisages a world of rapid change towards a more sustainable world in which technology and policy reinforce each other to phase out fossil fuels. The probability that outdated or polluting investments become obsolete is therefore high (high transition risk), while the physical risks from climate change are low as global warming is contained.

Wait and See scenario: too little too late
Our Wait and See scenario envisages a world of few changes in terms of fossil fuel use and its related emissions. It can be seen as a 'business as usual scenario' in which the world continues it's pre-coronavirus CO_2 and energy pathway. The physical risks of climate change are high as global warming could reach 4-5°C by the end of the century. Transition risks seem low at first glance as this scenario lacks fundamental change up to 2040. However, this scenario could lead to rising physical risks of runaway climate change and trigger even stronger policy responses than in the fast forward scenario (a Wait and See scenario followed by an "even faster forward scenario" in the future).

Why we focus on the Fast Forward and Wait and See scenarios

INSIGHT: technology and policy are related
Technology and policy do not operate in isolation. A world with strong policy intervention to phase out fossil fuels includes, for example, higher carbon prices and subsidies on carbon-reducing technologies. These are likely to spur innovation.

INSIGHT: scenarios with opposing technology and policy make less sense
Our **Green Liberalism scenario** describes a world in which market players take the lead in phasing out fossil fuels (a world with many "Tesla-like" companies). But without policy intervention this is unlikely to impact the course of fossil fuel demand. First, less demand causes fossil fuel prices to drop which triggers demand again (rebound effect). Second, less demand is likely to cause oversupply as producers flood the market to sell their vast reserves of fossil fuels (green paradox).

Our **Inefficiency scenario** describes a world in which governments try to push what the market just does not provide, which is a costly exercise. It is unlikely though that strong government-induced price increases of fossil fuels wouldn't spur innovation for substitutes.

1.5 Scenario similarities: people want prosperity and families

People strive for prosperity and thus favour a world with economic growth. Therefore, our scenarios do not reduce fossil fuel demand by shrinking the economy or through lifestyle changes. History also shows that people want to have children. That's why we keep our population assumptions constant for both scenarios.

In our approach, economic growth is equal in both scenarios, but may depend on how the actual scenario plays out. Strong policy interventions may reduce economic growth: the fossil fuel industry is highly efficient, while the renewables industry is less productive. However, the required rapid technological change described in our Fast Forward scenario may also be a consequence of a broader technological boom, leading to faster economic growth. We also assume the growth of various energy-intensive sectors to be equal in both scenarios, but that too may depend on the scenario's progress. Strong policy interventions in the Fast Forward scenario increase the relative prices of energy-intensive goods (eg, through carbon pricing), so we may see reduced demand for them. Using the same growth projections for all sectors in both scenarios means we are assuming technological advances will cancel out this impact on relative prices. This requires mixing taxations and subsidies to achieve this result.

Our approach seems more likely to underestimate the differences between the two scenarios. If in the Fast Forward world economic growth is lower or equal and relative prices of energy-intensive goods are higher than or equal to the Wait & See world, the difference in total fossil energy consumption would probably end up greater than we estimate.

Both scenarios assume growth of the global economy and energy intensive sectors

Assumed global growth 2020-2040 in both Fast Forward and Wait and See scenario and main developments

	Growth 2020-2040*	Annual growth	Main developments
Economy	+66%	2.7%	The global economy is likely to grow by around 2.7% per year on average up to 2040, despite the current and unprecedented slowdown from the coronavirus. Population growth of 0.8% and productivity growth of 1.9% on average are the main drivers.
Population	+17%	0.8%	Mainly driven by population growth in Africa and the Middle East.
Productivity	+52%	1.9%	Technological progress results in productivity gains that drive economic growth.
Industrial sector The stuff we want to buy	+62%	2.5%	A rising middle class will increase demand for industrial products. Industrial sector growth is lower than economic growth as the economy shifts from industrial products towards services.
Real estate The way we want to live	+72%	2.7%	Driven by population growth, a rising middle class and more households at the bottom of the pyramid acquiring access to energy. Growth in energy demand is strongest for appliances, heating and cooling.
Light duty vehicles How we use our cars	+35%	1.5%	Number of cars increases from 1.1 to 1.8 billion as car sharing and autonomous driving do not fully compensate for population and income growth. The number of miles driven per car increases 1% annually.
Trucks How we move our stuff	+44%	1.8%	Consumption growth and e-commerce will lead to an assumed increase of fleet size from 59 to 88 million. Scaling of trucks limits fleet growth. Around 3.5% of all trucks is scrapped yearly.
Shipping How we move our stuff	+6%	0.3%	International trade increases despite deglobalisation trends and increased local energy systems. The fleet is assumed to grow from 95,000 to 121,000 ships. Ship scaling limits fleet growth. 1.3% of the ships are dismantled globally.
Aviation How often we fly	+98%	3.3%	Rising welfare levels and trade spur demand for flying in the long run, despite the current and unprecedented coronavirus-induced drop in flights all over the world. Internal flights in large countries such as India and China are an important driver for future growth.

Sources: ING Research, UN, OECD, Oxford Economics, IEA, DNV-GL, Clarksons and BNEF. CAGRs are rounded. *2019-2040 period for economic growth

1.6 What a difference policy and technology can make

Technology and policy developments are the main drivers of our scenarios. Here we detail the key technology and policy differences between our scenarios to get a better feel of what the scenarios entail. Chapter 2 focuses on technology and policy developments for the energy-intensive sectors.

Main policy and technology assumptions in our Fast Forward and Wait and See scenarios

Overview of main assumptions that set the scenarios apart

	Fast Forward scenario	Wait and See scenario
	Policy	**Policy**
	Subsidies and taxes are a major policy instrument employed to phase out fossil fuel use. **Carbon prices** are implemented around the globe before 2025. Prices reach in the region of €100-125 per ton CO_2 in 2030 and around €150-175 per ton in 2040. **Carbon border taxes** are used by many countries as a means to incentivise free-riding countries.	Subsidies and taxes are used to a much lesser extent, so their impact is limited. Carbon prices remain highly fragmented across the globe. This will create an uneven playing field. Carbon prices will not exceed €50 per ton CO_2 in 2030 and €75 per ton in 2040 in countries that lead the way.
	In addition to price incentives, policy also sets many **norms and rules** to steer behaviour towards greener options. Examples include the banning of polluting cars from city centres and rules that require new buildings to be built energy-neutral or even energy-positive.	Rules and norms are weak so do not fundamentally change the behaviour of consumers or producers across the globe.
	No new **coal fired power plants** will be built after 2025 globally and many countries have phased out existing coal fired power plants before 2030.	Coal continues to be a major energy source up to 2040 in countries like China, India and Poland.
	Technology	**Technology**
	• Better insulation, more energy efficient equipment and increased recycling rates improve the energy efficiency in **manufacturing.** • Increased electrification and use of hydrogen reduces the use of coal in manufacturing.	• No improvement in energy efficiency in manufacturing. • Coal and oil remain the main energy sources in manufacturing.
	• LED lighting, more efficient appliances and increased use of energy information and monitoring systems improve the energy efficiency of the **built environment**. • Increased use of heat pumps and district heating reduce the use of coal and gas as the main heating source.	• No improvement in energy efficiency in the built environment. • Coal and gas remain the main energy sources in the built environment.
	• Continued engine downsizing in automotive, better aerodynamics of trucks and aeroplanes and better ship engines improve the energy efficiency in **transportation**. • Electric and hydrogen cars and trucks, LNG vessels and the use of bio- and synthetic fuels in aviation reduce oil demand.	• No major improvement in the efficiency of power trains in cars, trucks, buses, ships or aeroplanes. • Slow technological progress and implementation of new technologies that phase out oil in transportation.

Source: ING Research

Chapter 2

How technology and policy reduce fossil fuel demand in energy intensive sectors

2.1 Heavy users of fossil fuels: the power sector, transportation, manufacturing and real estate

Chapter 1 described our scenarios and how they are built from policy and technology developments. This chapter sheds light on the most promising technologies that can reduce fossil fuel demand in energy-intensive sectors by accelerating energy efficiency or facilitating a shift in a sector's energy mix away from fossil fuels. We also define the technology implementation pathways that we envisage for both our Fast Forward and Wait and See scenarios.

Focus on energy intensive sectors

Central are the power sector, transportation, manufacturing and real estate as these are the largest users of fossil fuels. Within transportation we will distinguish between light duty vehicles (mainly cars), trucks, ships and aeroplanes.

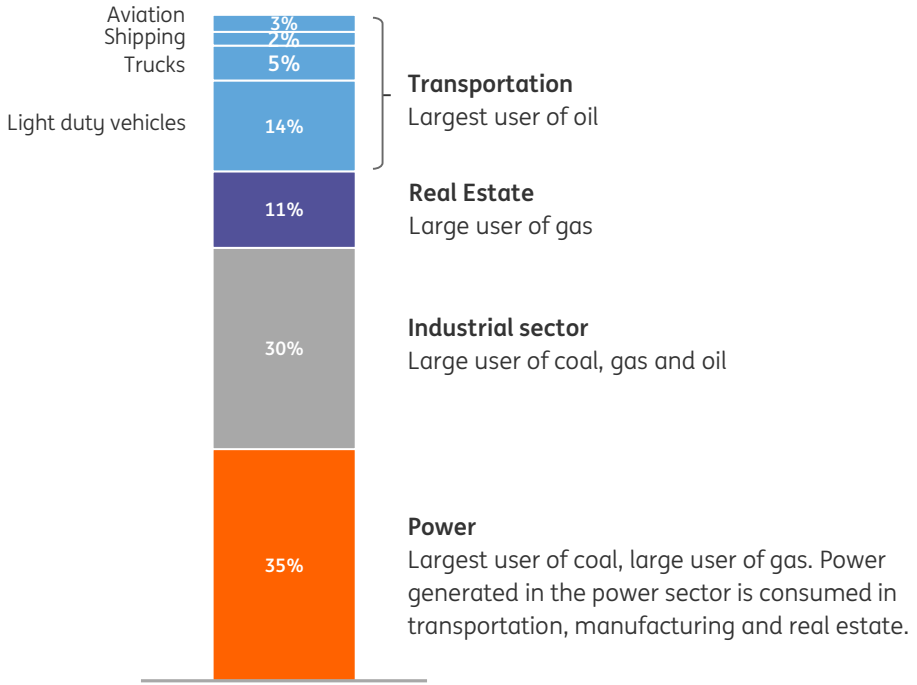
Realistic technology scenarios that reduce fossil fuel demand

We apply two criteria to select technologies:

1. The technologies are required to reduce fossil fuel consumption. Therefore technologies such as carbon capture storage and use (CCS and CCU), or direct air capture are not taken into account.
2. Our scenarios need to be realistic, not speculative, up to our planning horizon of 2040. We therefore exclude highly uncertain technologies such as nuclear fusion.

Power and industrial sectors are the largest users of fossil fuels

Share in total fossil fuel use, 2020



Source: ING calculations based on IEA

2.2 Manufacturing: more electrification and use of biofuels

Fossil fuels in the industrial sector are used as an energy source in production processes (75%) and as feedstock (25%). Our scenarios differ mainly due to a diverging pace of energy efficiency improvement in processes and, to a lesser extent, the phasing out of fossil fuels.

Large differences in the speed of energy efficiency gains...

Total energy demand in manufacturing is determined by insulation and reuse measures of existing processes (low hanging fruit) and redesign towards new processes (complex and costly). Insulation measures often have a positive business case (low payback period) and we see that happen in both scenarios, encouraged by stronger energy-efficiency norms. The Fast Forward scenario also includes stronger progress on carbon pricing and the abolishment of exemptions on energy taxation for heavy energy users. That improves the business case for a complete overhaul of industrial processes that are more energy efficient (eg, Hisarna steelmaking and 3D printing). Hence, our two scenarios differ significantly in the pace of improvement in energy efficiency (3.5% improvement per year in Fast Forward versus 0.5% in Wait and See).

...and the phasing out of fossil fuels.

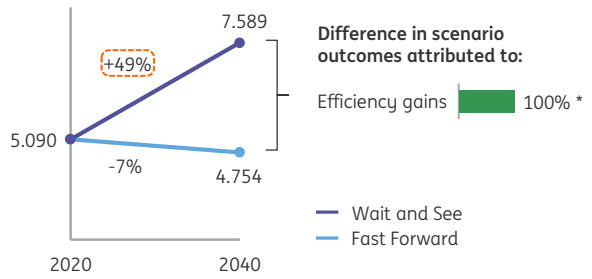
Reducing the dependency on fossil fuels in manufacturing is hard as it often requires a radical technological overhaul of industrial processes. Oil is also likely to remain a key feedstock for the petrochemical sector. Even in our Fast Forward scenario only 20% of feedstock comes from bio sources as conversion to its use is technically complicated and there is limited supply of biomass. Biomass is mostly used in the petchem industry for bioplastics. As a result, the current share of fossil fuel use (67%) drops to 46% in the Fast Forward and to only 63% in the Wait and See scenario.

Electrification is a major trend in the Fast Forward scenario

Electricity is increasingly used as an energy source, for example in recycling processes, steam production for low temperature heat and, to a lesser extent, the production of (green) hydrogen. In our Fast Forward scenario the electricity share increases from 22% today to 32% in 2040.

Without an increase in technological progress and policy, energy demand could rise by 49%

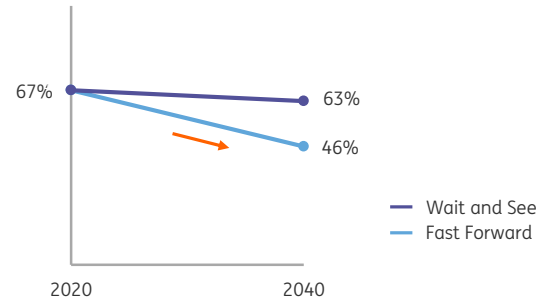
Energy demand in manufacturing in million tons of oil equivalent (feedstock included)



Source: ING Research, * As demand in manufacturing is equal for both scenarios

Strong reduction in fossil fuel use in Fast Forward world

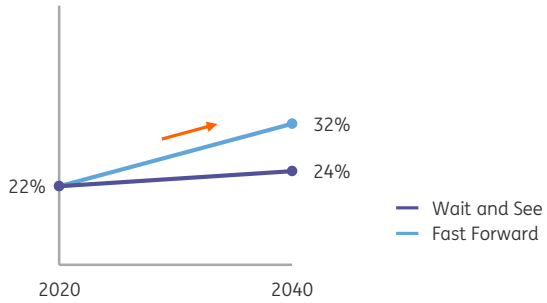
Share of fossil fuels in energy mix manufacturing (feedstock included)



Source: ING Research

Strong uptake in electricity use in Fast Forward world

Share of electricity in energy mix manufacturing (feedstock included)



Source: ING Research

2.3 Cars: more electric vehicles

The speed at which electric vehicles (EVs) replace conventional cars is the main cause of diverging oil demand in our two scenarios. Our scenarios also differ in the improvement of the efficiency of the internal combustion engine, but its impact is less significant.

Energy efficiency has minor impact on oil use...

The energy efficiency of light duty vehicles (LDVs) is determined by the efficiency of the internal combustion engine, the types of cars sold and the speed of scrapping the inefficient existing fleet. In the Fast Forward scenario, policy will have to prevent further growth of SUVs, lead to faster scrapping of gas guzzlers and enforce further optimisation of the combustion engine. The main policy instruments to achieve this are stronger energy-efficiency norms for car manufacturers, taxing carbon emissions through fuel consumption or distance driven, low emission zones in inner city centres and 'cash for clunkers' programmes. Hence, our two scenarios differ significantly in the pace of energy efficiency (3% improvement per year in Fast Forward versus 1% in Wait and See).

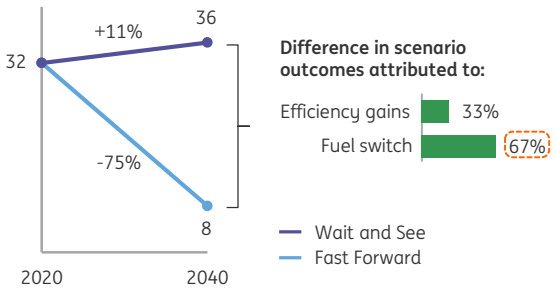
...EVs are the main driver of future oil demand

The shift to EVs, however, explains two-thirds of the difference in outcomes for oil demand between our scenarios. Our scenarios provide a two-tier world with regards to the uptake of EVs. In the Fast Forward world every car sold from 2035 onwards is an EV. The share of EVs in the global car fleet reaches 73% in 2040 as a result. In our Wait and See only 1 in every 4 cars sold is an EV in 2035 and EVs make up just 10% of the global car fleet by 2040.

Oil demand could fall strongly in Fast Forward world

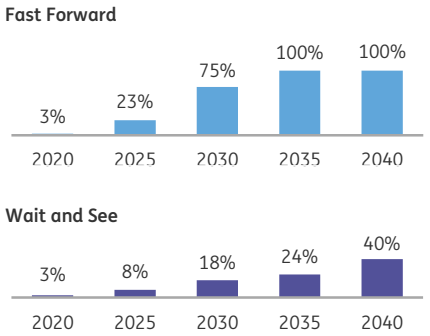
In our Fast Forward scenario oil demand drops by 75% in 2040 towards 8 million barrels of oil per day. Strong gains in energy efficiency and the shift towards electric vehicles by far outweigh the increase in demand for miles driven by a growing and wealthier population. In the Wait and See scenario demand outpaces technology shifts such as increased energy efficiency and the uptake of EVs.

Shift to EVs main driver of oil demand
Oil demand from cars in million barrels per day



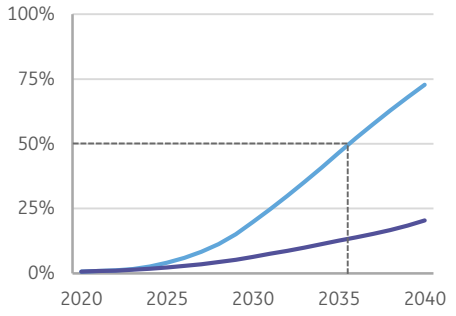
Source: ING Research

Sales of EVs on the rise
EV sales as a share of total car sales



Source: ING Research

Fast Forward: by 2035 over 50% of cars is electric
Share of EVs in global car fleet



Source: ING Research

2.4 Trucks: more electric trucks and use of biofuels

Unlike for light duty vehicles where electric cars have the potential to decrease oil demand by 75% in 2040, the potential for heavy duty vehicles is much smaller. Biofuels, electrification, hydrogen and improved energy efficiency could lower oil demand in this industry by 35% by 2040 in our Fast Forward scenario. Oil demand continues to grow by 19% in the Wait and See scenario as technology cannot compensate for increased demand.

Energy efficiency has minor impact on oil use...

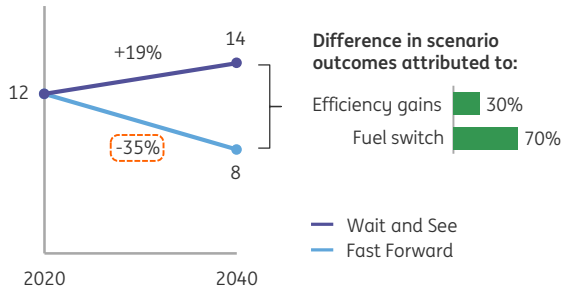
The energy efficiency for trucks is determined by the efficiency of the internal combustion engine, the types of trucks sold and the speed of scrapping the inefficient existing fleet. The Fast Forward world includes stronger carbon pricing, stronger energy-efficiency norms for truck manufacturers, abolishment of tax exemptions and more low emission zones. This spurs improvements in more efficient, larger and aerodynamic trucks, energy efficient tyres, truck platooning and driverless trucks. Hence, energy-efficiency gains are greater in the Fast Forward scenario (1.8% average improvement per year in Fast Forward versus 1% on average in Wait and See).

Electric and hydrogen trucks drive long-term demand

The shift to alternative fuels explains 70% in our scenario outcomes for oil demand. Blending biofuels and the take-up of electric and - at a later stage - hydrogen trucks are the main contributors to curb oil demand. In addition, LNG trucks phase out diesel, albeit that LNG is assumed to be an intermediate technology in trucking (but not for shipping). Nonetheless, trucking is an industry that will struggle to accommodate the energy transition and we see 97% of global trucks continuing to run on diesel in the Wait and See scenario by 2040 compared to 72% in the Fast Forward world.

Trucks use 35% less oil in Fast Forward world

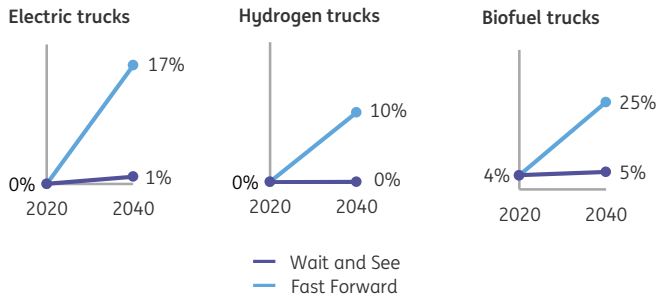
Oil demand from trucks in million barrels per day



Source: ING Research

Strong uptake of alternative fuels in Fast Forward world

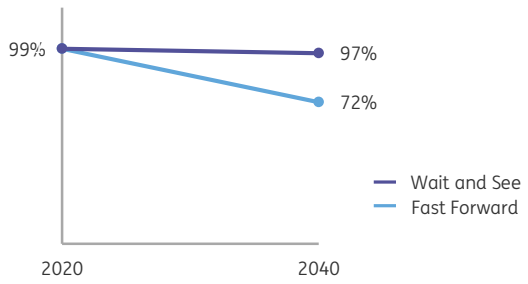
Share in global truck fleet



Source: ING Research

Diesel remains the dominant fuel for trucks

Share of diesel trucks in global truck fleet



Source: ING Research

2.5 Shipping: more LNG powered vessels

Just like heavy duty vehicles, ships will struggle to accommodate the energy transition. Energy efficiency and the shift from oil to LNG powered engines are the main technologies in this industry to curb oil demand. Even in the Fast Forward scenario oil demand 'only' drops by 18% by 2040 as the vast majority of ships (82%) continue to run on oil.

Energy efficiency explains 40% of the scenario differences…

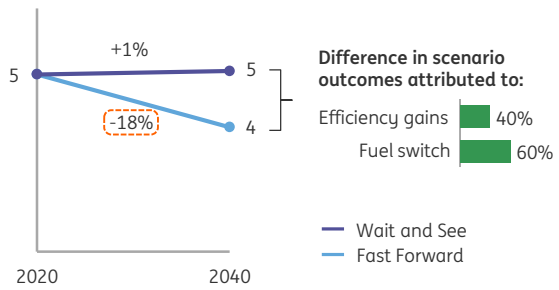
Replacing old marine fuel engines in ships for newer and more efficient diesel ones is complex and costly. Energy efficiency in shipping is improved by replacement of old ships, slow steaming, more efficient sailing (eg, adaptations to propellers, rudder and hull), the use of larger vessels and the use of shore-power compared to letting ships run idle in harbours. IMO targets for energy efficiency and emissions, carbon pricing, abolishment of tax exemptions and differentiation in port tariffs for 'clean' and 'dirty' ships are major policy instruments that set our scenarios apart. Fuel efficiency improves on average by 2.0% per year in the Fast Forward scenario and by 1.0% a year in the Wait and See scenario.

…shift to alternative fuels has the biggest impact

The shift to alternative fuels explains the majority (60%) of our scenario differences, despite the fact that there are few technologies available that can phase out oil in shipping. LNG appears to be the most promising. The fact that a part of the fleet that currently sail on marine fuel can be retrofitted with LNG engines contributes to the outlook. As a result, one out of eight ships in the world run on LNG by 2040 in our Fast Forward scenario. In 2040, fully electric ships are used for inland shipping but only represent 4% of the global fleet in the Fast Forward scenario. In both of our scenarios hybrid ships remain an exception as it remains expensive to invest and maintain ships with both a diesel and an electric engine.

Fuel switching main driver by 2040

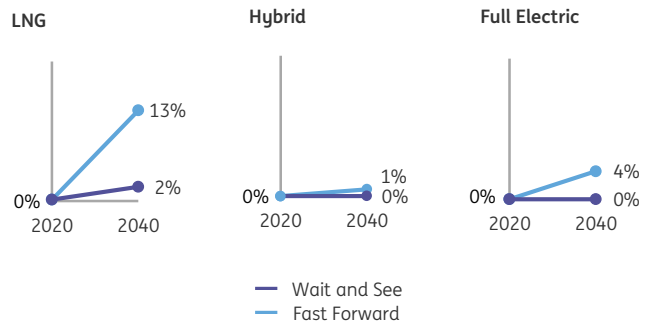
Oil demand in million barrels/day



Source: ING Research

LNG is the most promising fuel to substitute oil in shipping

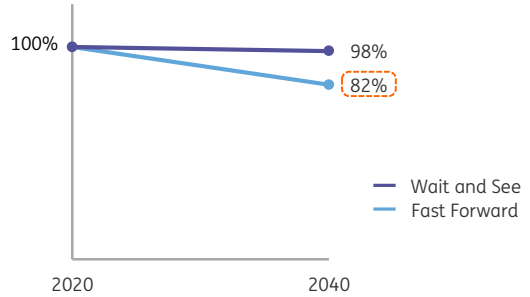
Share in global fleet of all ships



Source: ING Research

Oil powered ships remain the norm in both scenarios

Share of oil powered ships in global fleet



Source: ING Research

2.6 Aviation: more use of bio- and synthetic fuels

Aviation is the sector that is hardest to curtail. First, increasing prosperity levels and international trade spur demand for flying in the long run. Despite the devastating impact of Covid-19 on the short term outlook, aviation is expected to be among the fastest growing industries towards 2040. Second, there are very few technologies available up to 2040 that can phase out the use of bunker oil. Oil demand grows stongly in both of our scenarios as a result.

Covid-19 causes swings in energy efficiency

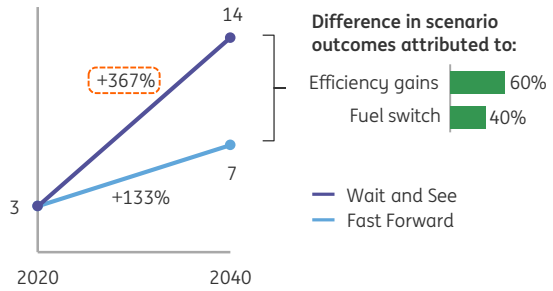
In the long run energy efficiency is determined by improved aerodynamics, the creation of more efficient routes and optimal flying conditions (straight lines, right altitude and speed and flight formation) and replacement of older planes by new and more efficient ones. Long investment horizons of 20 to 30 years make replacement of planes a slow process. Strong policy intervention is needed to increase the pace of energy efficiency. This is lacking in the Wait and See scenario and energy efficiency grows at 1% a year on average. The Fast Forward scenario involves stronger and geographically wider applied carbon pricing, abolishment of tax redemptions, single sky regulations and stronger ICAO regulation for emissions and efficiency. Hence energy efficiency improves on average by 2.5% per year.

Fuel switching ultimately the main determinant

Diverging energy efficiency rates explain 60% of the difference in oil demand between our scenarios. 40% is explained by fuel switching. In our Fast Forward scenario around 55% of fossil kerosene is replaced by bio and particularly synthetic versions, compared to just 9% in our Wait and See scenario. Electric and probably hydrogen propulsion might technically be possible by 2040, but its take-up also depends on hard-to-predict social acceptance. Even in the Fast Forward world they account for only 3%. Electric taxing precedes these new forms of flying.

Oil demand rises in both scenarios and could be up by 367% by 2040 in Fast Forward world

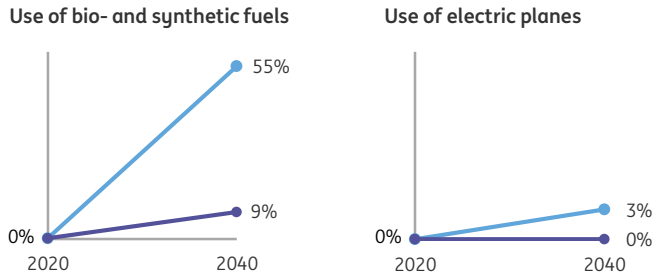
Oil demand in millions barrels per day



Source: ING Research

Bio- and synthetic fuels show more opportunities to phase out oil than electric planes

Share in oil demand



Source: ING Research

2.7 Real estate: more electrification and renewable energy sources

Contrary to the use of biofuels for cars, trucks and airplanes, the burning of wood (biomass) for heating and cooking is not considered a sustainable energy source. It is the speed of electrifcation of heating systems and the phasing out of biomass - particularly in developing countries - that determine our scenario outcomes for the real estate sector.

Don't expect significant changes in energy efficiency...

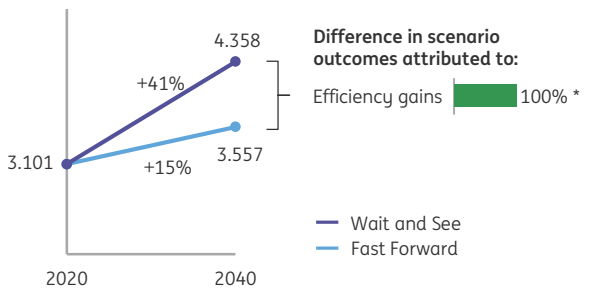
It is hard to raise the pace of energy efficiency in the built environment. Stricter energy-efficiency norms usually only apply to new buildings not for the vast majority of existing houses, offices and shopping centres. So, although the difference in energy-efficiency gains between our Wait and See scenario (1% yearly) and our Fast Forward scenario (2% yearly) might seem small, a doubling of the pace of energy efficiency is quite an achievement. Carbon pricing in real estate and subsidies for retrofits are important policy instruments. Nevertheless, energy demand rises in both scenarios as energy efficiency cannot offset population growth and more households at the bottom of the pyramid gaining access to energy and increasing demand from air-conditioning as global warming continues to set heatwave records.

...so phasing out fossil fuels comes from new energy sources

In the long run, changes in the real estate energy mix are just as important as energy efficiency. Our two scenarios differ mainly in the speed at which developing countries phase out biomass (wood) for heating and cooking, and the speed at which some developed counties phase out gas. A second distinction comes from the uptake of new energy sources. Options include the electrification of heating sources, for example with heat pumps, the use of district heating networks, the uptake of geothermal energy, solar thermal energy and hydrogen.

Efficiency reduces energy demand over time

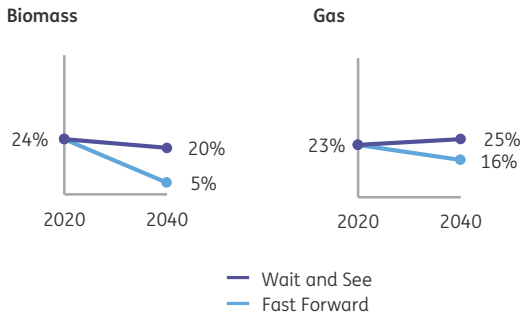
Energy demand in the built environment in Mtoe



Source: ING Research, * As demand in real estate is equal for both scenarios

Less use of biomass in both scenarios, but use of gas could increase in Wait and See scenario

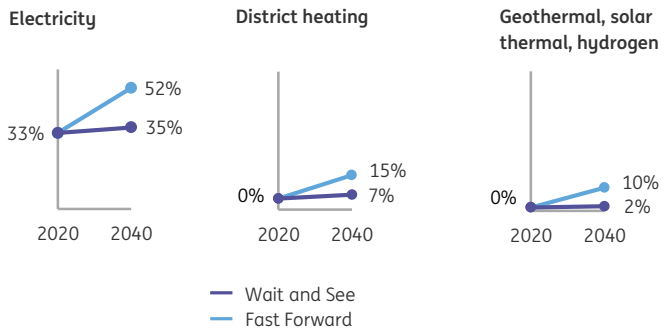
Share in energy mix of main traditional sources



Source: ING Research

Strong push for electrification in Fast Forward scenario

Share in real estate energy mix



Source: ING Research

2.8 Power sector: increasing power demand met with renewables

The power sector generates the electricity that the other energy-intensive sectors demand. Electrification is a major strategy globally to phase out fossil fuels in manufacturing, transportation (particularly cars and trucks) and real estate. As a result, power demand rises strongly in both of our scenarios. It is the much stronger pace of renwables integration in electricity systems across the world that sets the two scenarios apart.

Towards more solar and wind energy

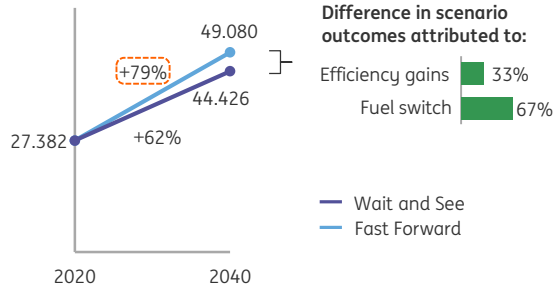
Global electricity demand in the power sector rises by 79% in our Fast Forward scenario compared to 62% in our Wait and See scenario. Outcomes do not differ much due to the interplay between electrification and energy efficiency in the energy-intensive sectors that demand electricity. On the one hand, the Fast Forward world has a much stronger uptake of electric cars, trucks and heat pumps in buildings and industrial processes that increase power demand. On the other hand, energy efficiency is also much higher in the Fast Forward world, thereby curbing power demand.

Towards more solar and wind energy

In the Fast Forward world the take-up of renewables is strong, driven by price declines and supported by subsidies, carbon pricing and the abolishment of tax exemptions on fossil fuels. Renewables therefore make up 70% of the global power mix by 2040. In stark contrast, the Wait and See world remains predominantly dependent on fossil fuels. Our scenarios count less on **nuclear power** than the IEA sustainable development scenario. Nuclear fusion is not available at large scale by 2040. And policies for nuclear power plants are mixed with Germany phasing out nuclear power and the UK building a new plant. We assume limited growth in nuclear power as a result. And with rising power demand its share in the energy mix falls in both scenarios.

Power demand rises strongly in both scenarios and is up 79% in Fast Forward world by 2040

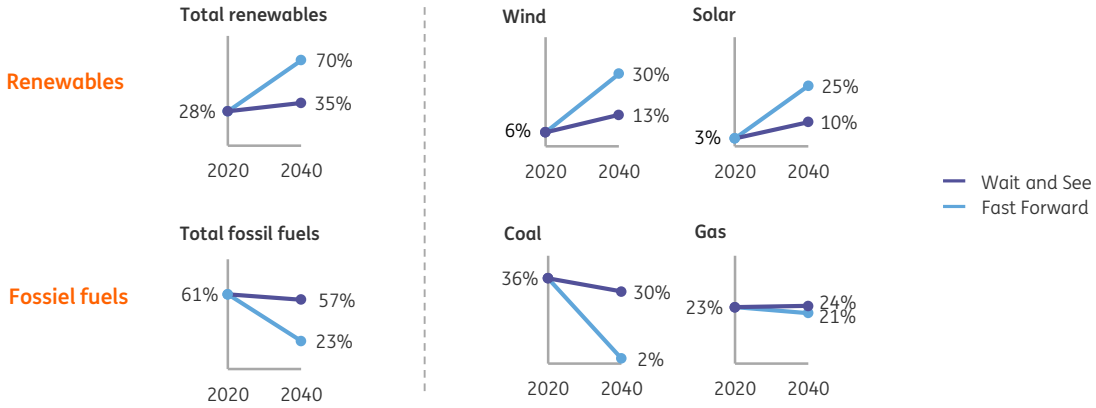
Global electricity generation (TWh)



Source: ING Research

Power sector no longer dominated by fossil fuels as renewables take over in Fast Forward scenario

Share of energy source in global power mix



Source: ING Research

What our scenarios tell us about fossil fuel demand

3.1 Addicted to fossil fuels with abundant reserves available

Chapter 1 described how our scenarios are built from policy and technology drivers. Chapter 2 showed the differing technology pathways in our scenarios. This chapter sheds light on current fossil fuel demand and presents our scenario outcomes for oil, gas and coal up to 2040.

We use vast amounts of fossil fuels...

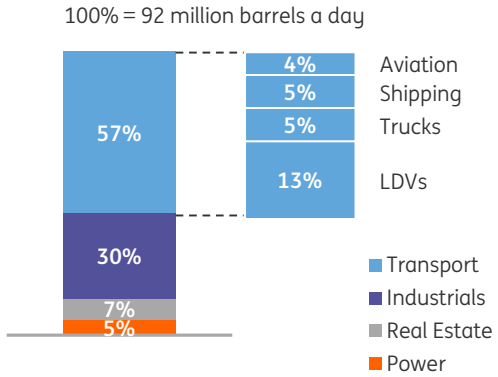
About two-thirds of global CO_2 emissions is energy related and stems from the use of fossil fuels. In 2019 oil demand stood at 100 million barrels a day but is expected to fall to 92 million barrels per day in 2020 due to the Covid-19 pandemic. Gas use will be around 3,850 billion cubic metres and coal use around 5 billion tons.

...and we could do so for decades to come

Not only is demand high for fossil fuels, there is ample supply too. Proven coal reserves are by far the largest (and dirtiest) and equal around 140 years of current demand. Proven oil and gas reserves stand at 50 to 60 years. Burning all these reserves in the way we have been used to, without capturing and storing the carbon emissions, would result in emissions six times higher than the remaining carbon budget to limit global warming to 2°C. That could trigger runaway global warming and the creation of what scientists call 'hothouse earth'.

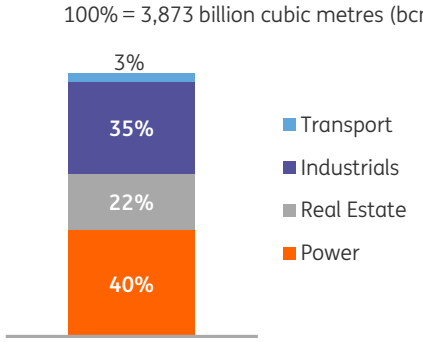
Oil use around 92 million barrels a day

Global yearly oil demand per sector, 2020



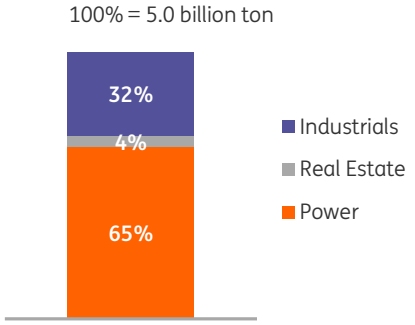
Gas use around 3,850 billion cubic metres

Global yearly gas demand per sector, 2020



Coal use around 5 billion tonnes

Global yearly coal demand per sector, 2020



Sources: OPEC, IEA.

3.2 Covid-19 doesn't cure the world's addiction to fossil fuels

The Covid-19 pandemic is having a dramatic impact on economic growth and fossil fuel use in 2020. In the long run, however, the world economy is forecast to be 66% larger by 2040. Before Covid-19, the forecast would have been 72%. So the Covid-19 effect on its own will do little to phase out fossil fuel use and to reach the Paris Agreement goals. The transition towards a low carbon economy still needs to come from green technologies and strong policy intervention.

Covid-19 impacts GDP, business flights, ...

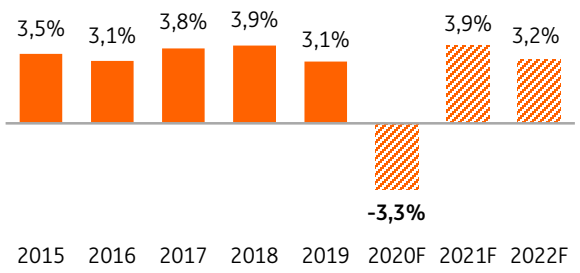
The immediate impact of the Covid-19 pandemic in our Energy Transition model runs through three major channels:

1. We reduced our growth forecast for world **GDP**. Without the pandemic, global GDP would be 6% higher in 2040, based on comparing the IMF's pre-coronavirus forecast for world GDP with the current one. Using this forecast, we have incorporated some of the impact of Covid-19 into our scenarios, most notably in real estate and manufacturing as energy demand is GDP related.
2. We reduced our growth forecast for **aviation**. Pre-coronavirus we expected annual growth of 4.5%. Now we anticipate aviation to drop by two-thirds in 2020 and to recover slowly in the coming years. While holiday travel could rebound strongly once a vaccine is available, digitisation has a longer lasting impact on business travel as employees are used to online meetings and companies save on travel costs.
3. We changed our pathways for **energy effeciency** in trucking and aviation. Efficiency is higher in the 2020-2025 period as old and inefficient trucks and aeroplanes are less deployed. Covid-19 also results in a drop in orders for new trucks and in particular aeroplanes that take a few years to impact the fleet. Hence we anticipate lower energy efficiency in the 2025-2030 period.

...sales and energy efficiency

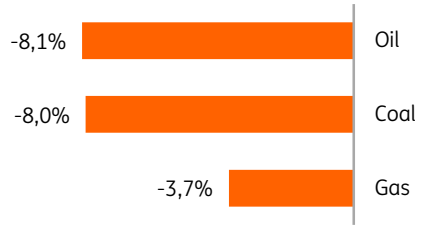
However, the impact of these changes on fossil fuel demand is dwarfed by the overall impact of policy and technology on fossil fuel demand. Hence, the next section is about the impact of Covid-19 on policy and technology developments.

Strong decline in world GDP in 2020...
Year on year change in global GDP



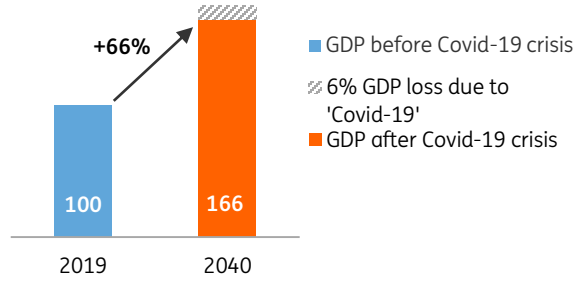
Source: IMF, ING Research.

...and in fossil fuel use...
Change in fossil fuel use in 2020



Source: IMF, ING Research.

...but economy is 66% larger in 2040
Global GDP, index 2019 = 100



Source: IMF, ING Research.

3.3 Covid-19 could put the world in Wait and See gear

While Covid-19 lockdowns across the globe cause unprecedented drops in fossil fuel use and CO_2 emissions, the economy in itself has not become greener. Whether Covid-19 will break or make the energy transition depends on its impact on the implementation of policies and thus green technologies. The key question is whether the chances of ending up in a Wait and See or Fast Forward world have changed over the course of 2020. While in theory Covid-19 can act as an impulse for both the Fast Forward and Wait and See scenarios, in practice, there is little evidence yet that Covid-19 puts the energy transition in Fast Forward mode. There is much talk about building back a better economy in Europe, but that is not yet supported by strong additional policy measures. Covid-19 response plans still focus on preserving both clean and dirty jobs and green conditionality in state support for airliners is weak at best. Asia's response to the crisis can hardly be seen as green. Based on the evidence so far, we believe Covid-19 is more likely to slow down the energy transition and increase chances of ending up in our Wait and See scenario.

	Covid-19 as an impulse for the Fast Forward scenario **Developments we would be looking for**	Covid-19 as an impulse for the Wait and See scenario **Developments we would be looking for**
	Governments are in 'build back better mode' as they significantly green their Covid-19 policy response packages. They also implement carbon pricing faster and stronger as a means to raise revenues and restore budgets. Policies are internationally coordinated and aligned. The lobbying from producers is ineffective as carbon pricing is implemented at a time when emission rights are abundant and prices low. Policy changes are supported by the public as their appreciation for clean air and nature close to home has been transformed permanently by Covid-19.	Governments are in 'virus-first mode' as saving incomes and jobs are a top priority. Policy makers prefer 'dirty jobs' over no jobs in the fight against rising unemployment, which is boosted by a strong fall in demand and increased digitization. Runaway budget deficits lead to austerity measures that cut back on subsidies for and investments in the energy transition. The introduction of carbon taxes by major countries or regions is delayed as policy makers do not want to hurt producers and there is a lack of international coordination. Consumers return to 'business as usual' as soon as a vaccine is available.
	The greening of Covid-19 policy responses includes **manufacturing** with support provided for green technologies such as hydrogen, Carbon Capture Utilization and Storage and electrolyzers. Many pilot projects across the globe over the next two years followed by a scaling up phase are pointers towards the Fast Forward world.	Manufacturers are heavily hit by the Covid-19 crisis, particularly steelmakers, petrochemicals and producers of cars and aircraft. Many companies are in survival mode and put investments in green technology on hold. Some are cutting back on R&D budgets or delaying pilot projects which are early signs of a push towards the Wait and See scenario.
	**Real estate** gets a lot of attention from policy makers in the search for green jobs as retrofitting buildings is labour intensive and there might be opportunities to retrain workers from sectors that are hit hard by Covid-19. A speeding up of retrofitting offices and houses investments in grid infrastructure are Fast Forward signs.	Momentum in national strategies for greening existing houses and buildings is lost as governments are in 'virus-first mode'. Real estate owners and tenants rise up against government initiatives to green entire neighbourhoods or protest against rising energy bills. Populist parties are cleverly capitalising on these sentiments.
	Energy efficiency is improved by **airliners** by taking old planes out of the fleet, reducing short distance flights and increased use of biofuels. Airliners accept a form of carbon pricing. **Car** and **Truck** manufacturers move away from the internal combustion engine and increase R&D budgets. Investments in charging grids and power systems are increased and many countries provide subsidies for EVs.	All transportation sectors are hit hard by the Covid-19 crisis. Early warning signs of the Wait and See scenario at the supply side are postponement of the carbon offset and reduction scheme in aviation (CORSIA), reduction of R&D budgets, postponement in the introduction of new models and delays in grid infrastructure (electric and hydrogen charging stations). On the demand side buyers postpone their investment decision and extend the period they use their current vehicle.
	Conclusion	**Conclusion**
	The evidence so far does not suggest that Covid-19 acts as an impulse for the Fast Forward scenario.	We believe that the Covid-19 virus is slightly more likely to put a brake on the energy transition plans of governments and companies in the short run.

Source: ING Research

3.3 Coal has peaked

We designed our scenarios around technology and policy drivers as they are hardest to predict. The Covid-19 virus creates even more uncertainty. With all this uncertainty the question of 'what is most likely to happen', often arises. ING's **Likely Tech** scenario (see box) is based on the most likely technology pathways and the corresponding policy developments. The next sections show how coal, oil and gas are likely to evolve up to 2040 under our scenarios.

Coal has already peaked

ING's Likely Tech scenario suggests that coal has already peaked. Future coal demand follows the same trend as the IEA's Sustainable Development Scenario (SDS); one of the major benchmark scenarios for meeting the Paris Agreement goals. Despite the similar trend, coal use remains much higher in 2040. On the other hand, coal use could end up lower than the SDS benchmark if technology and policy are pushed to the max (the Fast Forward scenario). Developments in the power sector determine, to a large extent, future coal demand.

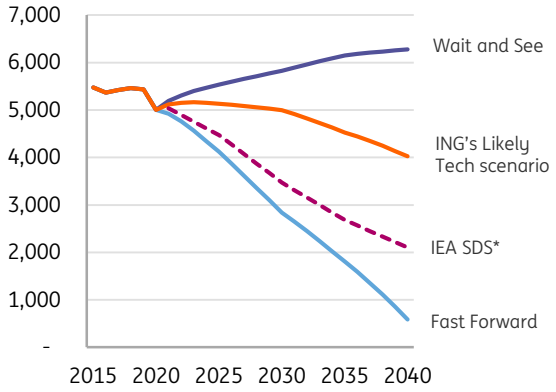
ING's Likely Tech scenario...

Our Fast Forward and Wait and See scenarios set the boundaries of the wide range of possible future outcomes for fossil fuel demand based on different technology pathways (see data appendix for the main scenario inputs). However, neither scenario provides insights into the likely technology path. ING's Likely Tech scenario does just that. It is a plausible scenario as its technology pathway is:

1. tech wise achievable: there is enough market-ready technology available;
2. policy wise achievable: the technology can be scaled up without draconian policy interventions and economic costs;
3. likely as it follows past and current technology trends in energy-intensive sectors combined with stated policy intentions from governments.

Coal demand could almost be phased out by 2040

Million ton coal equivalent per year

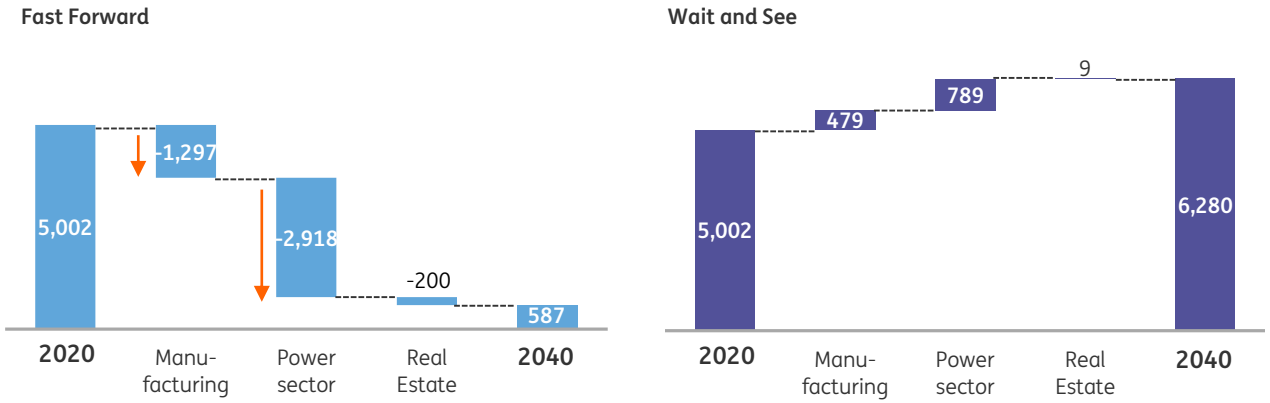


*Sustainable Development Scenario from the International Energy Agency

Sources: ING Research

Power sector and manufacturing drive change in coal demand

Million ton coal equivalent per year



3.4 Oil is not likely to exceed its pre-coronavirus level

Oil peaked in 2019

Prior to the coronavirus pandemic our scenarios indicated that oil demand would peak around 2025. Factoring in the immediate effects of the pandemic, it appears likely that oil has already peaked. ING's Likely Tech scenario shows modest improvement of oil demand up to 2025, but it does not exceed the 2019 level.

Oil demand could drop by 50% in the Fast Forward world

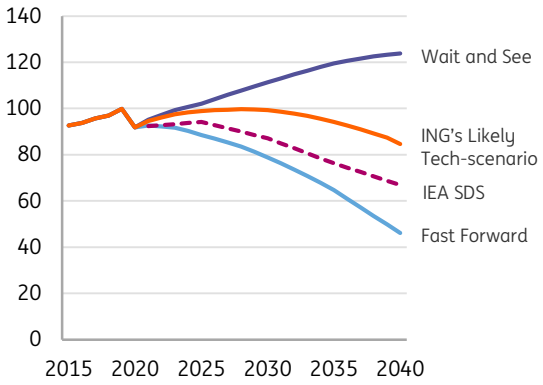
Given our demand forecasts for energy-intensive sectors, the future of oil demand depends on the pace of energy efficiency and the greening of energy sources. With the moderate improvements in our Wait and See scenario, oil demand could be a third higher by 2040. Based on the acceleration anticipated in the Fast Forward scenario oil demand could drop by 50% to 46 million barrels per day.

Electric vehicles hold the key

The reduction in oil demand in our Fast Forward scenario is driven by electric vehicles, which reduce oil demand by 24 million barrels of oil per day by 2040. The use of biofuels in manufacturing and electrification in real estate contribute to a combined 15 million barrels per day reduction in total.

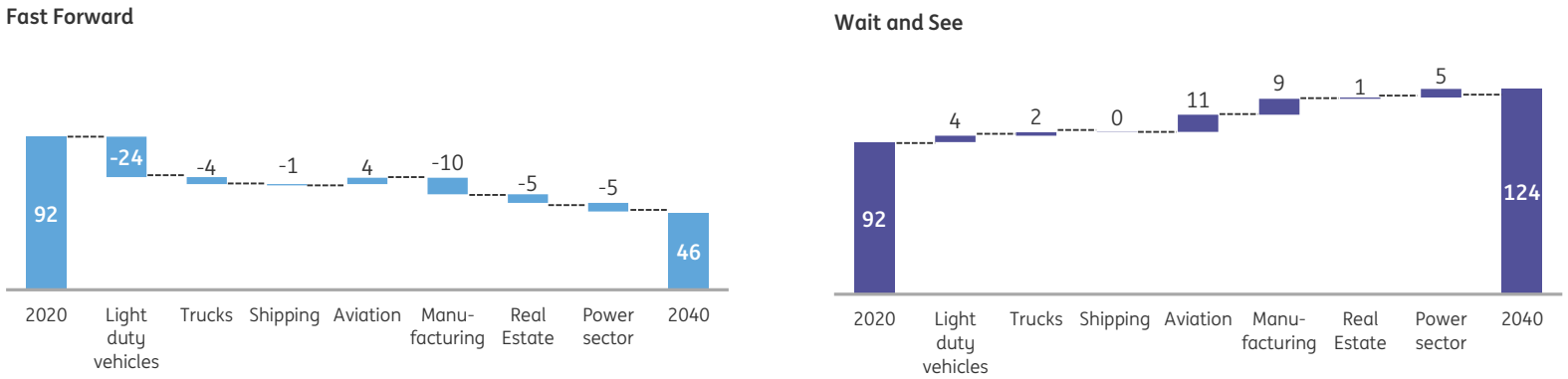
Oil demand could halve by 2040

Million barrels per day



Electric vehicles, aviation and manufacturing drive change in oil demand

Million barrels per day



Sources: ING Research

3.5 Gas is up in every scenario and peaks by 2036

Not game over for gas

Gas is the only fuel that is likely to see increased demand. In our Likely Tech scenario, gas demand increases by 22% and peaks around 2035. Gas demand is up by even 52% in our Wait and See world where progress in energy efficiency and the shift to renewables cannot keep up with demand for products and services in the energy intensive sectors.

In our Fast Forward scenario, gas demand remains fairly constant up to 2030. But even in the Fast Forward scenario, gas demand increases by 22% by 2040. Main reasons are increased LNG use in shipping, increased production of methanol, ammonia and hydrogen in manufacturing and surging power demand after 2030 as electrification in transportation and real estate kicks in. A back-up fuel is needed to generate power when wind and solar are low in supply. Batteries increasingly act as small-scale back-up facilities. Gas is a reliable large scale back-up fuel, especially in power systems with high penetration of renewables (70% of renewables in the Fast Forward scenario). Gas is a relatively clean fossil fuel too, as it emits 50% less greenhouse gasses compared to coal.

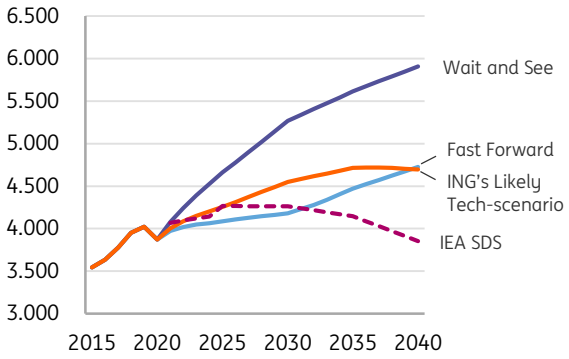
From large gas fired power plants towards peakers

Although gas continues to play a major role in the power sector in both of our scenarios, the composition of the fleet of gas fired power plants will change. In the Fast Forward scenario, gas is increasingly used in peaker plants that run for short periods of time when power from wind and solar farms is low and electricity prices are relatively high. In the Wait and See scenario, power continues to come from combined cycle power plants that are larger and run for long periods to meet baseload power demand.

In addition to the power sector, the manufacturing and real estate sectors contribute to the large increase in gas demand in the Wait and See scenario where efficiency gains are low and the transition to renewables is slow.

Gas demand is likely to continue to rise

Billion cubic meters (bcm) per year

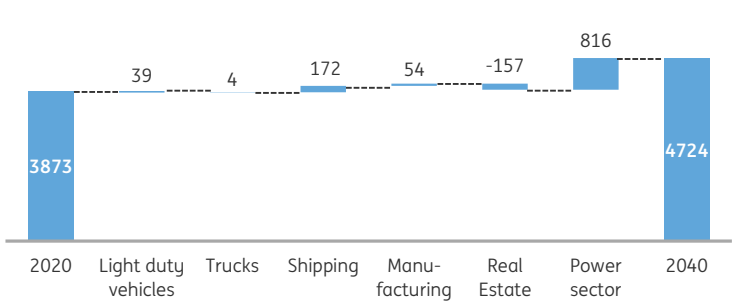


Sources: ING Research

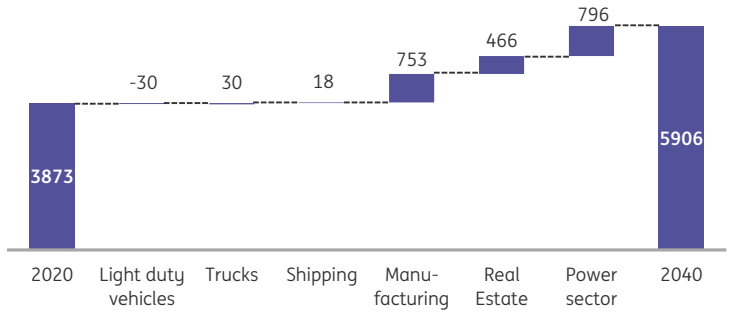
The power sector, real estate, manufacturing and shipping drive change in gas demand

Million barrels per day

Fast Forward



Wait and See



3.6 Fast Forward world reshapes oil and gas supply chain

Russian and American oil fields pushed out of the market

In our Fast Forward scenario, oil demand drops from about 92 million barrels of oil today to around 46 million barrels a day in 2040. Upstream, oil producers are hit hard. Based on the current cost curve for oil production, demand can almost entirely be met by the onshore oil fields in the Middle East and the offshore fields. Oil producers in Russia and North America are likely to suffer most from the technology driven drop in demand as they struggle to compete with the cheapest onshore and offshore fields. Declining demand in the Fast Forward scenario is likely to lead to price weakness in the oil market and widespread write-offs, especially for the fields with high production costs.

Oil tanker fleet could nearly halve

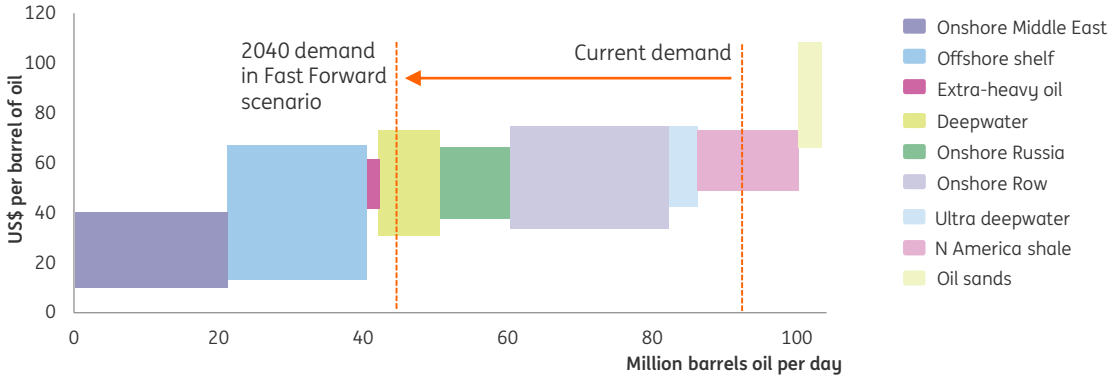
Lower demand reduces international trade of crude oil. The oil tanker fleet could drop by 45% in our Fast Forward scenario by 2040. Further downstream, lower demand reduces refining capacity at refineries across the globe.

Oil demand will continue to grow in the Wait and See scenario

By contrast, oil demand will continue to grow in the Wait and See scenario. It will lead to further exploration of offshore and deep water oil fields, pushing the oil cost curve to the right. Even oil sands might be needed to meet 2040 demand of 120 million barrels a day in the Wait and See scenario. Price fundamentals could improve as a result.

Fast Forward scenario results in sizable drop in equilibrium oil price

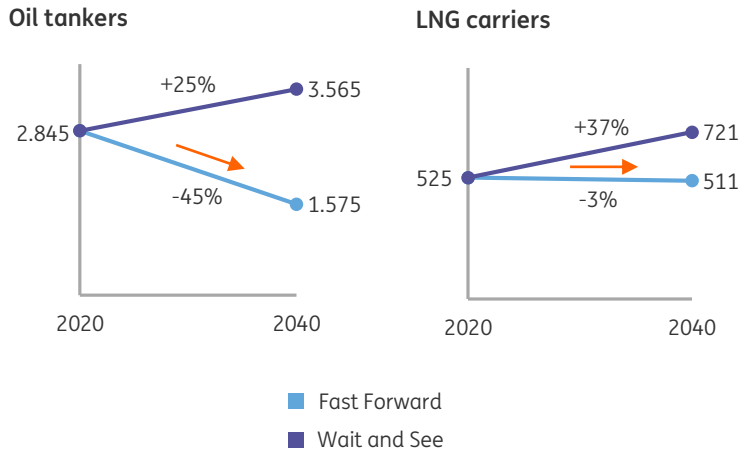
Current global crude oil supply cost curve (US$ per barrel) versus 2040 oil demand



Source: ING Research based on Rystad.

Fleet numbers for both oil tankers and LNG carriers fall in the Fast Forward world

Number of ships in Fast Forward and Wait and See scenarios



Source: ING Research

3.7 What we learned from scenario planning: makers and breakers for the global energy transition

Scenario planning is a powerful tool to analyse a highly uncertain future. In chapter 1 we describe why we use it and what our main scenarios are. Chapter 2 highlights the main technology trends that determine the development of fossil fuels. This chapter shows the impact for coal, oil and gas demand up to 2040. We close this report by looking back on our journey so far with energy scenario planning by sharing the five lessons we learned.

1) Technology needs viable business cases…

Technology is not the constraining factor for achieving the Paris Agreement goals. With enough policy in place, technological advances can lower fossil fuels enough to limit global warming. Electric vehicles and renewables have the largest potential to phase out fossil fuels, but every technology is needed and every sector has to contribute. As such it requires immense investments, mostly by companies and to a lesser degree by governments*. For those corporate investments to take place, viable business cases for clean technologies are needed soon.

2) …that policy can bring

Our scenario planning process revealed that policy and technology are the main uncertainties for the global energy transition. They are not independent: policy drives the feasibility of technological advances. It also made clear that the world is currently not on the path of limiting global warming to 2˚C and needs a strong push forward. Policy interventions are not bold enough to make investments in fossil fuels unprofitable and to ensure enough investment in green technologies. If we take the Paris Agreement goals seriously, we must assume policy makers all over the world are willing to change course drastically within a couple of years. We will either end up in a world with a lot of policy, making fossil fuels unattractive and green technologies attractive - the energy transition will be in full swing and climate change is limited. Or we will end up in a world with little policy and many of the needed technologies not being commercially viable. In this world, the chance of runaway climate change is high, increasingly enforced by tipping points.

3) Policy provides guidance for corporate decision makers

Companies and financial institutions face two risks: the energy **transition risk – our Fast Forward world**, where fossil assets might get stranded and the **climate risk – in our Wait and See world**, where assets or profitability are negatively impacted by the physical risks from climate change such as extreme weather events or the loss of biodiversity. Corporate strategic decision makers need to take both risks into account but face enormous uncertainties: global energy use and emissions have continued to rise since the Paris Agreement was signed, while a sharp and prolonged reduction is needed to limit global warming. If the chances of effective mitigation strategies diminish, it becomes rational to invest in adaptation measures to cope with, rather than prevent, climate risks. A shift in focus from mitigation to adaptation may 'break' the energy transition: a self-fulfilling prophecy as companies hesitate or only make 'no regret' investments.

4) As Covid-19 does not 'make it'…

Uncertainty is amplified by the Covid-19 pandemic, now that fighting the global pandemic is the main priority. Regained confidence in governments, confident policy makers and global cooperation would be necessary to bring about impactful policies, such as carbon pricing. So far, we do not see much evidence of a move in that direction.

5) …burning platforms and corporates can help to 'make it'

It will probably take more heatwaves, forest fires, floods and loss of biodiversity to provide the 'burning platform' for policy makers to act. Prepared corporate decision makers can help to bring this moment closer by supporting international policy intervention.

* We estimate required investments in wind farms and solar panels alone to be around US$13 trillion.

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Also of interest

Technology , the climate saviour?

To what extent can technology contribute to the climate goals?

Rethinking the road to the circular economy

Circular economy is shrinking, not growing

Appendix: main scenario inputs

Scenario inputs for power sector and real estate

Average annual improvement in 2020-2040 period

		Wait and See scenario	Likely Tech scenario	Fast Forward scenario
	2020	2040	2040	2040
Power mix				
Coal	36%	30%	20%	2%
Gas	24%	24%	17%	21%
Oil	2%	3%	1%	0%
Nuclear	10%	8%	7%	7%
Hydro	16%	8%	14%	10%
Wind	6%	13%	22%	30%
Solar	3%	10%	17%	25%
Real estate energy mix				
Coal	4%	3%	2%	0%
Gas	23%	25%	22%	16%
Oil	14%	9%	5%	2%
Electricity	27%	35%	45%	52%
Heat (district heating)	5%	6%	7%	15%
Bio-energy	24%	20%	15%	5%
Other renewables	2%	2%	4%	10%

Source: ING Research

Scenario inputs for manufacturing

Average annual improvement in 2020-2040 period

		Wait and See scenario	Likely Tech scenario	Fast Forward scenario
	2020	2040	2040	2040
Industrial processes				
Coal	23%	20%	14%	5%
Gas	24%	26%	25%	23%
Oil	14%	10%	7%	4%
Electricity	27%	30%	38%	45%
Heat	5%	6%	7%	10%
Bioenergy	7%	8%	9%	13%
	2020	2040	2040	2040
Industrial feedstock				
Coal	7%	5%	1%	0%
Gas	13%	11%	20%	30%
Oil	79%	80%	70%	50%
Bio based / other	1%	4%	9%	20%

Source: ING Research

Scenario inputs for energy efficiency

Average annual improvement in 2020-2040 period

	Wait and See scenario	Likely Tech scenario	Fast Forward scenario
Manufacturing	0.5%	2.0%	3.5%
Light duty vehicles	1.0%	1.5%	3.0%
Trucks	1.0%	1.5%	1.8%
Shipping	1.0%	1.5%	2.0%
Aviation	1.0%	1.5%	2.5%
Real Estate	1.0%	1.7%	2.0%

Source: ING Research

Appendix: main scenario inputs *(continued)*

Scenario inputs for transportation sectors

Average annual improvement in 2020-2040 period

		Wait and See scenario	Likely Tech scenario	Fast Forward scenario
	2020	2040	2040	2040
Light duty vehicles				
Share of EVs in total car sales	3%	40%	100%*	100%*
Trucks				
Share of LNG trucks in total fleet	1%	2%	3%	1%
Share of electric trucks in total fleet	0%	1%	8%	17%
Share of hydrogen trucks in total fleet	0%	0%	3%	10%
Share of diesel trucks in total fleet	99%	97%	86%	72%
Share of bio- and synthetic fuel use in diesel trucks	4%	5%	15%	25%
Shipping				
Share of oil powered ships in total fleet	100%	98%	90%	80%
Share of LNG powered ships in total fleet	0%	2%	7%	15%
Share of hybrid ships in total fleet	0%	0%	2%	1%
Share of electric ships in total fleet	0%	0%	1%	4%
Share of bio- and synthetic fuels in total fuel use	1%	5%	15%	23%
Aviation				
Share of bio- and synthetic fuels in total fuel use	0%	8%	20%	35%
Share of electric aeroplanes in total fleet	0%	0%	1%	2%

* 100% starting in 2040 in Likely Tech scenario and in 2035 in the Fast Forward scenario.
Source: ING Research

Would you like to know more?

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