TotalEnergies

TotalEnergies
Energy Outlook 2023

Analysis by sector and by scenario

13 November 2023

Key features of our 2023 Momentum & Rupture scenarios

Momentum: NZ50 countries and China scale-up by 2050 (not all 2030 NDCs met); lack of support to Global South

GDP growth : +2.8%/yr
Energy demand growth: +0.3%/yr

- **Clean electrification of end-use,** in particular road transport, in NZ50 countries and China, much less in Global South
- **Coal exit** in NZ50 countries, strong reduction in China, slight growth in Global South
- In all countries**, natural gas** is the transition energy for electricity and industry
- Significant **energy efficiency** gains in all countries
- **H_2 potential** confirmed in industry with ramp up after 2030 in NZ50 countries and China
- High **polymer recycling** objectives and demand saturation in NZ50 countries

Rupture: how to reach well-below 2°C – integration of Global South into world's energy transition

GDP growth : +2.8%/yr
Energy demand growth: +0.1%/yr

- Application of Net Zero decarbonization levers to the entire world, while meeting Global South legitimate growth expectations
- Further penetration of **electricity & renewables** in Global South
- Significant **coal reduction** in China and Global South
- Extension of transport revolution: **higher Zero Electric Vehicle penetration** worldwide; **increased Sustainable Liquid Fuels penetration** in aviation & marine
- Higher penetration of **new energy carriers** (clean H_2 in industry & transport, e-fuels, biofuels and biogas…)
- Higher **polymer recycling** in China and Global South

Key modeling drivers of Momentum & Rupture scenarios

	2021	Momentum 2050	Rupture 2050
Strong electrification of end-use	~20% of final demand	~35%	~40%
Deep decarbonization of power supply	2 900 TWh* (~10% of power generation)	24 000 TWh* (~50%)	32 000 TWh* (~60%)
Gas going greener	<1% green gases** in gas supply	~20%	~30%
Sustainable mobility	~ 1% Battery & Fuel Cell Electric Vehicles in light vehicles fleet	~65%	~80%
	~100% kerosene fueling aircrafts	Sust. aviation fuels (SAF) @ ~35% of demand	SAF @ ~65%
Increasing plastics' circularity	~7% of gross demand coming from recycled materials	~35%	~45%
CCS to abate remaining emissions	~35 Mt (0.1% CO_2 emissions)	3 Gt (~12%)	6 Gt (~45%)
Energy efficiency acceleration	1.4%/yr energy intensity improvement since 2000	+2.4%/yr	+2.7%/yr
Support to Global South	~20% of non-fossil sources in primary energy demand	~30% (vs ~65% in NZ50 countries)	~55% (vs ~65% in NZ50 countries)

** Excluding Renewable electricity generation for green H_2*
*** Green gases include Biomethane and H_2 -- excluding H_2 share for liquid e-fuels production*

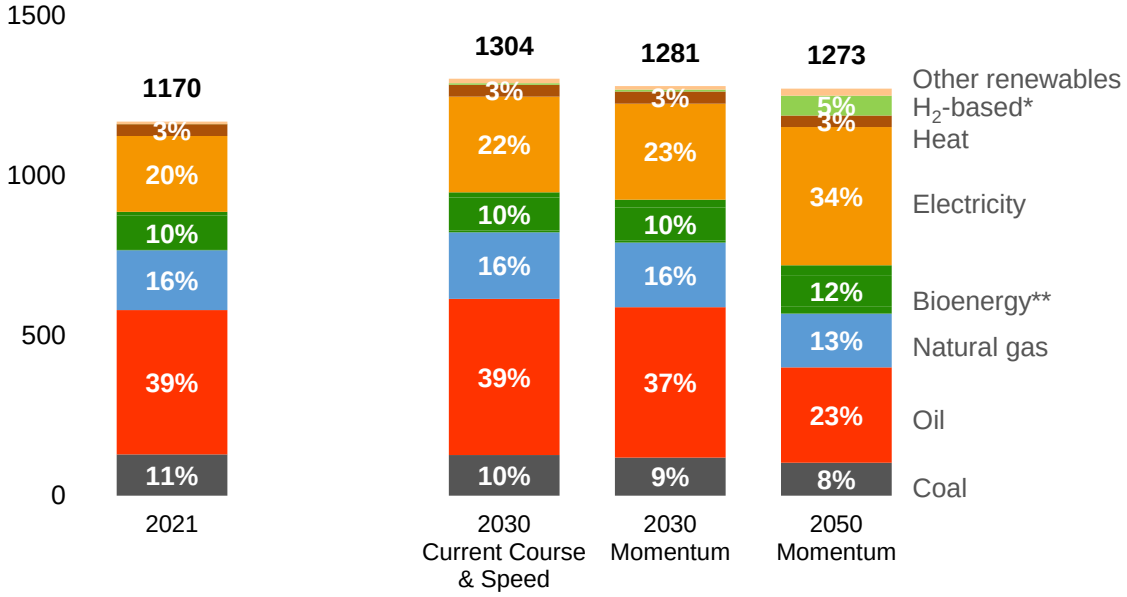
Momentum

World Total Final Consumption

End-usage electrification main driver of all NZ50 policies

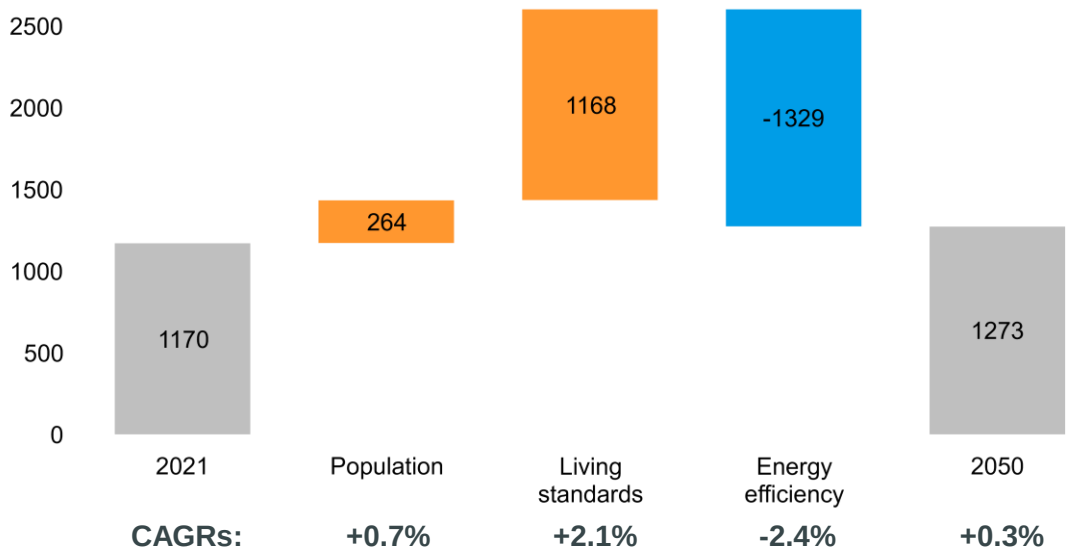
Total Final Consumption

PJ/d



Changes in annual Total Final Consumption over 2021-2050*** (Momentum)

PJ/d



- As early as 2030, Momentum requires an inflection compared to Current Course & Speed: increased energy efficiency and decreased Fossil Fuel share
- In Momentum, fossil fuels share down from ~65% to ~45% by 2050, driven by China and NZ50 countries

- Reining-in increased energy demand induced by higher living standards requires a significant step-up in energy efficiency gains from 2.0% p.a. in the last 5 years pre-covid years to 2.4% p.a. over the next 30 years
- Energy efficiency levers differ across countries: massive clean electrification in NZ50 countries and China, substitution of traditional energy by modern energy in Global South

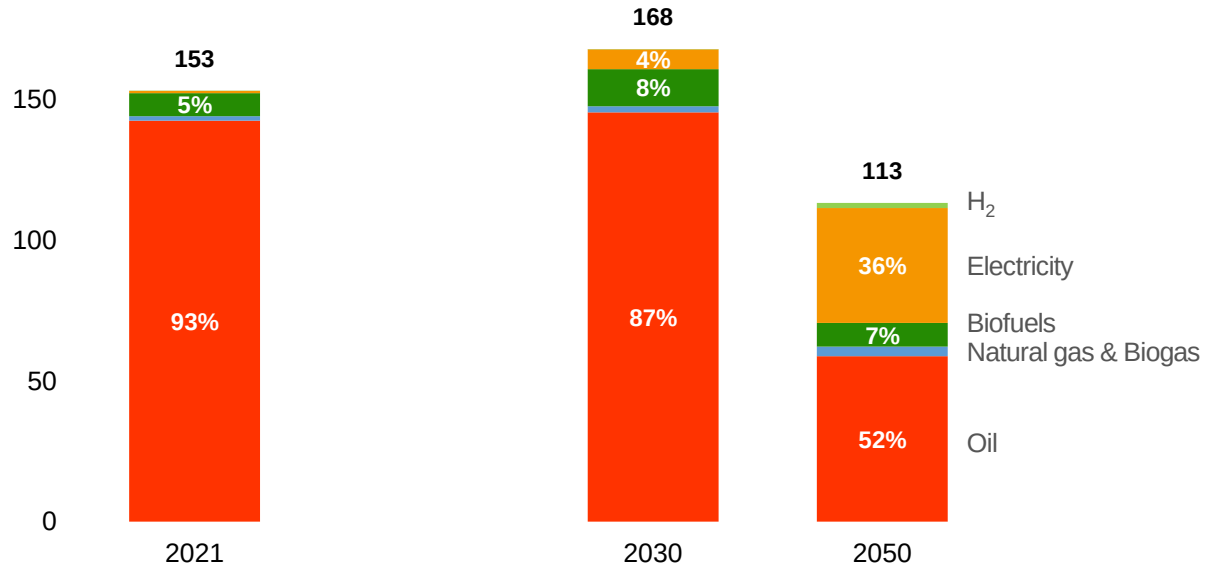
** Includes H2, e-fuels (H2 + CO2), methanol, ammonia…*
*** Includes traditional use of biomass, waste, biofuels, biogas …*
**** Living standards: GDP per capita ($/person); Energy efficiency: energy required to produce 1$ of GDP (MJ/$)*

Momentum

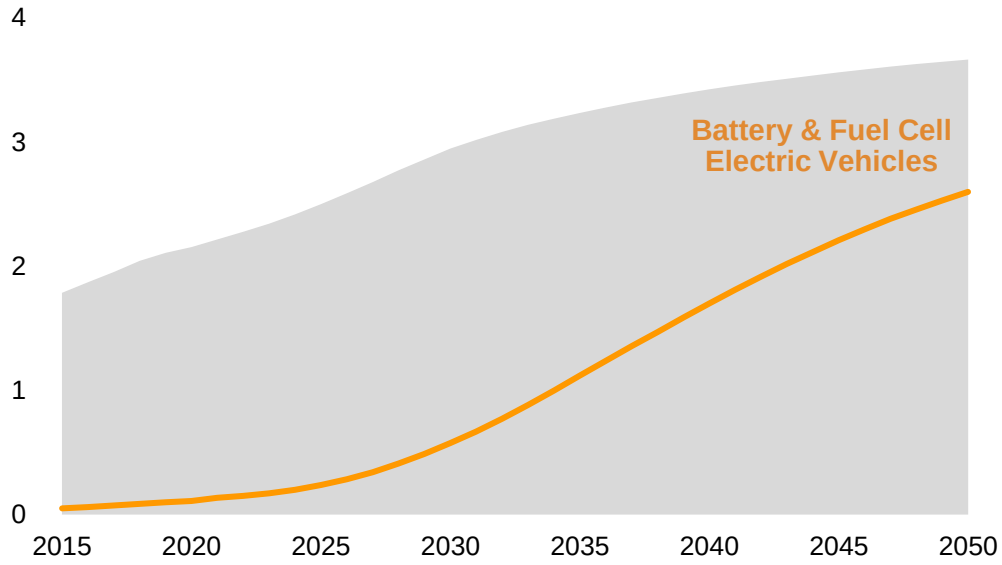
Electrification of Light Duty Vehicles

China and NZ 2050 countries leading widespread electricity adoption

Light Duty Vehicles* Final Consumption (Momentum)
PJ/d



Light Duty Vehicles fleet (Momentum)
Billion



- LDV: 50% of 2021 Transport final energy demand and CO_2 emissions
- In Current Course and Speed, ~ 25 PJ/d (~ 5 Mb/d) of oil demand is displaced by 2030, hence oil demand is ~29 Mb/d; Momentum assumes quicker penetration of EVs, hence ~1 Mb/d more is displaced
- 20% of this oil demand reduction comes from 2-3 wheelers electrification

- Battery & Fuel Cell EV sales penetration of Passenger Cars by 2030 accelerates from 10% in last year's outlook to 13% this year, driven by current China's dynamic and USA IRA incentives
- By mid-century, ~ 90% of the LDV fleet in NZ50 countries and China is converted to electricity, ~ 55% in Global South
- By 2050 in Momentum, LDV electricity demand rises to ~4 000 TWh, around 9% of global electricity demand

** Passenger cars + Light Commercial Vehicles + 2-3 wheelers*

Momentum

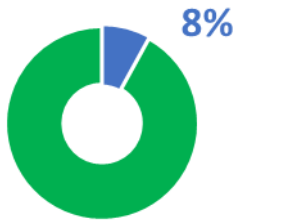
China leads the way for Light Duty Vehicles decarbonization

Faster Electrification of two and three-wheelers expected in Global South

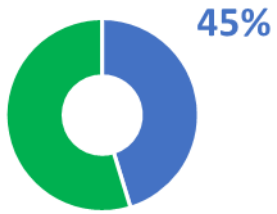
In 2022

Split of Light Duty Vehicles (LDV*) sales

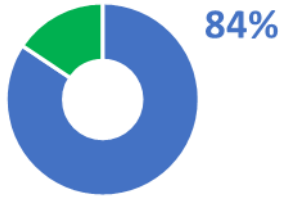
%



NZ50 countries



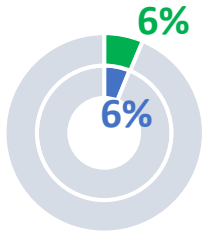
China

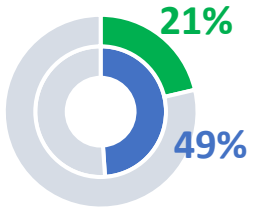


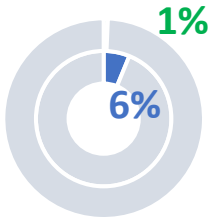
India

Share of Battery Electric Vehicles in LDV Sales

%

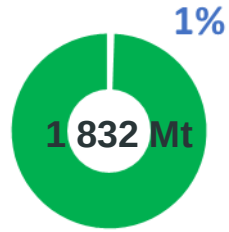


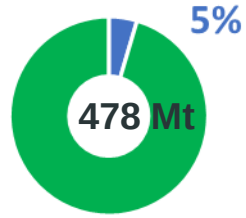


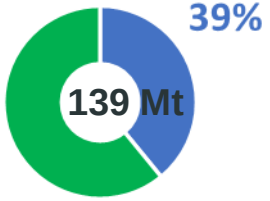


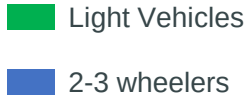
CO_2 emissions of LDV

Mt CO_2









- In many low- and middle-income countries, 2-3 wheelers provide affordable personal mobility, hence are the fastest growing transport mode
- China has by far the highest Battery Electric Vehicles penetration rate

- In Global South, electrification of 2-3 wheelers is a priority to lower emissions and improve air quality
- CO_2 abatements costs (in $ per ton of CO_2) are ~2 times lower for 2-3 wheelers than for passenger cars

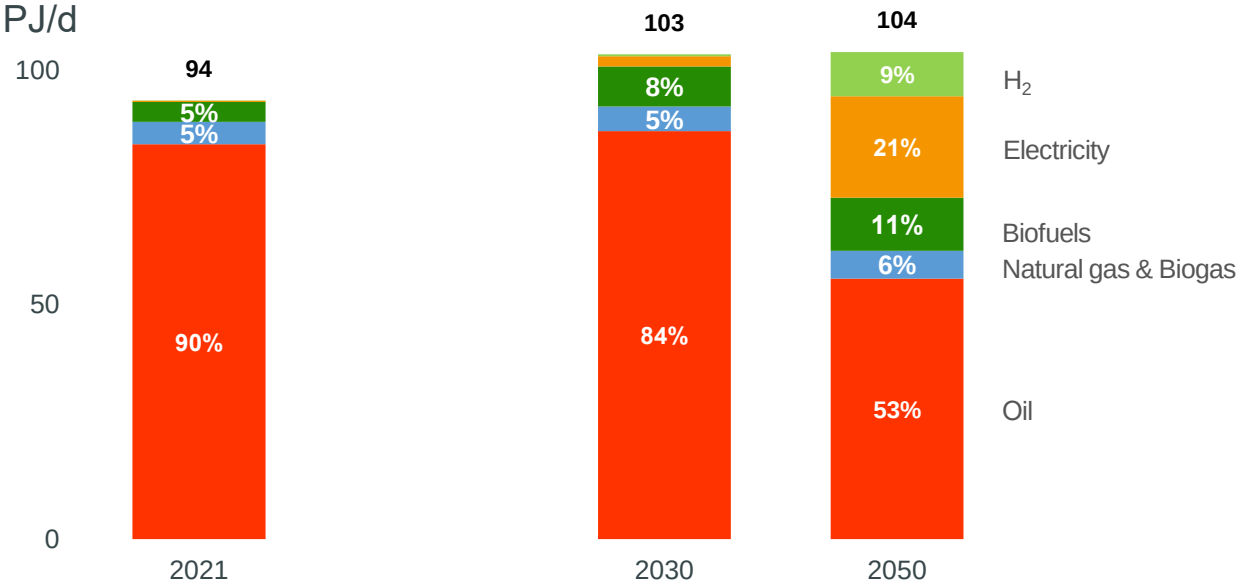
** LDV = Passenger cars + Light Commercial Vehicles + 2-3 wheelers*

Momentum

Mix diversification in Heavy Duty Vehicles

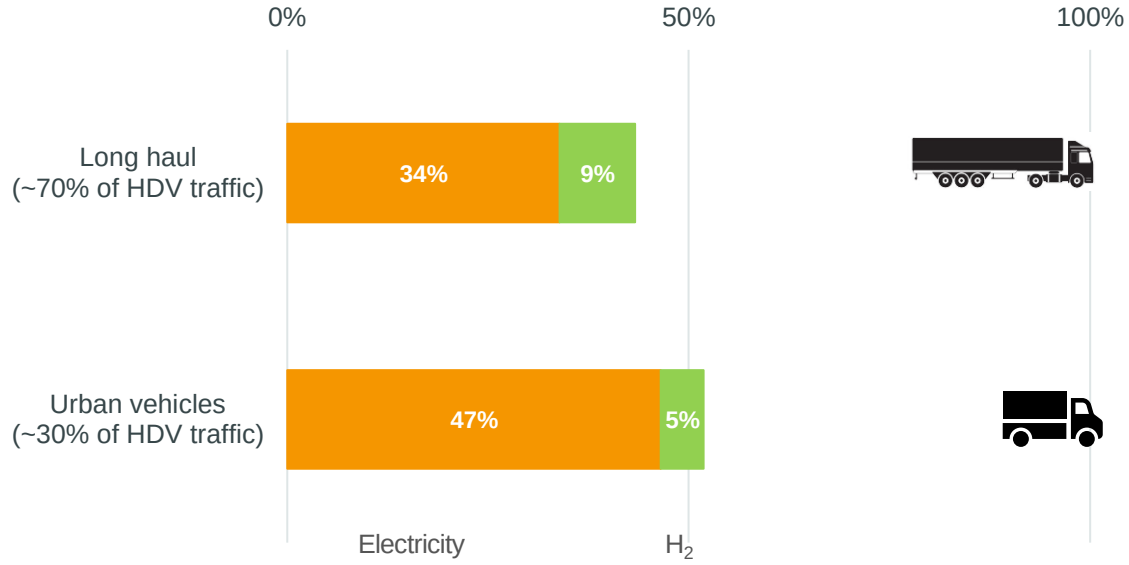
Electrification is becoming the primary lever for trucking decarbonization

Heavy Duty Vehicles* Final Consumption (Momentum)



Zero Emissions Vehicles share of HDV traffic (Momentum)

2050, % of km travelled



- HDV: 30% of 2021 Transport final energy demand and CO_2 emissions
- By 2030 in Momentum, oil demand is ~15 Mb/d, ~ 1 Mb/d lower than in Current Course and Speed due to higher penetration of biofuels
- Compared to TEO22, electricity share in Momentum is much higher (21% vs. 16%) and H_2 share much lower (9% vs. 14%)

- New perspective reflects the rapid increase in batteries' performance, the high number of models of electric model buses and trucks offered, and the growing investment in fast charging infrastructure
- Despite Battery Electric Vehicles progress, fuel-cells remain the preferred solution for Long Haul inter-regional transport corridors, served by Hydrogen Refueling Stations

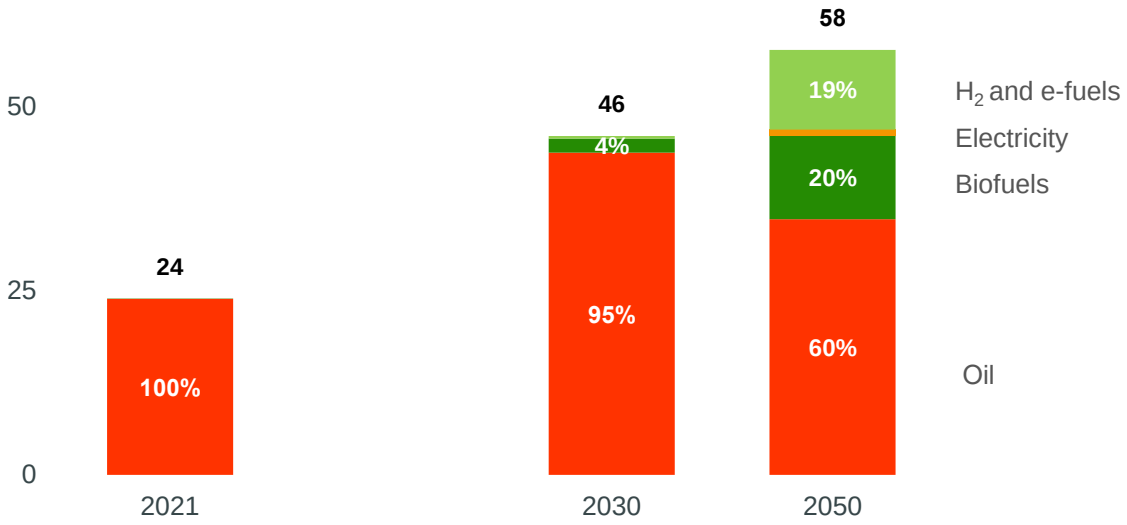
** Trucks + Buses + Coaches*

Momentum

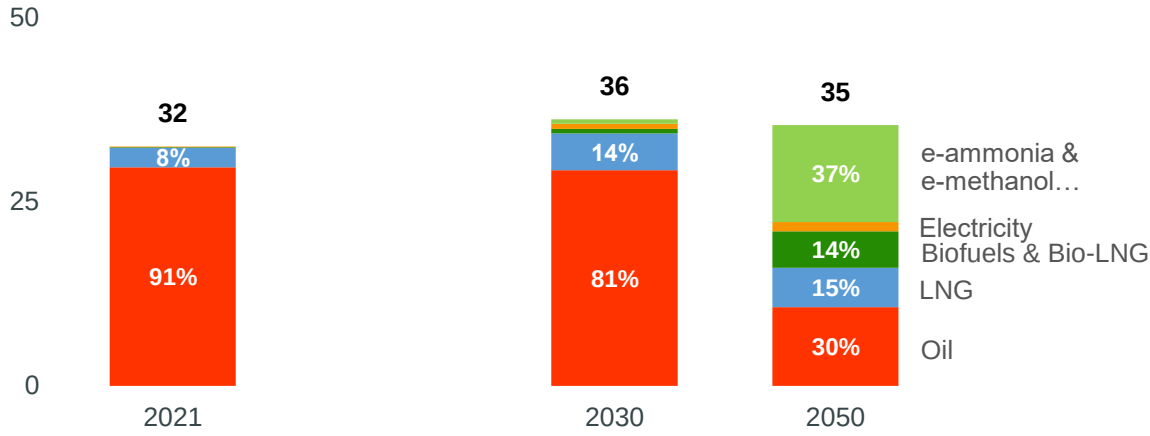
Multiple decarbonization paths for Aviation & Marine

Bio-energies and e-fuels to decarbonize these hard-to-abate Transport sectors

Aviation Final Consumption (Momentum)
PJ/d



Marine final consumption (Momentum)
PJ/d



- Aviation: 8% of 2021 Transport final energy demand and CO_2 emissions
- By 2030, in Momentum, oil demand is ~8 Mb/d, ~ 0.5 Mb/d lower than the Current Course & Speed due to higher penetration of biofuels
- In 2023, 115 countries (representing ~ 70% of emissions) have committed to limit their CO_2 emission by 2035 at 85% of their 2019 level (including carbon compensation). This objective is met in Momentum

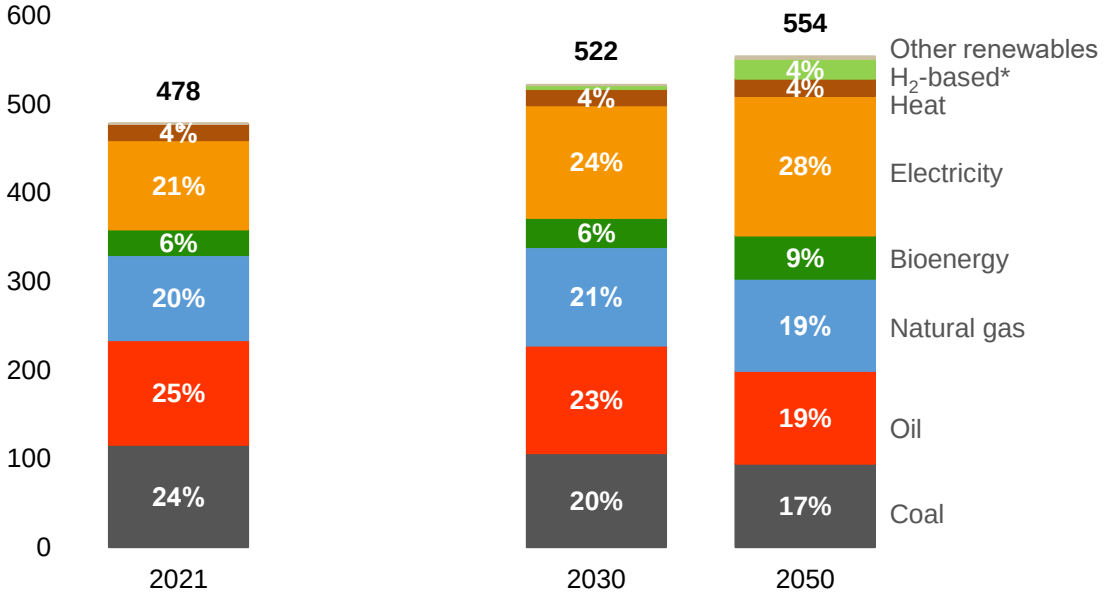
- Marine: 10% of 2021 Transport final energy demand and CO_2 emissions
- By 2030, Momentum and Current Course & Speed are similar
- LNG, moving to bio-LNG, plays a key role in the energy transition in the short-term while e-fuels will be deployed after 2035
- In July 2023, the International Marine Organization proposed a NZ50 strategy for international shipping. It is partially achieved in Momentum: 2050 emissions are reduced by ~45% from 2008

Momentum

Decarbonization underway in Industry

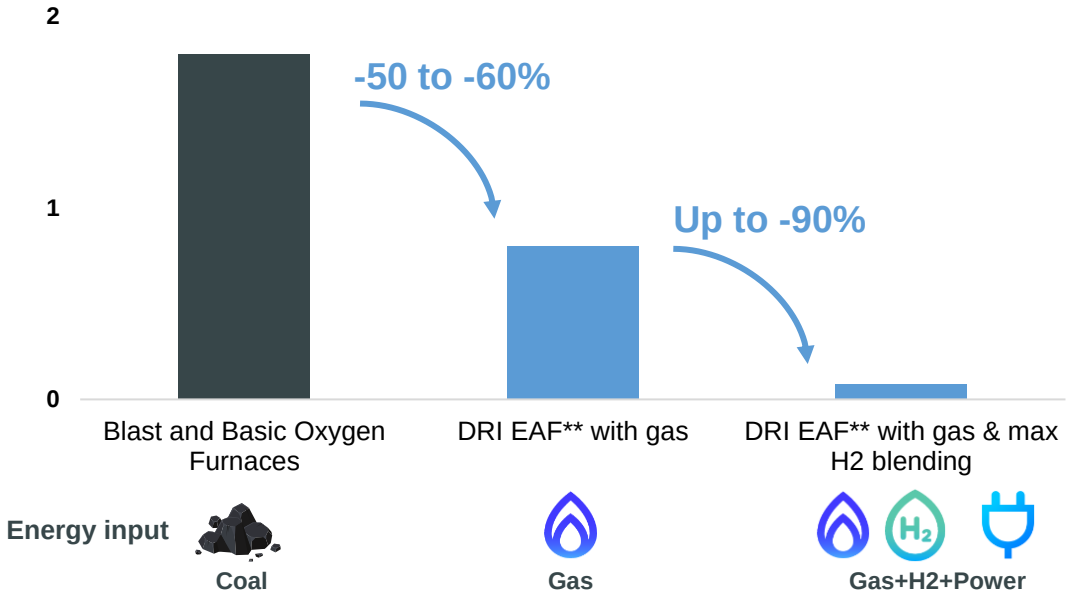
Industry Total Final Consumption (Momentum)

PJ/d



Steel decarbonization example

ton CO_2 emissions* / ton of steel



- Until 2030, Momentum and Current Course and Speed are similar, mix evolution is relatively slow
- Post 2030, industry decarbonization accelerate via replacement of coal & fuel oil by electricity and natural gas
- Carbon Capture and Storage helps abate the remaining fossil share, especially in 2030+
- By 2050, net fossil fuel emissions fall by ~55% per $ of industrial GDP

- Today, steel production represents ~8% of global CO_2 emissions
- Steel used is expected to grow in Global South from 1-2 tons per capita today to ~6 tons per capita by 2050 (half of today's OECD average)
- Switching from coal to gas and electricity is a quick win to immediately reduce emissions by 50% to 60%, with the option of later blending H_2 with gas or using CCS to further reduces emissions by up to 90%

** Energy related + Process related*
*** Direct Reduced Iron and Electric Arc Furnace*

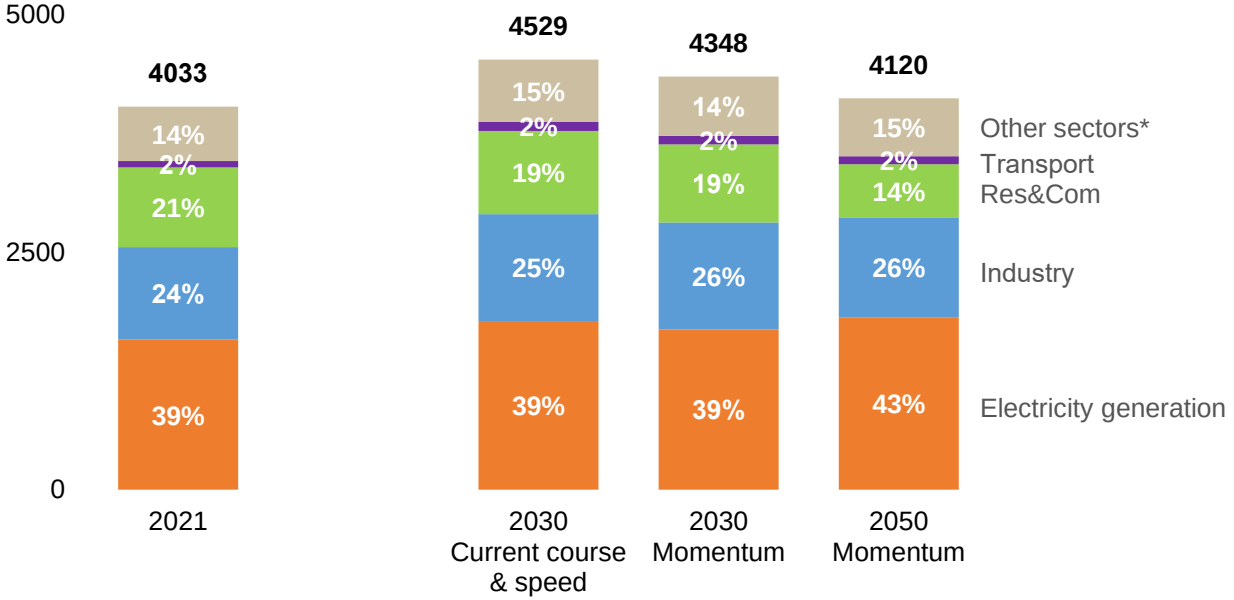
Momentum

World Liquids & Natural Gas Demand

Natural gas key for energy transition; oil demand starts decreasing after 2030

Natural gas demand by sector, excluding gas for Blue H_2

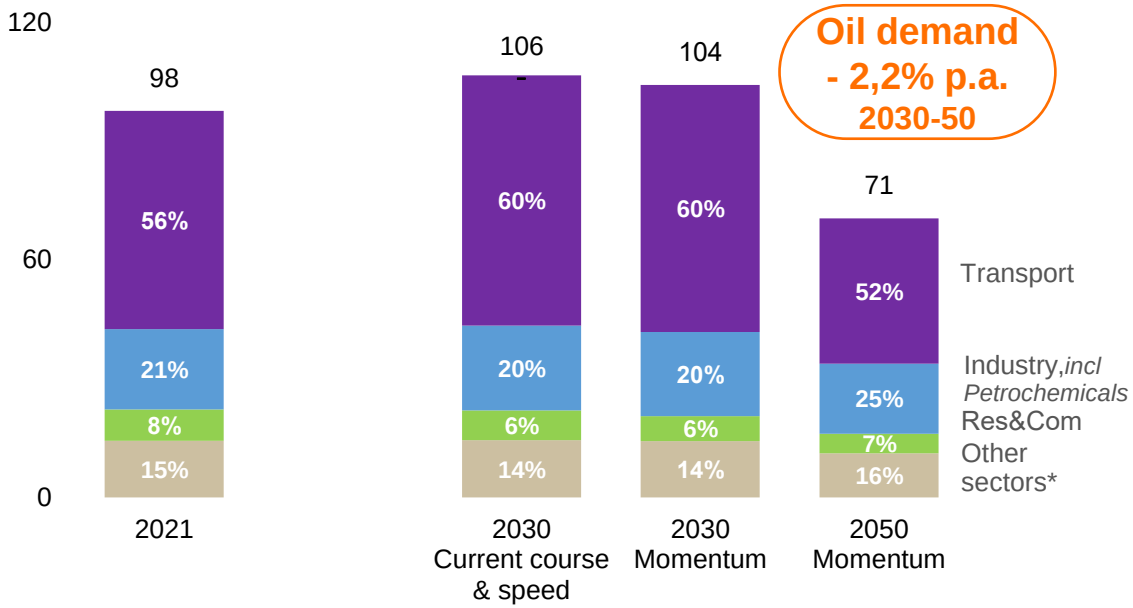
Bcm



- In Momentum, natural gas demand increases by +0.8% p.a from 2021 to 2030 on average, vs +1.3% p.a in Current Course and Speed
- Natural gas is a key transition fuel, growing until the mid 2040's, as dispatchable natural gas fired generation continues to ensure the reliability of electricity systems

Liquids (oil + bio-fuels) demand by sector

Mb/d



- By 2030, accelerated electrification of the Transport and Buildings sectors reduces oil demand to 98 Mb/d in Momentum, compared to 102 Mb/d in Current Course & Speed
- In Momentum, oil demand starts decreasing post-2030 but slower than 4-5% p.a. natural decline of existing oil fields. Meeting demand requires therefore developing new fields

** Other energy and non-energy use, agriculture…*

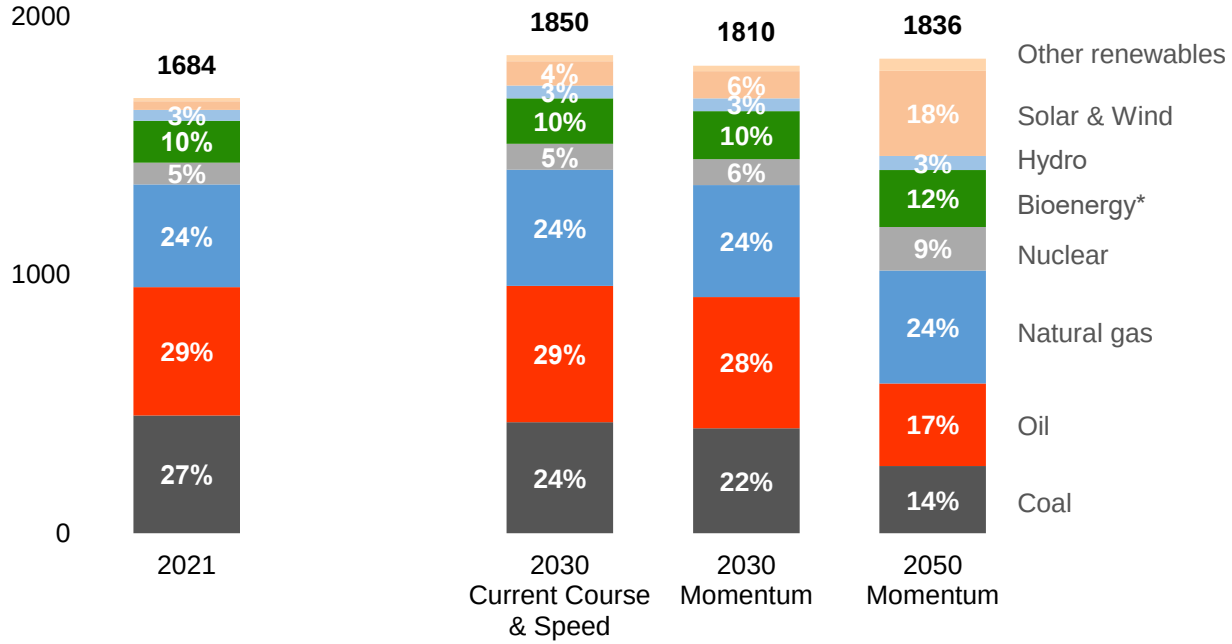
Momentum

World energy demand and CO_2 emissions

Sustained investment towards energy transition but insufficient to meet global targets

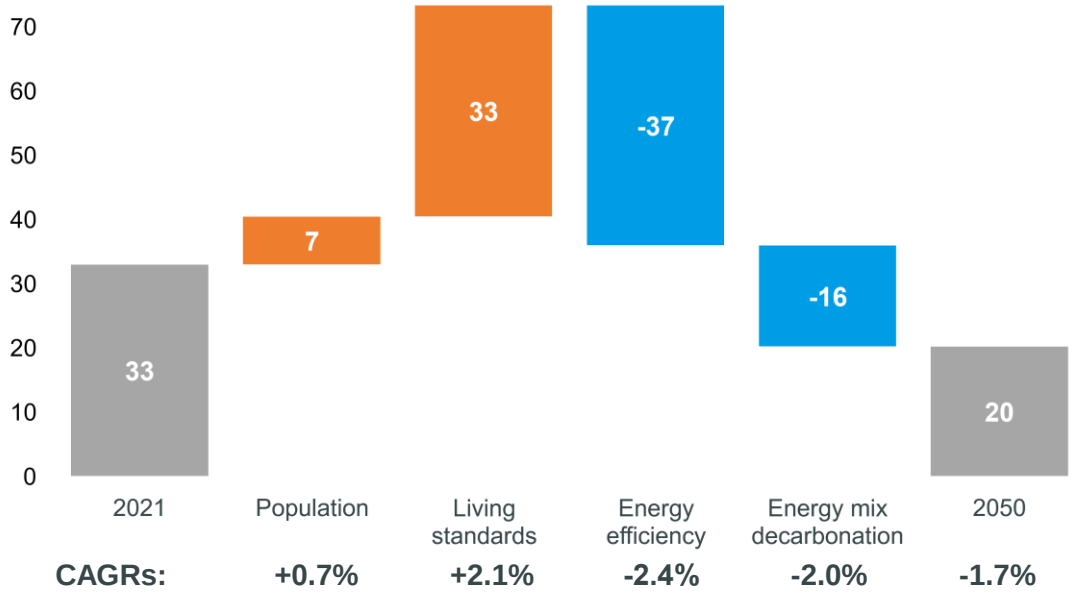
Total Primary Energy Demand

PJ/d



Changes in annual CO_2 emissions over 2021-2050** (Momentum)

Gt CO_2



- In Momentum, fossil fuels share decreases from 80% in 2021 to 74% as early as 2030, vs. 77% in Current Course and Speed
- By 2050, fossil fuels share is down to 55% in Momentum
- Renewables & natural gas both growing in absolute terms, playing key complementary roles

- Significant increase in energy efficiency almost compensates increased emissions associated with growing population and increased living standards
- Energy mix decarbonization primarily in NZ50 countries and China leads to ~40% emissions reduction
- Temperature would rise by +2.1-2.2°C by 2100 (P66***)

* *Includes traditional use of biomass, waste, biofuels, biogas…*

** *Living standards: GDP per capita ($/person), Energy efficiency: energy required to produce 1$ of GDP (MJ/$), emission mix decarbonization: CO_2 emissions per unit of energy (gCO2/MJ)*

*** *Temperature range ascertained by comparing energy-related CO_2 emissions trajectories with the IPCC AR6 scenarios.*

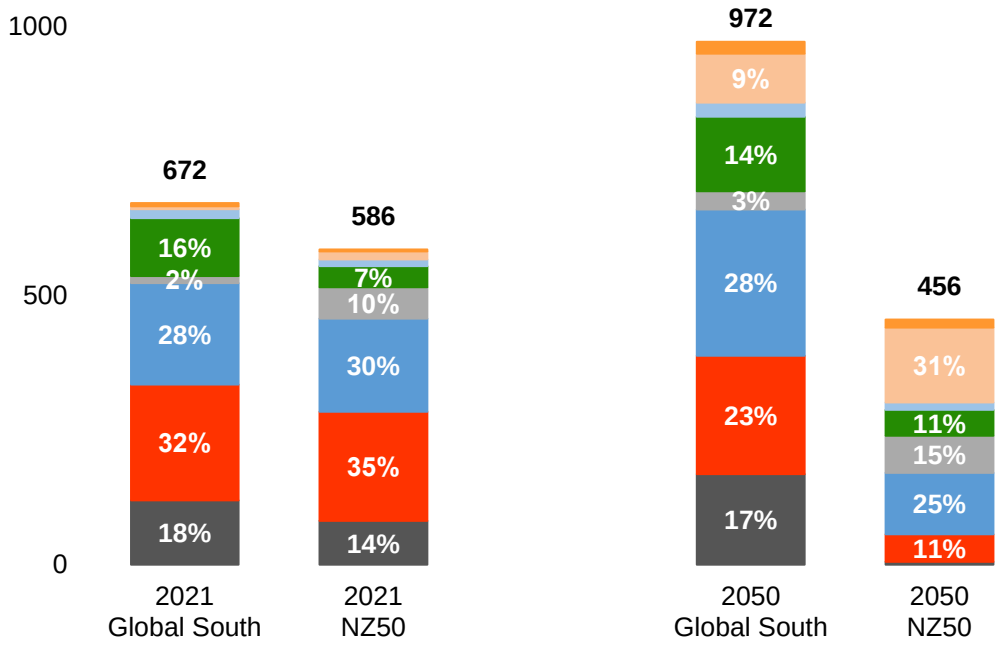
Momentum

Energy transition in Global South

Meeting growing needs

Total Primary Energy Demand Global South vs. NZ50 countries (Momentum)

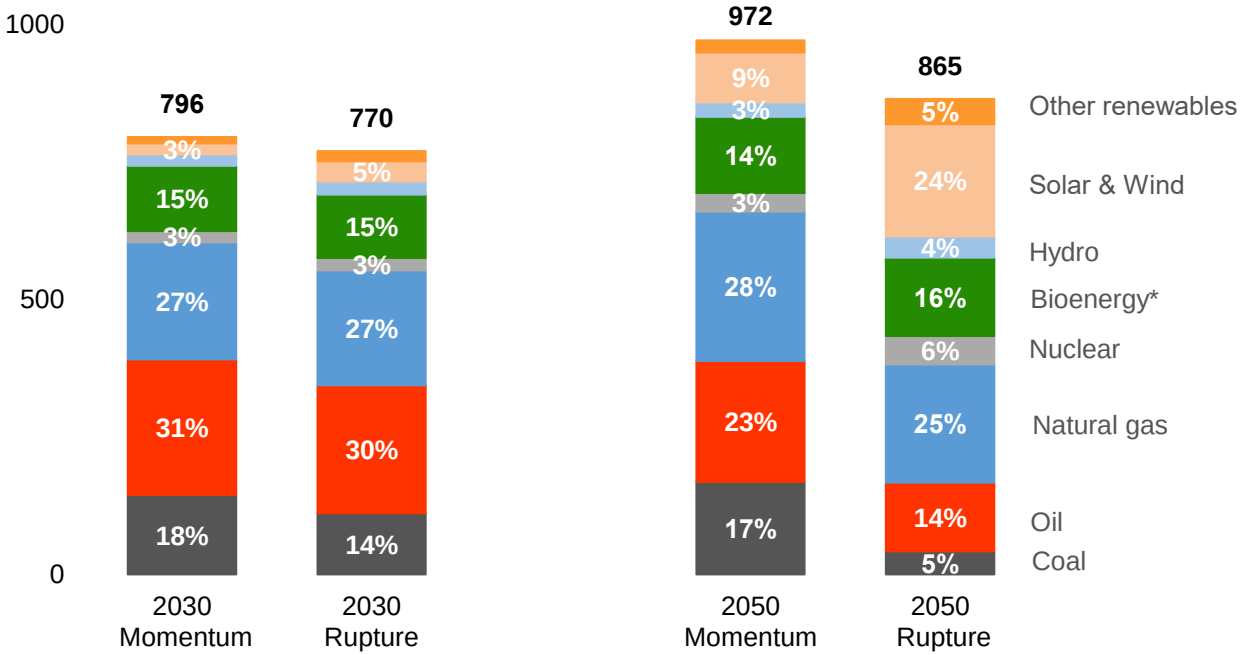
PJ/d



- In 2021, the share of fossil fuels in the TPED is roughly the same in NZ50 countries and in Global South (~80%)
- By 2050, it decreases to ~40% in NZ50 countries vs. ~70% in Global South in Momentum

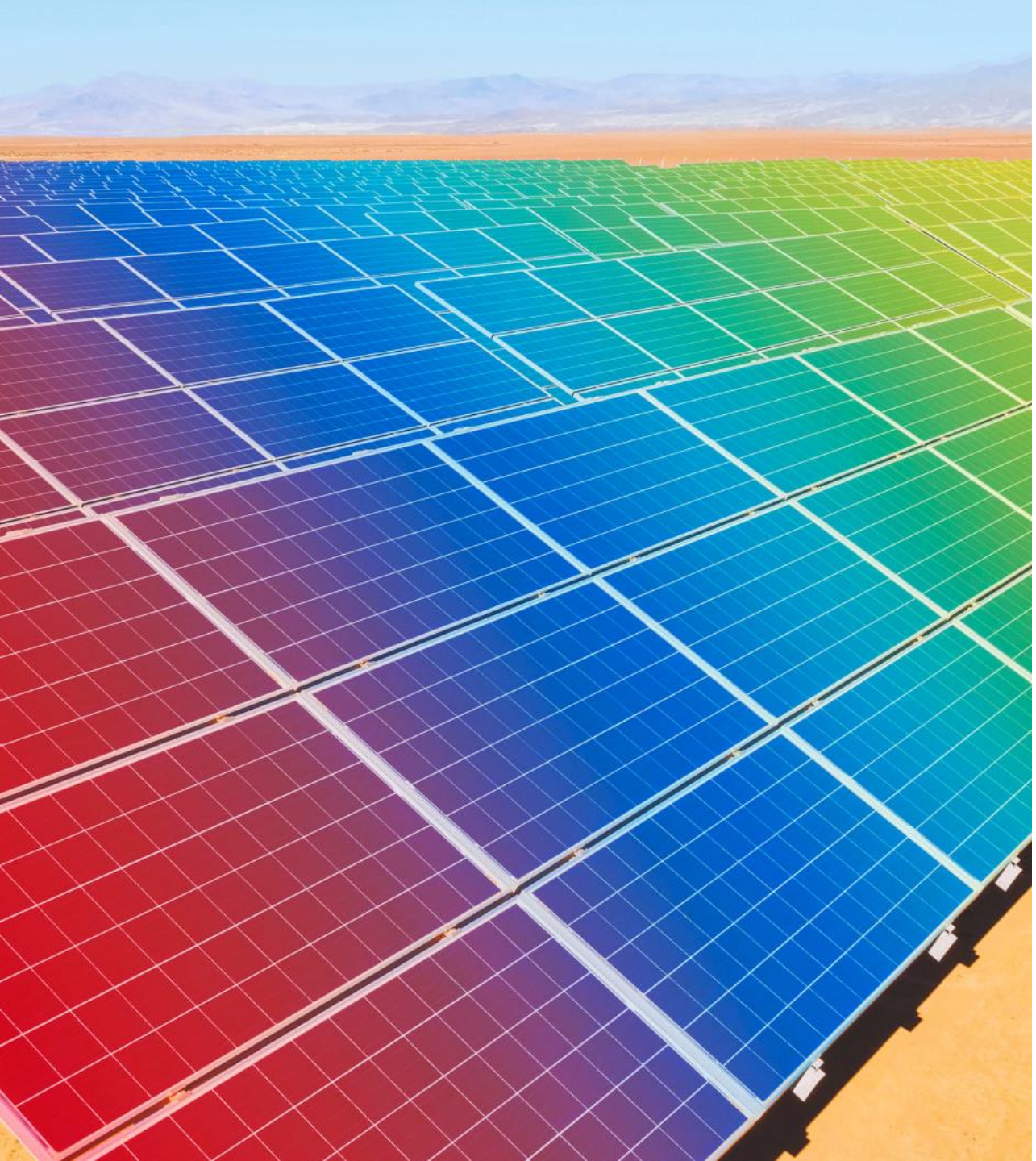
Total Primary Energy Demand Global South (Momentum vs. Rupture)

PJ/d



- In 2030, fossil fuels share decreases to 76% in Momentum and 71% in Rupture (2050 evolution is even more spectacular: 68% vs. 44%)
- Global South will need support to deliver such decarbonization level, all the while increasing energy access
- A quick win is for advanced economies to contribute to funding energy efficiency, coal-to-gas switching, and access to clean energy

** Includes traditional use of biomass, waste, biofuels, biogas…*

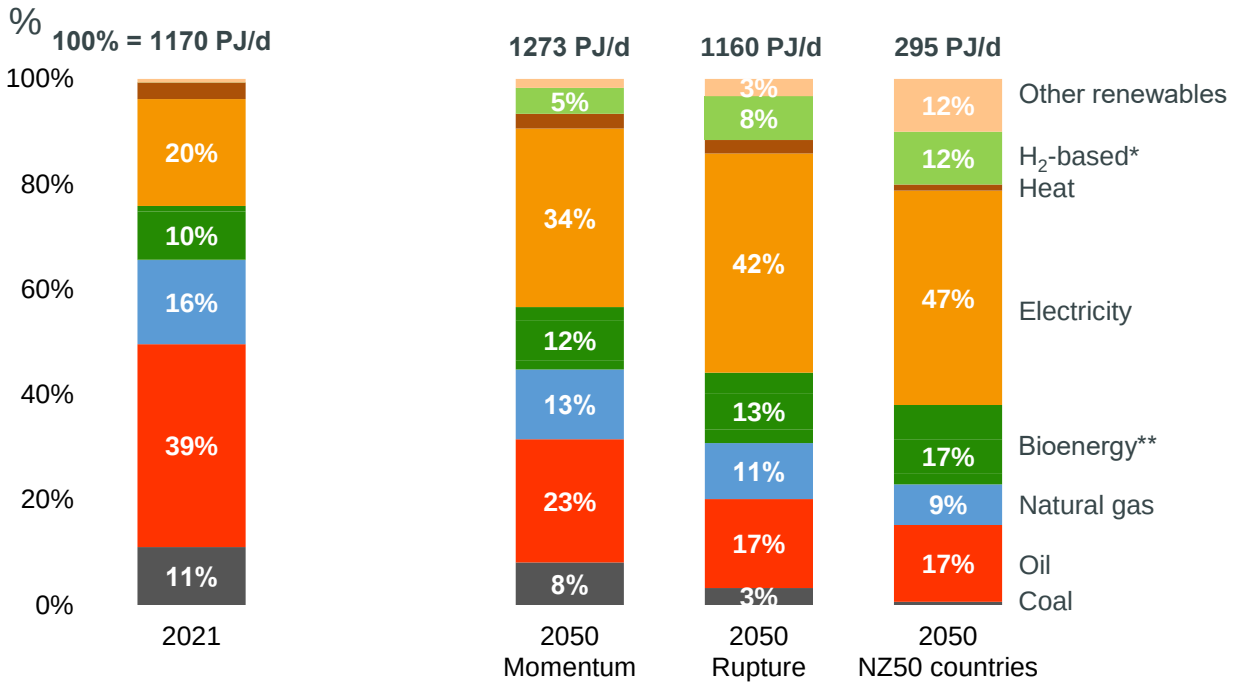


Rupture

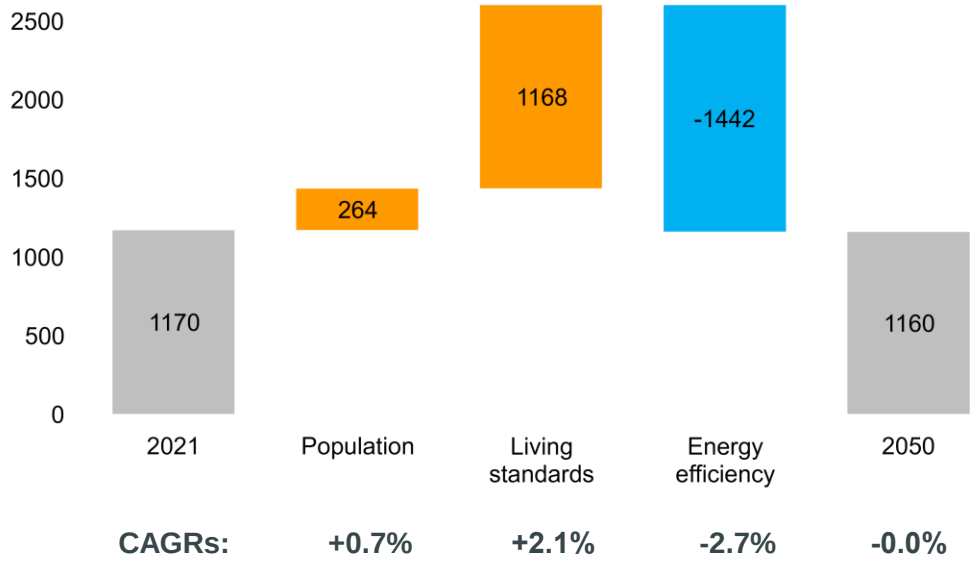
World Total Final Consumption

Increased electrification in Global South essential to remain well-below 2°C

Total Final Consumption



Changes in annual Total Final Consumption over 2021-2050*** (Rupture)



- Application of decarbonization levers to the entire world: energy shares in global TFC in Rupture close to the NZ50 countries
- Continued role for natural gas and green gases, strong reduction in oil, almost complete phase-out of coal

- Growth in population and living standards identical to Momentum
- Higher energy efficiency mainly driven by higher electrification

** Includes H_2, e-fuels (H_2 + CO_2), methanol, ammonia…*
*** Includes traditional use of biomass, waste, biofuels, biogas …*
**** Living standards: GDP per capita ($/person), Energy efficiency: energy required to produce 1$ of GDP (MJ/$)*

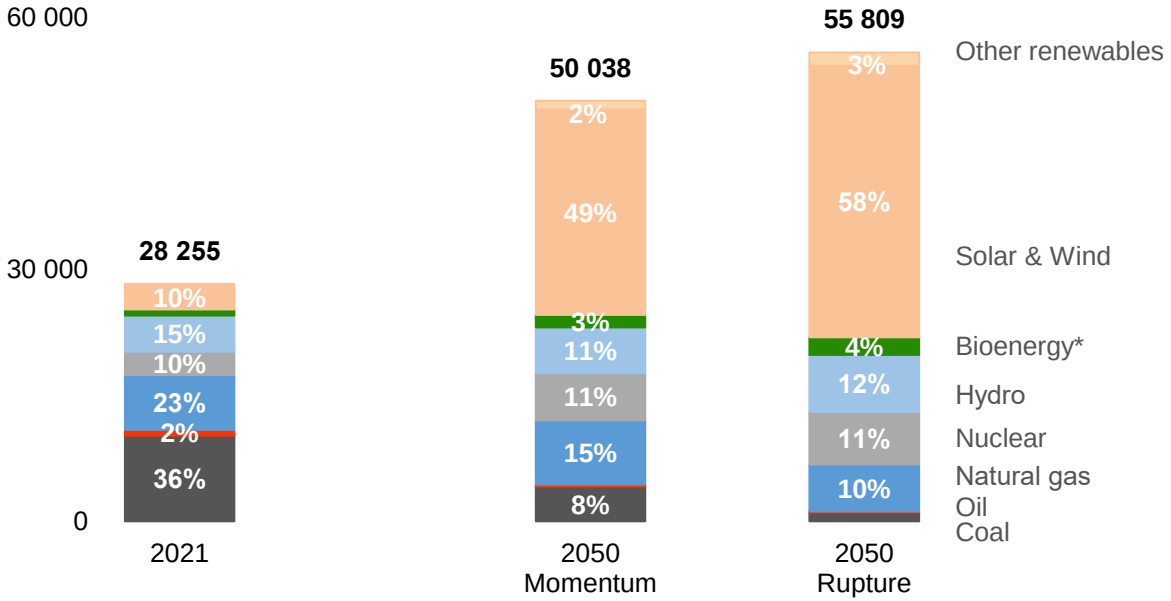
Rupture

World electricity demand and generation

A world well-below 2°C requires a new electricity system

Electricity generation, excluding electricity for Green H_2

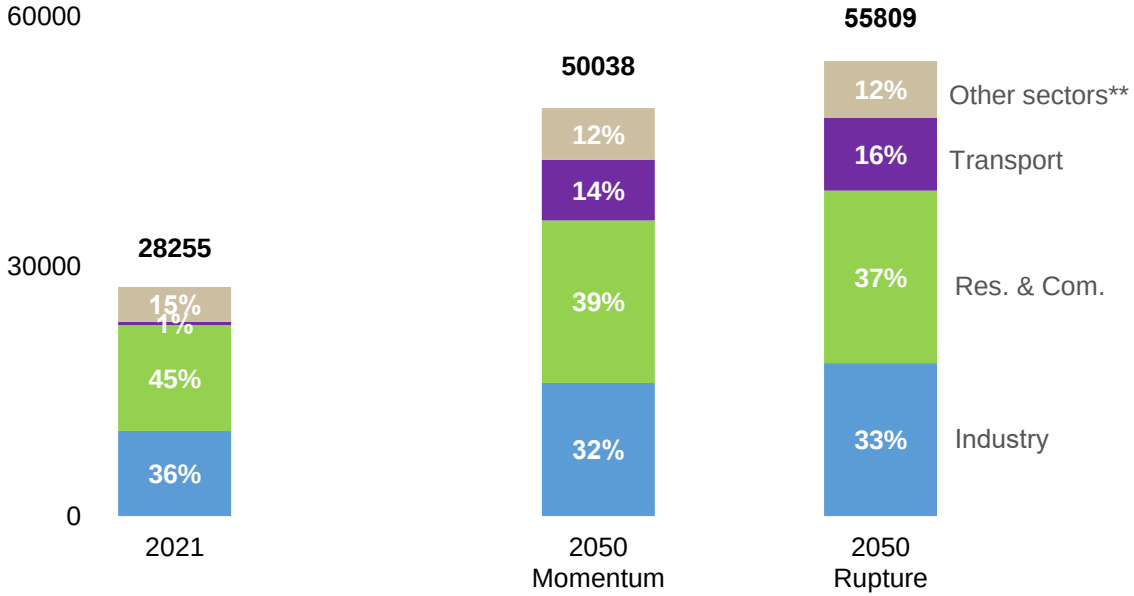
TWh



- Solar & Wind generation in Rupture 2050 ~15% larger than total electricity generation in 2021
- Coal almost disappears in Rupture, natural gas still required to manage variability of renewable energies
- Massive renewable penetration requires deployment of energy storage systems (batteries, electrolysers), flexible generation plants, and grid expansion

Electricity demand, excluding electricity for Green H_2

TWh



- Electricity demand accelerating at 2.5% p.a. to 2050 (vs. 2% p.a. in Momentum)
- Res. & Com. and Industry demand doubling by 2050 in Rupture
- Transport electricity demand in 2050 in Rupture representing almost one third of total electricity demand today

** Includes traditional use of biomass, waste, biofuels, biogas…*
*** Other energy use and agriculture*

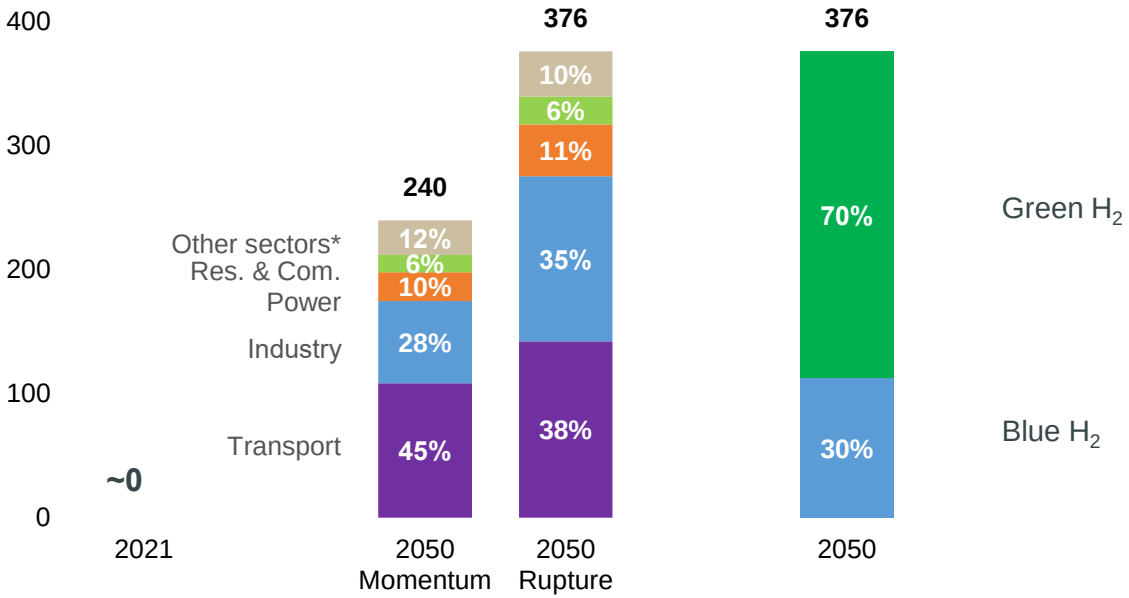
Rupture

Clean Hydrogen

Adding ~15% to natural gas and power demand in 2050

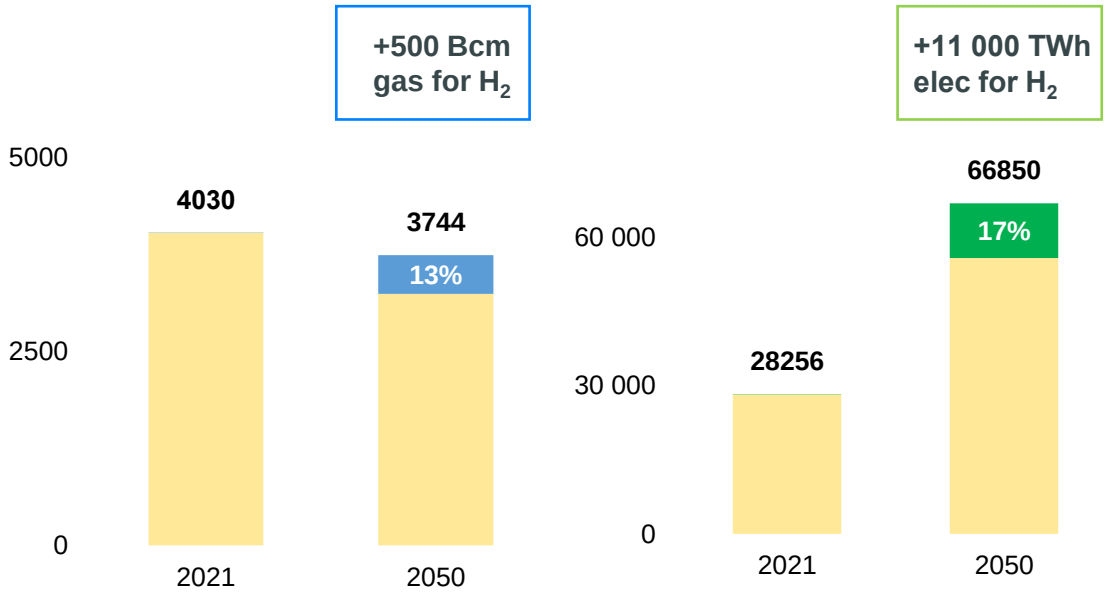
Clean H_2 balance

MtH_2



Nat Gas and Power demand by sector including H_2

Bcm & TWh



- Revised H_2 perspective since our 2022 Outlook: slow adoption before 2030 in Momentum, demand in 2050 lower by around 20% in Momentum and Rupture
- Transport & Industry are the main users of clean H_2
- Massive innovation required to improve competitiveness of H_2 and e-fuels, including in infrastructure and logistic

- Blue H_2 becomes a significant growth driver for natural gas demand starting in the 2030's, representing in 2050 more than today Europe gas demand
- Power for Green H_2 increases power demand CAGR to 2050 from 2.0%/y to 2.5%/y, representing in 2050 ~40% of today world power demand

** Other energy use, non-energy use and agriculture*

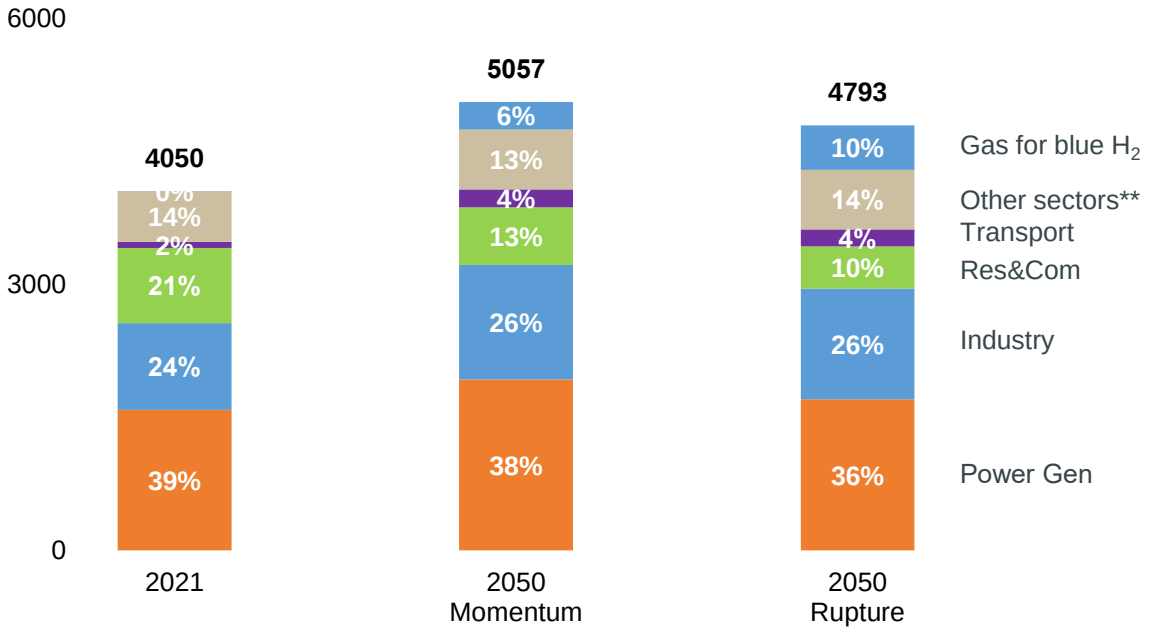
Rupture

World Gases demand

Towards low-carbon gases predominance

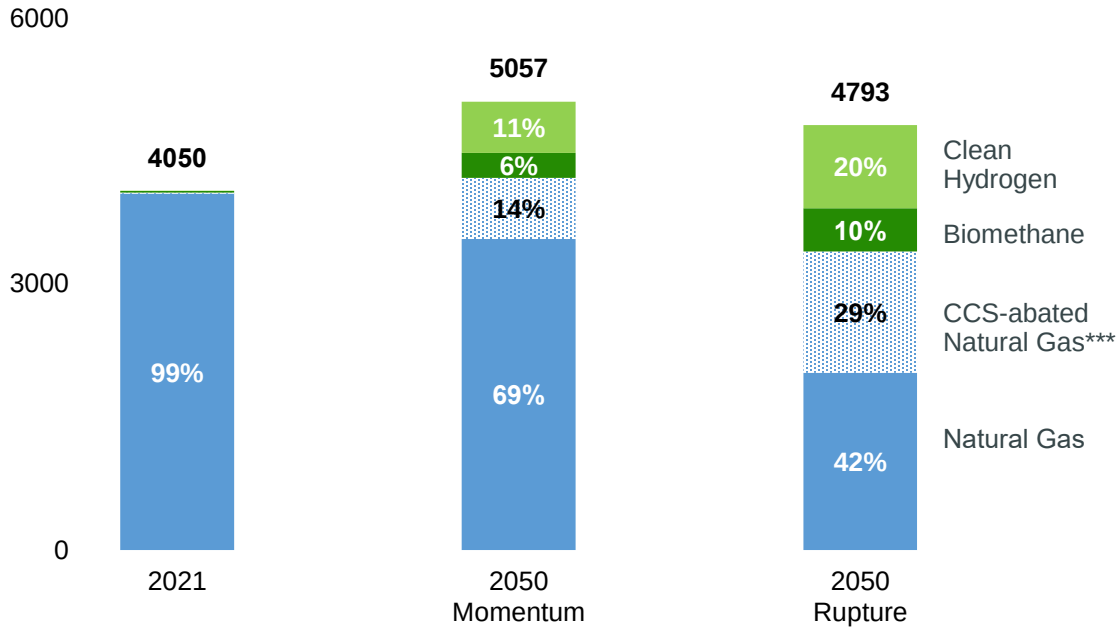
Gases demand by sector

Bcm*



Gases demand by type

Bcm*



- Natural gas keeps its role as a key transition energy in all sectors (except Res&Com) and in the production of blue H_2
- All gases combined growing ~0.6%/y to 2050 in Rupture vs ~0.8%/y in Momentum

- Green gases and CCS-abated natural gas making ~60% of world demand in 2050 in Rupture vs ~30% in Momentum

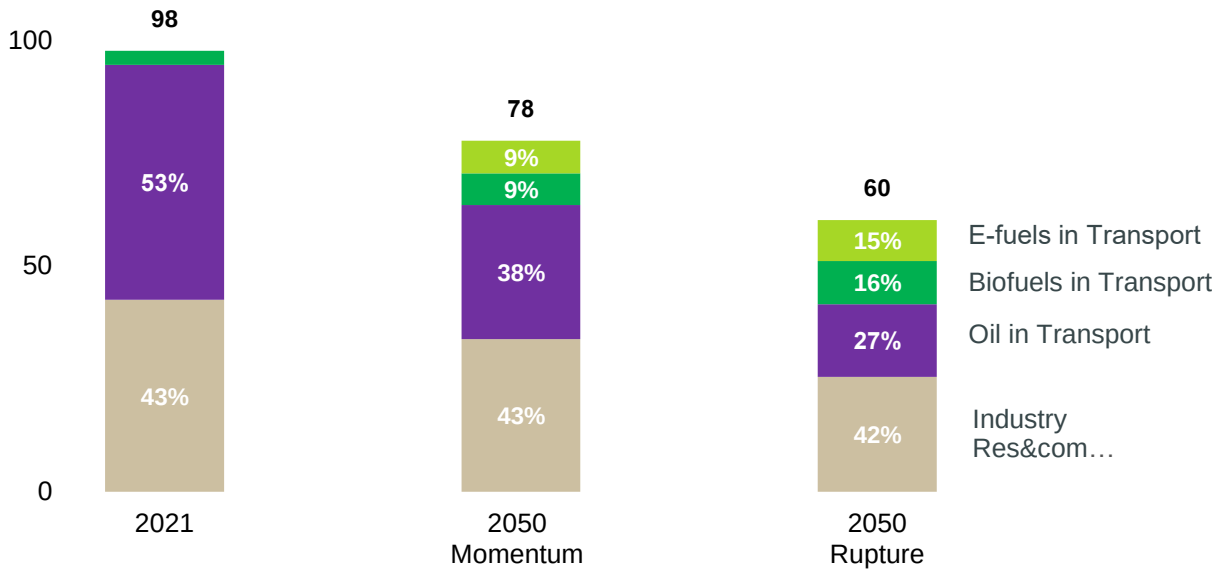
** For hydrogen: volumetric equivalence of natural gas in energy terms; H_2 supply for liquid e-fuels production is excluded*
*** Other energy use, non-energy use and agriculture*
**** CCS-abated natural gas demand excl. the portion used to produce hydrogen through SMR+CCS*

Rupture

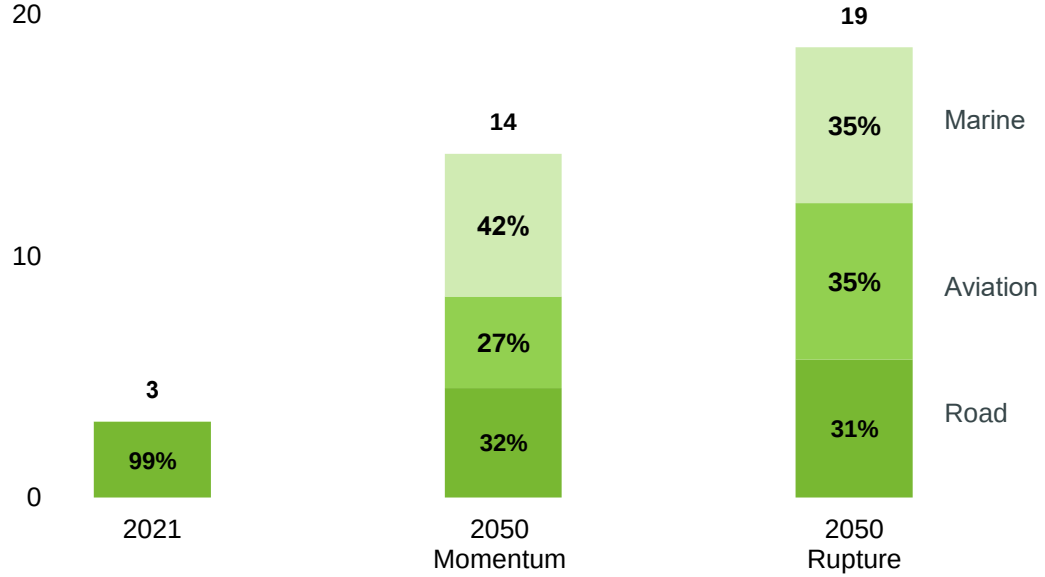
World Liquid Fuels demand

Low Carbon Fuels share will represent up to 30% of the liquids demand

Liquid Fuels (oil + biofuels + e-fuels) demand by sector
Mb/d



Biofuels + e-fuels demand in transport
Mb/d



- Oil demand plateaus until 2030, before reaching ~63 Mb/d in Momentum and ~41 Mb/d in Rupture in 2050
- Sustainable Liquid Fuels represent more than 50% of Transport liquids demand in Rupture (equally split between e-fuels and biofuels)

- Aviation and Marine segments will more than quintuple the need of Sustainable Liquid Fuels by 2050 in Rupture
- E-fuels are key for transport hard-to-abate sectors, and will require significant deployment beyond 2035 to meet long-term demand

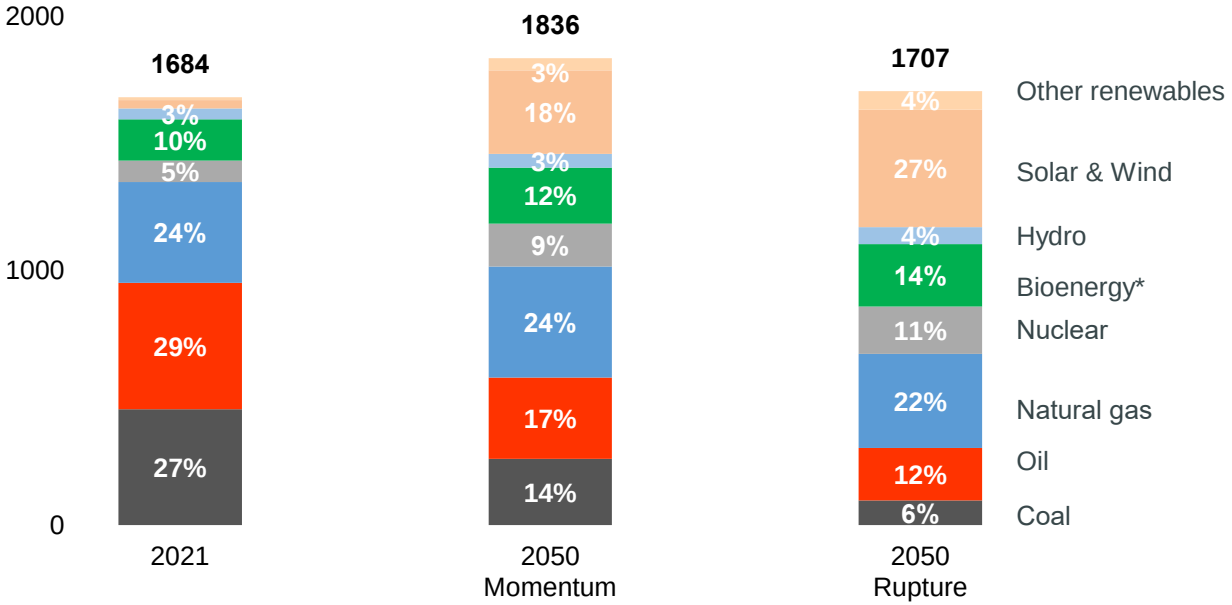
Rupture

World Primary Energy Demand

Greening the Global South enables sustainably improving living standards

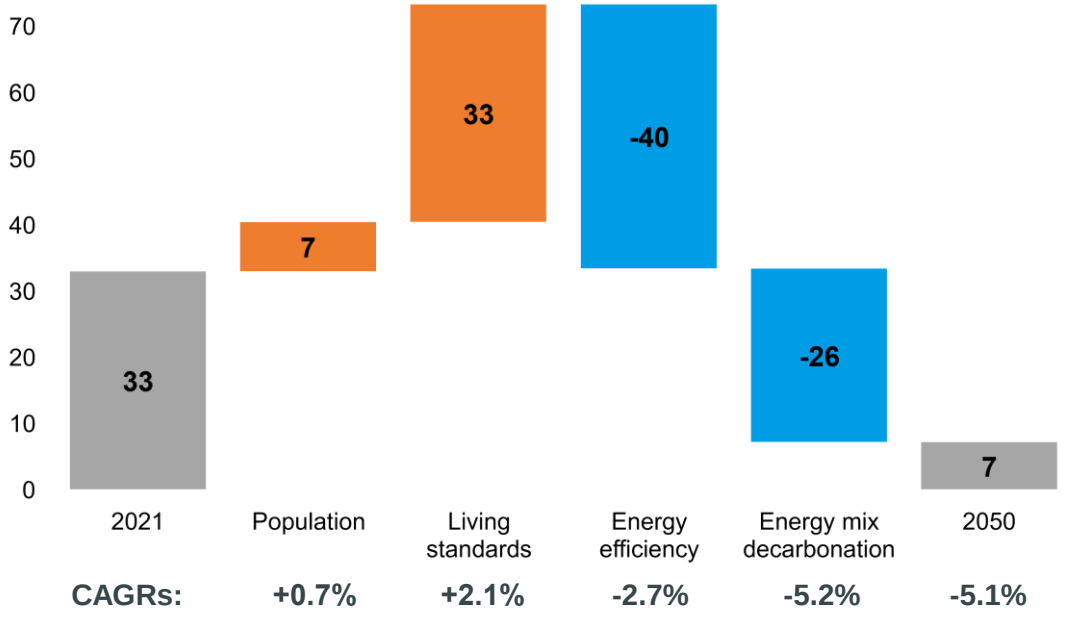
Total Primary Energy Demand

PJ/d



Changes in annual CO_2 emissions over 2021-2050 (Rupture)**

Gt CO_2



- Slight energy demand growth to 2050 in Rupture
- Natural gas use, largely abated by CCUS, remains stable (key in power, industry and for blue H_2)
- Solar & Wind demand multiplied by 15, growing to more than 25% of the primary mix by 2050

- Unabated fossil fuels share decrease in the energy mix reduces its emission intensity
- Temperature would rise by +1.7-1.8°C by 2100 (P66***)

** Includes traditional use of biomass, waste, biofuels, biogas…*

*** Living standards: GDP per capita ($/person), Energy efficiency: energy required to produce 1$ of GDP (MJ/$), energy mix decarbonization: CO2 emissions per unit of energy (gCO2/MJ)*

**** Temperature range ascertained by comparing energy-related CO_2 emissions trajectories with the IPCC AR6 scenarios.*

Rupture

World Primary Energy Demand and power generation

World primary energy demand (PJ/d)

		MOMENTUM				RUPTURE			
	2021	2030	2040	2050	CAGR 21/50	2030	2040	2050	CAGR 21/50
Coal	456	407	341	261	-1,9%	351	224	97	-5,2%
Oil	496	507	415	319	-1,5%	487	352	207	-3,0%
Natural gas	398	433	443	437	0,3%	429	409	369	-0,3%
Nuclear	84	100	127	168	2,4%	102	133	187	2,8%
Hydro	42	49	52	54	0,8%	52	60	67	1,6%
Solar	14	52	104	161	8,7%	66	161	251	10,4%
Wind	18	53	111	169	7,9%	62	134	211	8,8%
Bioenergy*	163	186	207	221	1,1%	184	213	245	1,4%
Other renewables	12	22	34	47	4,8%	30	53	73	6,4%
Total	**1684**	**1810**	**1836**	**1836**	**0,3%**	**1762**	**1738**	**1707**	**0,0%**

World power generation ('000 TWh)

		MOMENTUM				RUPTURE			
	2021	2030	2040	2050	CAGR 21/50	2030	2040	2050	CAGR 21/50
Coal	10	9	7	4	-3,0%	8	5	1	-7,5%
Oil	1	0	0	0	-3,9%	0	0	0	-6,2%
Natural gas	6	7	7	8	0,6%	7	6	6	-0,5%
Nuclear	3	3	4	6	2,4%	3	4	6	2,8%
Hydro	4	5	5	5	0,8%	5	6	7	1,6%
Solar	1	4	9	14	9,6%	6	14	22	11,1%
Wind	2	5	11	17	7,9%	6	14	21	8,8%
Bioenergy*	1	1	1	1	2,4%	1	2	2	3,7%
Other renewables	0	0	1	1	7,0%	0	0	0	-6,2%
Total	**28**	**36**	**46**	**57**	**2,5%**	**37**	**52**	**67**	**3,0%**

* Includes traditional use of biomass, waste, biofuels, biogas …

Avertissement - Propriété intellectuelle

Définition TotalEnergies / Compagnie
Les entités dans lesquelles TotalEnergies SE détient directement ou indirectement une participation sont des personnes morales distinctes et autonomes. Les termes « TotalEnergies », « compagnie TotalEnergies » et « Compagnie » qui figurent dans ce document sont utilisés pour désigner TotalEnergies SE et les entités comprises dans le périmètre de consolidation. De même, les termes « nous », « nos », « notre » peuvent également être utilisés pour faire référence à ces entités ou à leurs collaborateurs. Il ne peut être déduit de la simple utilisation de ces expressions une quelconque implication de TotalEnergies SE ni d'aucune de ses filiales dans les affaires ou la gestion d'une autre société de la compagnie TotalEnergies.

Avertissement
Cette présentation peut contenir des déclarations prospectives, au sens du Private Securities Litigation Reform Act de 1995, relatives à la situation financière, aux résultats d'exploitation, aux activités, à la stratégie et aux projets de TotalEnergies, qui sont soumis à des facteurs de risque et à des incertitudes résultant de changements dans, notamment, le développement et l'innovation technologiques, les sources d'approvisionnement, le cadre juridique, les conditions de marché, les événements politiques ou économiques. TotalEnergies n'assume aucune obligation de mettre à jour publiquement les déclarations prospectives, que ce soit en raison de nouvelles informations, d'événements futurs ou autres. De plus amples informations sur les facteurs susceptibles d'affecter les résultats financiers de la Compagnie sont fournies dans les documents déposés par TotalEnergies auprès de l'*Autorité des Marchés Financiers* et de la US Securities and Exchange Commission. En conséquence, aucune certitude ne doit être accordée à l'exactitude ou à la justesse de ces déclarations.

Propriété intellectuelle