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GEMM Insights

ENERGY SECTOR OUTLOOK

16TH EDITION

NOVEMBER 2023

Brown Energy

Transition

Sustainable energy

Green energy

Introductory Message

Dear reader,

GEMM Insights 16th edition will focus on energy sector outlook.

Energy use and improved living standards go hand in hand. You cannot have one without the other. Energy – in all its forms – enables growth and prosperity. As economies grow, as technology advances, as consumers become more environmentally aware, and as policies adapt, global energy demand will evolve to meet changing needs.

When energy is scarce or expensive, people can suffer material deprivation and economic hardship. When it is obtained in ways that fail to minimize environmental and political costs, these too can threaten human wellbeing in fundamental and pervasive ways.

The energy problem today combines these syndromes: much of the world's population has too little energy to meet basic human needs; the monetary costs of energy are rising nearly everywhere; the environmental impacts of energy supply are growing and already dominant contributors to local, regional, and global environmental problems (including air pollution, water pollution, ocean pollution, and climate change); and the sociopolitical risks of energy supply (above all the danger of conflict over oil and the links between nuclear energy and nuclear weapons) are growing too.

World demand for crude oil in 2022 was 99,57 million b/d (94,5 million b/s for 2021) and demand for natural gas was 143,76 Tcf in 2022 compared to 149 Tcf for 2021. While the International Energy Agency (IEA) projects increasing use of renewables, improved energy efficiency and a shift toward electric vehicles, oil and natural gas will continue to meet rising demand for petrochemicals and to fuel transportation by land, sea and air.

Regardless of the source of energy, demand is growing. With the global population expected to increase by about two billion over the next two decades, and with improving standards of living, it is estimated that electricity consumption will increase 50% from 2022 to 2040.

In our newsletter we will focus on the following areas:

- Global population statistics and trends
- Global energy statistics and forecasts
- Clean, Green & Renewable energy outlook.

Yours faithfully,

George M. Ioannides

Founder & CEO

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Global population statistics & trends

Global population fundamentals and economic expansion (1/2)

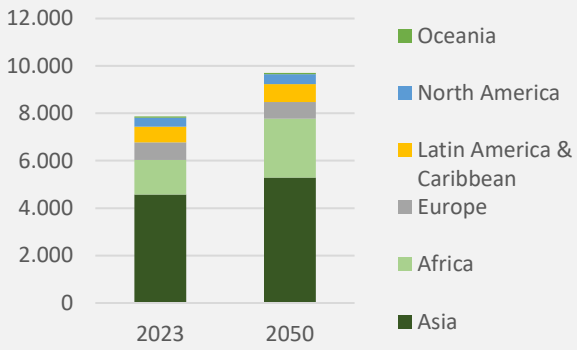
Energy is essential for human progress. Economic expansion and improving access to energy enable longer, more productive lives for the growing global population.

Currently the world population is approximately 7,8 billion and is expected to increase to 9,7 billion by 2050.

World Population per region		
	2023	**2050**
Regions	**in millions**	**in millions**
Asia	4.573	5.292
Africa	1.460	2.485
Europe	742	703
Latin America & Caribbean	664	749
North America	379	421
Oceania	46	58
Total	**7.864**	**9.708**

Source: OECD & GEMM analysis

World population by region



65% of this growth is in Africa and the Middle East, over 25% in Asia Pacific, and only around 3% in OECD countries.

Economic expansion is a key driver of energy demand. The world economy contracted in 2020 due to the COVID pandemic, then recovered in 2021 to the pre-COVID level. It is now facing significant uncertainties because of high inflation and rising global tension.

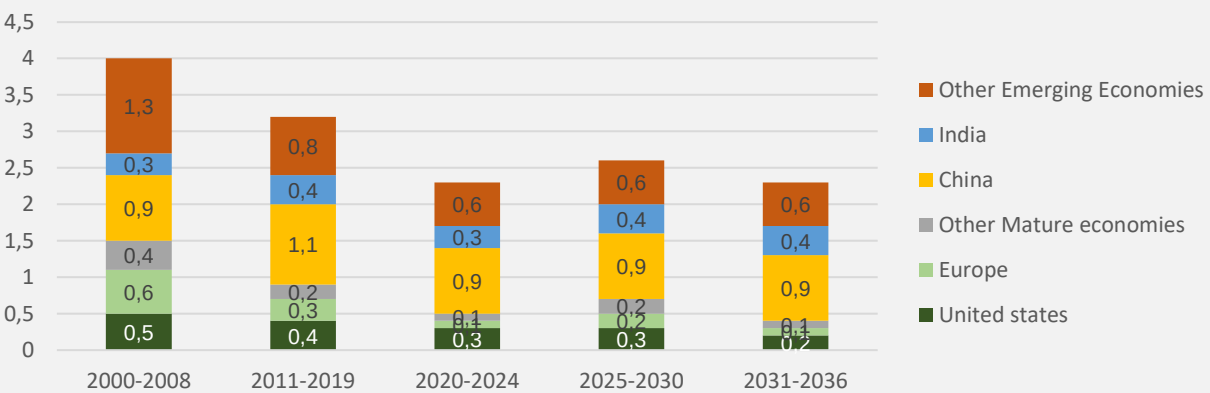
World GDP is projected to more than double from 2021 to 2050, with developing nations growing at more than twice the rate of developed countries.

By 2050, developing countries will account for almost 55% of global GDP, up from about 40% today. China's growth from 2021 to 2050 is similar to the growth of the entire developed world.

The widespread economic expansion among developing nations suggests continued robust energy demand in these economies.

The graph below illustrates that the emerging economies will remain the key global growth engine.

Regional contribution to GDP growth (average annual % change)



Source: OECD & GEMM analysis

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Global population fundamentals and economic expansion (2/2)

Access to energy enables economic progress and improves quality of life. As income grows, it enables families to own homes, purchase labour-saving appliances, pursue education, travel, and obtain needed medical treatment.

As GDP grows faster than population around the globe, average personal incomes rise everywhere, with significant country and regional variations.

By 2050, China GDP per capita is expected to more than triple to reach about 75% of all developed nations at that time.

India's per capita GDP is likely to grow even faster than China's. It will remain below the global average by 2050.

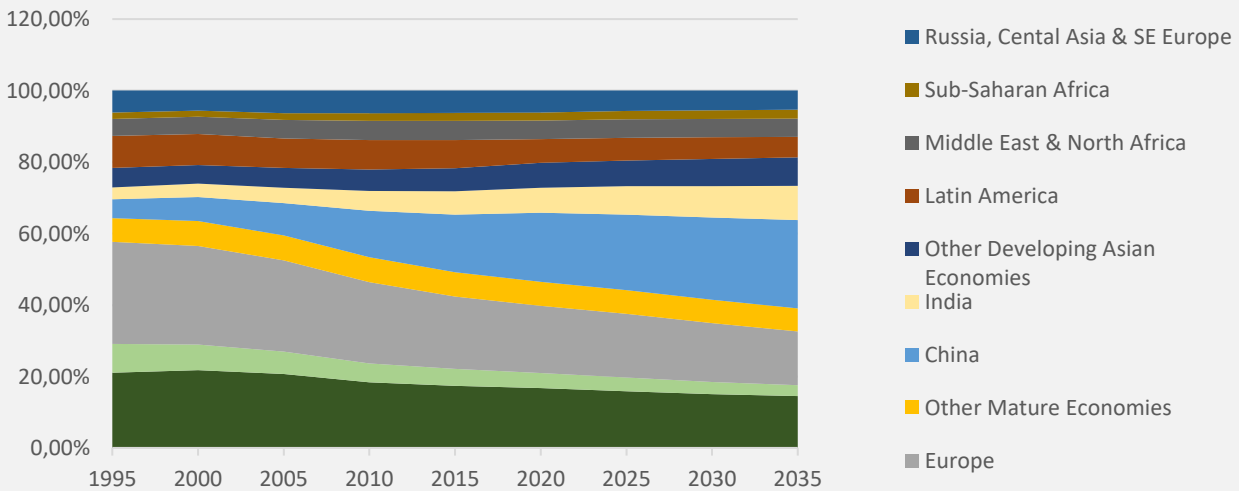
Africa per capita GDP is expected to add about 45%. Yet in 2050, it is still at around 10% of the average of developed countries.

The table and graph below illustrate that global spending power is still skewed toward mature economies.

Global GDP shares using Purchasing Power Parity									
	1995	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**
United States	21,10%	21,80%	20,70%	18,40%	17,40%	16,80%	15,90%	15,10%	14,50%
Japan	8%	7,10%	6,30%	5,30%	4,70%	4,20%	3,80%	3,40%	3,10%
Europe	28,60%	27,60%	25,50%	22,70%	20,30%	18,80%	17,80%	16,40%	15%
Other Mature Economies	6,60%	7%	7%	7%	6,80%	6,70%	6,70%	6,60%	6,50%
China	5,30%	6,70%	9%	13%	16,10%	19,30%	21,10%	23%	24,70%
India	3,30%	3,80%	4,30%	5,50%	6,50%	7%	8%	8,80%	9,60%
Other Developing Asian Economies	5,50%	5,20%	5,60%	6%	6,50%	7%	7,10%	7,60%	7,90%
Latin America	8,90%	8,70%	8,20%	8,3%	7,90%	6,60%	6,40%	6,10%	5,80%
Middle East & North Africa	4,80%	4,80%	5,20%	5%	5,30%	5,20%	5,20%	5,10%	5,10%
Sub-Saharan Africa	1,80%	1,70%	1,90%	2,20%	2,30%	2,30%	2,30%	2,40%	2,50%
Russia, Cental Asia & SE Europe	6,10%	5,60%	6,30%	6,30%	6,20%	6,10%	5,70%	5,50%	5,30%
Total	**100,00%**	**100,00%**	**100,00%**	**100,00%**	**100,00%**	**100,00%**	**100,00%**	**100,00%**	**100,00%**

Source: OECD & GEMM analysis

Global GDP share per region using PPP



Source: OECD & GEMM analysis

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Global energy statistics and forecasts

Energy Demand growth drivers

Growth drivers

A good understanding of energy demand of different sectors is an important component for energy planning and policy of a country. Energy demand depends on different socioeconomic factors such as population, urbanization, industrialization, net capital income and development of technologies.

The three main drivers of energy demand are a) consumer preferences, b) technology and c) policies.

Consumer Preferences - Demand for energy and products begins with the choices consumers make. These preferences can shift as new technology enables better options, such as lower costs and lower emissions. Consumer preferences can also be altered over time by policies that reward choices, like a carbon tax that encourages lower-emission electricity supply.

Technology - New technology enables people to do more with less. The most successful technologies often have the supporting government policies and commercial frameworks to achieve scale. A policy like tax incentives can spur development of new technology, which then needs to compete without subsidies to reach a large enough scale to impact global markets. Consumer preferences can also create a “pull effect” that increases demand in the marketplace for new technologies.

Policies - Clear and consistent government policies can stimulate new technology and influence consumer choices. For example, policies can encourage adoption of new technology (free parking for electric vehicles) or discourage the use of an existing technology (restrictions on coal-based power).

Energy demand has significant impacts on carbon emissions and system costs and is triggered by what people do in their homes, at work and when they move around. Understanding the structure of energy demand involves analysis over individual behaviours related to energy, the structure of everyday life, how practices are sequenced throughout the day and how energy demand varies in time and space. Behavioural approaches can explain how individuals react to internal and external factors . Examples include how people respond to direct feedback (via smart metres) and change the structure of their load profiles. Additionally, social practices provide a consistent framework for understanding the structure of energy demand.

Energy demand statistics (1/4)

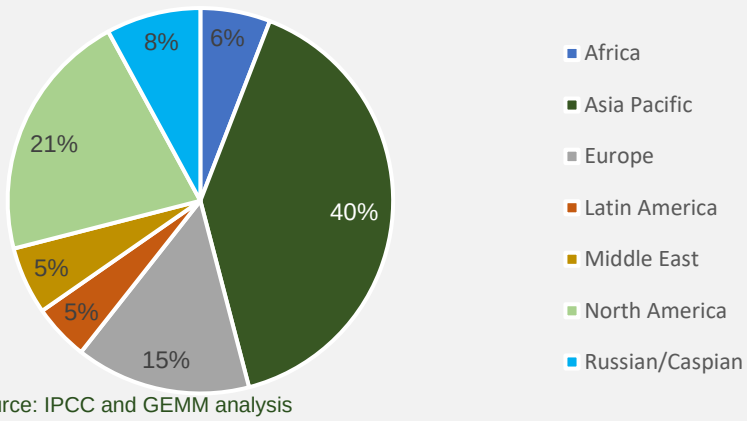
Energy demand by region

The table and graphs below illustrate the energy demand by region for the period from 2000 to 2021 and for the projected period 2030 and 2050.

Energy demand by region (quadrillion BTUs)						
	Actual				Projected	
	2000	**2010**	**2020**	**2021**	**2030**	**2050**
Africa	22	29	34	35	43	58
Asia Pacific	122	198	242	256	286	319
Europe	77	80	70	73	69	64
Latin America	19	25	25	27	30	35
Middle East	17	29	34	36	41	51
North America	111	109	102	108	109	98
Russian/Caspian	37	42	41	42	38	35
Total World	**405**	**512**	**548**	**577**	**616**	**660**
OECD	**220**	**225**	**204**	**214**	**209**	**190**
Non OECD	**185**	**287**	**344**	**363**	**407**	**470**

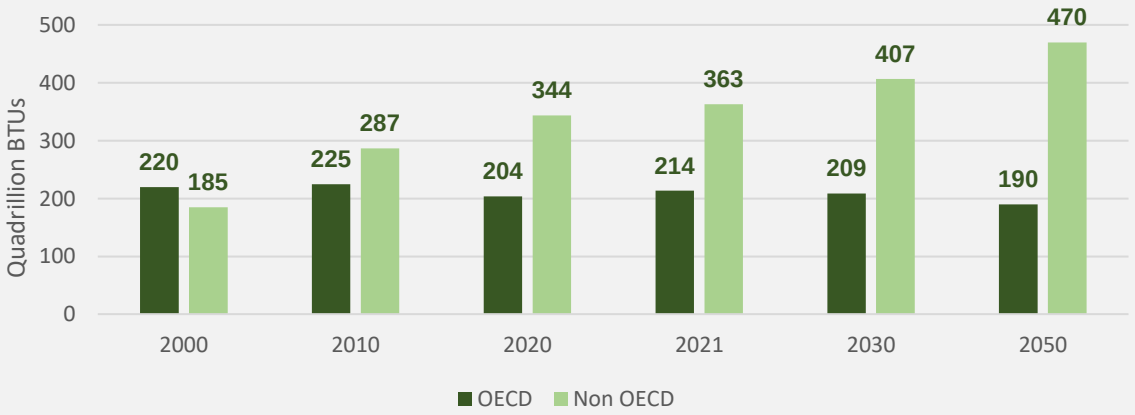
Source: IPCC and GEMM analysis

Energy demand by region (2000-2021)



Source: IPCC and GEMM analysis

World energy demand by OECD and non-OECD countries



Source: IPCC and GEMM analysis

Energy demand statistics (2/4)

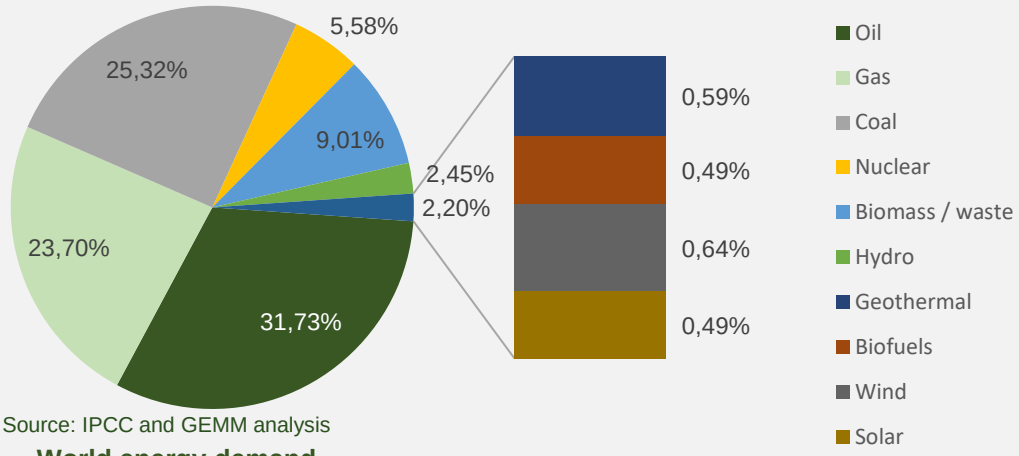
Energy demand by type

The table and graphs below illustrate the energy demand by type for the period from 2000 to 2021 and for the projected period 2030 and 2050.

Energy demand by type (quadrillion BTUs)						
	Actual				Projected	
	2000	**2010**	**2020**	**2021**	**2030**	**2050**
Oil	147	164	163	174	188	185
Gas	89	116	136	143	157	175
Coal	91	140	139	147	133	91
Nuclear	28	29	28	29	34	43
Biomass / waste	39	44	50	51	52	53
Hydro	9	13	14	14	16	19
Geothermal	2	2	4	4	5	7
Biofuels	0	2	4	4	6	17
Wind	0	1	6	6	14	37
Solar	0	1	4	5	11	33
Total	**405**	**512**	**548**	**577**	**616**	**660**

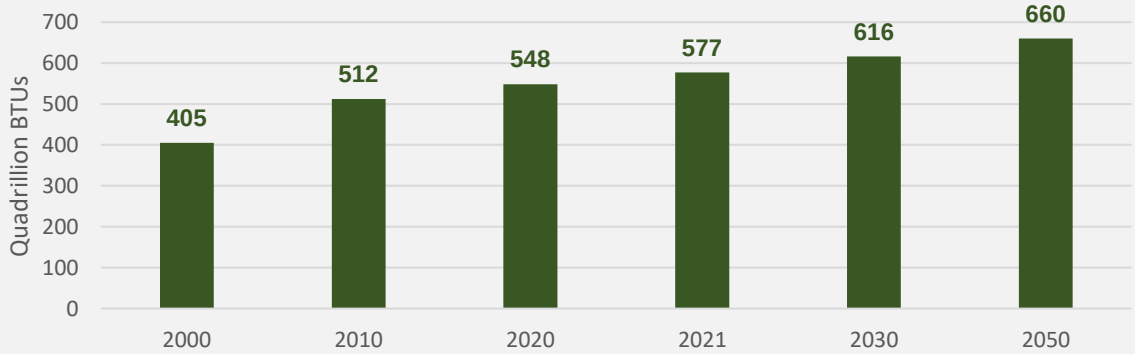
Source: IPCC and GEMM analysis

Energy demand by type (2000-2021)



Source: IPCC and GEMM analysis

World energy demand



Source: IPCC and GEMM analysis

Energy demand statistics (3/4)

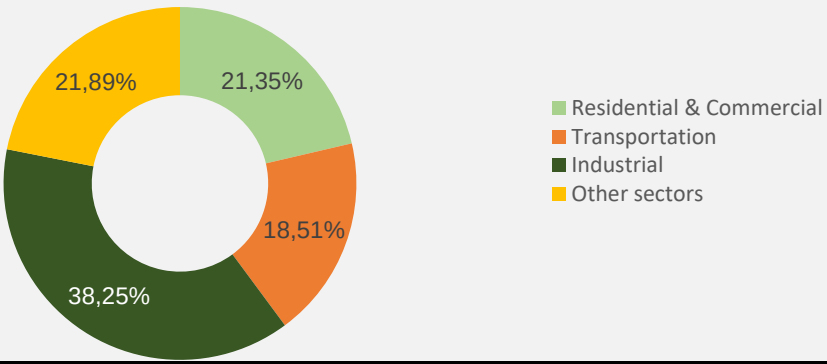
Energy demand by end use sector

The table and pie chart below illustrate the energy demand by end use sector for the period from 2000 to 2021 and for the projected period 2030 and 2050.

Energy demand by end use sector (quadrillion BTUs)						
	Actual				Projected	
	2000	2010	2020	2021	2030	2050
Residential & Commercial						
Oil	13	11	11	11	10	9
Gas	21	24	27	29	29	26
Biomass/Waste	28	28	28	28	27	24
Electricity	22	33	38	40	50	67
Other	10	11	11	12	11	11
Total	94	107	115	120	127	137
Transportation						
Oil	76	91	92	100	113	101
Biofuels	0	2	3	4	6	17
Gas	0	1	2	2	3	7
Other	1	1	1	2	5	18
Total	77	95	98	108	127	143
Industrial						
Oil	45	51	54	56	60	71
Gas	37	44	53	56	61	70
Coal	26	51	48	48	42	32
Electricity	22	31	40	43	51	69
Other	14	18	22	22	22	19
Total	144	195	217	225	236	261
Other sectors	90	115	118	124	126	119
Grand total	**405**	**512**	**548**	**577**	**616**	**660**

Source: IPCC and GEMM analysis

Energy demand by end use sector (2000-2021)



Energy demand statistics (4/4)

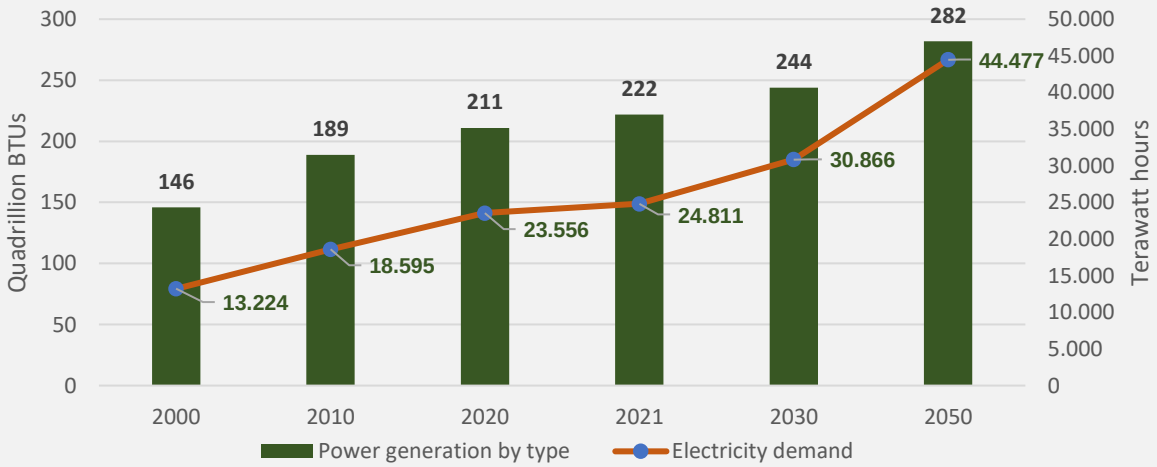
World power generation and electricity demand

The table and graphs below illustrate the world power generation and electricity demand from 2000 to 2021 and for the projected period 2030 and 2050.

World Power generation (quadrillion BTUs) & Electricity demand (terawatt hours)						
	Actual				Projected	
Power generation by type	**2000**	**2010**	**2020**	**2021**	**2030**	**2050**
Oil	14	10	6	7	5	2
Gas	31	46	54	56	63	75
Coal	61	84	87	95	88	58
Nuclear	27	29	28	29	34	43
Hydro	9	12	15	14	16	19
Wind	0	1	6	6	14	37
Solar	0	0	3	3	9	29
Other renewables	4	7	12	12	15	19
Total	**146**	**189**	**211**	**222**	**244**	**282**
Electricity demand						
World	**13.224**	**18.595**	**23.556**	**24.811**	**30.866**	**44.477**

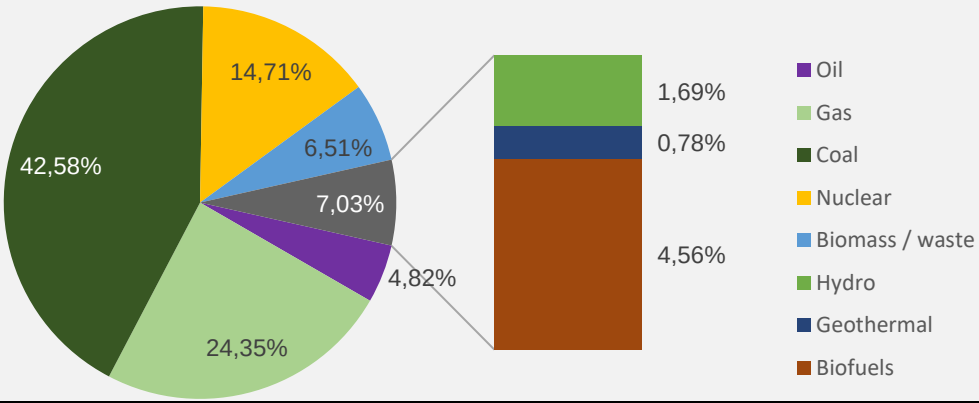
Source: IPCC and GEMM analysis

World power generation & electricity demand



Source: IPCC and GEMM analysis

World power generation by type of energy (2000-2021)



Energy supply statistics (1/3)

General overview

Whilst 2022 saw energy demand continue to recover from the COVID-19 pandemic, legacy supply chain issues, along with conflict in Ukraine, continued to impact the global energy sector.

In our analysis we will review the historic development in the production and price evolution of the following sources of energy:

- Oil
- Oil Liquids
- Natural Gas
- Coal
- Renewable energy

Oil supply

Global oil production increased by 3.8 million b/d in 2022, with OPEC+ accounting for more than 60% of the increase. Among all countries, Saudi Arabia (1,18 million b/d) and the US (1,09 million b/d), saw the largest increases. Nigeria reported the largest decline in production (184K b/d) with production in Libya declining by 181K b/d too. Refining capacity increased slightly by around 534K b/d in 2021 driven by an increase in capacity in non-OECD countries.

Brent crude oil prices averaged $101/bbl in 2022, its highest level since 2013.

Natural gas

Global gas production remained relatively constant compared to 2021. LNG supply grew 5% (26 Bcm) to 542 Bcm in 2022, similar to 2021. LNG supply increases came mostly from North America (10 Bcm) and APAC (8 Bcm). All other regions made a positive contribution to LNG supply growth in 2022 (8 Bcm).

Natural gas prices reached record levels in Europe and Asia in 2022, rising nearly threefold in Europe (TTF averaging US$37/mmBtu) and doubling in the Asian LNG spot market (JKM averaging US$34/mmBtu). US Henry Hub prices rose over 50% to average US$6.5/mmBtu in 2022 – their highest annual level since 2008.

Coal

Global coal production increased by over 7% compared to 2021, reaching a record high of 175 EJ. China, India, and Indonesia accounted for over 95% of the increase in global production.

Coal prices reached record levels in 2022, with European prices averaging US$294/tonne and the Japan CIF spot price averaging US$225/tonne (increases of 145% and 45% over 2021 respectively).

Renewable energy

Renewable power (excluding hydro) rose 14% in 2022 to reach 40.9 EJ. This was slightly below the previous year's growth rate of 16%. Solar and wind capacity continued to grow rapidly in 2022 recording a record increase of 266 GW. Solar accounted for 72% (192 GW) of the capacity additions.

The largest portion of solar and wind growth was in China accounting for about 37% and 41% of global capacity additions respectively.

Hydroelectricity generation increased by 1.1% in 2022 whilst output from nuclear fell by 4.4%.

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Energy supply statistics (2/3)

Production/generation and price evolution statistics

The table below illustrates the production/generation of energy from 2015 to 2022.

World regional energy productrion & generation								
	2015	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
North America								
Oil (million tonnes)	910,90	883,00	920,30	1.029,20	1.108,40	1.058,70	1.078,30	1.131,10
Natural Gas liquids (thousands of barrels per day)	4.194,00	4.412,00	4.659,00	5.255,00	5.726,00	6.041,00	6.265,00	6.751,00
Natural gas in billion cubic meters	949,00	936,10	955,70	1.052,90	1.129,20	1.117,20	1.154,90	1.203,90
Coal (exajules)	19,64	16,33	17,30	16,90	15,72	11,96	12,97	13,39
Renewable energy generation (terawatt-hours)	372,20	432,00	483,60	523,00	562,50	633,20	719,10	817,80
South & Central America								
Oil (million tonnes)	410,60	391,20	374,20	341,50	323,10	305,00	304,60	326,50
Natural Gas liquids (thousands of barrels per day)	411,00	389,00	414,00	379,00	378,00	342,00	323,00	325,00
Natural gas in billion cubic meters	178,00	177,90	180,90	175,40	171,80	155,30	157,50	162,00
Coal (exajules)	2,73	2,84	2,79	2,65	2,58	1,63	1,83	1,77
Renewable energy generation (terawatt-hours)	106,10	124,50	140,60	159,60	181,60	199,10	226,30	252,80
Europe								
Oil (million tonnes)	166,60	167,90	165,00	163,30	159,50	167,80	160,50	147,60
Natural Gas liquids (thousands of barrels per day)	416,00	451,00	465,00	446,00	419,00	395,00	339,00	275,00
Natural gas in billion cubic meters	260,80	259,90	262,70	251,30	234,80	218,70	211,00	220,40
Coal (exajules)	7,87	7,73	7,45	7,47	6,35	5,47	5,80	5,79
Renewable energy generation (terawatt-hours)	626,10	635,50	718,30	758,40	837,80	922,70	942,90	1.040,10
CIS								
Oil (million tonnes)	684,50	696,10	702,30	714,90	719,60	660,50	676,40	682,60
Natural Gas liquids (thousands of barrels per day)	521,00	528,00	533,00	518,00	548,00	526,00	590,00	582,00
Natural gas in billion cubic meters	754,30	755,70	799,30	841,10	857,00	809,90	891,20	805,90
Coal (exajules)	9,84	10,10	10,78	11,52	11,47	10,62	11,20	11,36
Renewable energy generation (terawatt-hours)	1,40	1,80	2,10	2,50	3,80	6,80	10,30	13,30
Middle East								
Oil (million tonnes)	1.406,20	1.493,30	1.470,30	1.484,50	1.408,30	1.294,90	1.315,90	1.441,60
Natural Gas liquids (thousands of barrels per day)	3.494,00	3.715,00	3.576,00	3.596,00	3.597,00	3.378,00	3.504,00	3.691,00
Natural gas in billion cubic meters	600,90	624,30	639,60	662,40	674,60	687,80	706,20	721,30
Coal (exajules)	0,03	0,04	0,04	0,05	0,04	0,04	0,04	0,04
Renewable energy generation (terawatt-hours)	2,30	3,70	4,70	7,20	12,10	15,70	22,40	27,00
Africa								
Oil (million tonnes)	386,40	364,90	385,50	392,60	397,30	330,70	345,30	332,30
Natural Gas liquids (thousands of barrels per day)	472,00	467,00	481,00	485,00	492,00	430,00	488,00	518,00
Natural gas in billion cubic meters	208,00	211,80	229,50	241,70	242,90	231,20	259,00	249,00
Coal (exajules)	6,33	6,32	6,47	6,62	6,47	6,21	5,93	6,00
Renewable energy generation (terawatt-hours)	19,30	23,80	27,90	33,00	40,50	45,40	48,80	50,80
Asia Pacific								
Oil (million tonnes)	399,60	383,30	368,70	360,80	361,50	353,30	348,70	345,60
Natural Gas liquids (thousands of barrels per day)	551,00	580,00	594,00	602,00	634,00	591,00	616,00	548,00
Natural gas in billion cubic meters	560,00	579,00	605,70	626,80	657,40	646,40	673,80	681,30
Coal (exajules)	115,40	110,09	112,41	119,99	124,51	122,72	124,73	136,21
Renewable energy generation (terawatt-hours)	509,70	624,40	805,10	1.005,50	1.160,90	1.323,70	1.694,80	2.002,60
Total World								
Oil (million tonnes)	**4.364,80**	**4.379,70**	**4.386,30**	**4.486,80**	**4.477,70**	**4.170,90**	**4.229,70**	**4.407,30**
Natural Gas liquids (thousands of barrels per day)	**10.059,00**	**10.542,00**	**10.722,00**	**11.281,00**	**11.794,00**	**11.703,00**	**12.125,00**	**12.690,00**
Natural gas in billion cubic meters	**3.511,00**	**3.544,70**	**3.673,40**	**3.851,60**	**3.967,70**	**3.866,50**	**4.053,60**	**4.043,80**
Coal (exajules)	**161,84**	**153,45**	**157,24**	**165,20**	**167,14**	**158,65**	**162,50**	**174,56**
Renewable energy generation (terawatt-hours)	**1.637,10**	**1.845,70**	**2.182,30**	**2.489,20**	**2.799,20**	**3.146,60**	**3.664,60**	**4.204,40**

Source: Energy Institute and GEMM analysis

Energy supply statistics (3/3)

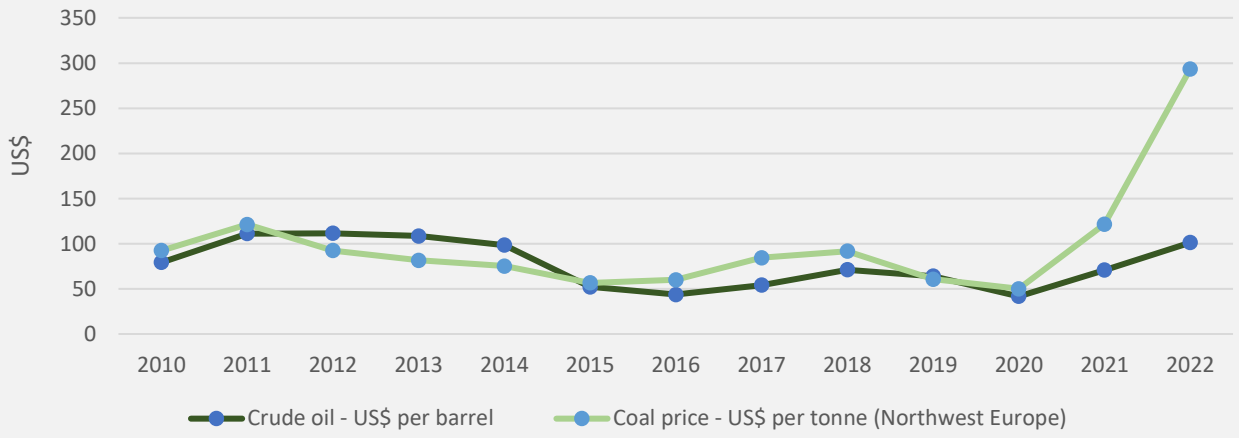
Production/generation and price evolution statistics (cont.)

The table and charts below illustrate the price evolution of selected energy commodities from 2010 to 2022

World Energy prices	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Crude oil - US$ per barrel	79,5	111,26	111,67	108,66	98,55	52,39	43,73	54,19	71,31	64,21	41,84	70,91	101,32
Liquified natural gas (LNG) - US$ per million BTU (Japan Korea Marker)	7,72	14,02	15,12	16,56	13,86	7,45	5,72	7,13	9,76	5,49	4,39	18,6	33,98
Natural gas - US$ per million BTU (Us Henry Hub)	4,39	4,01	2,76	3,71	4,35	2,6	2,46	2,96	3,12	2,51	1,99	3,84	6,45
Natural gas - US$ per million BTU (German import price)	8,03	10,49	10,93	10,73	9,11	6,72	4,93	5,62	6,64	5,03	4,06	8,94	24,17
Coal price - US$ per tonne (Northwest Europe)	92,5	121,48	92,5	81,69	75,38	56,79	60,09	84,51	91,83	60,86	50,16	121,7	293,63

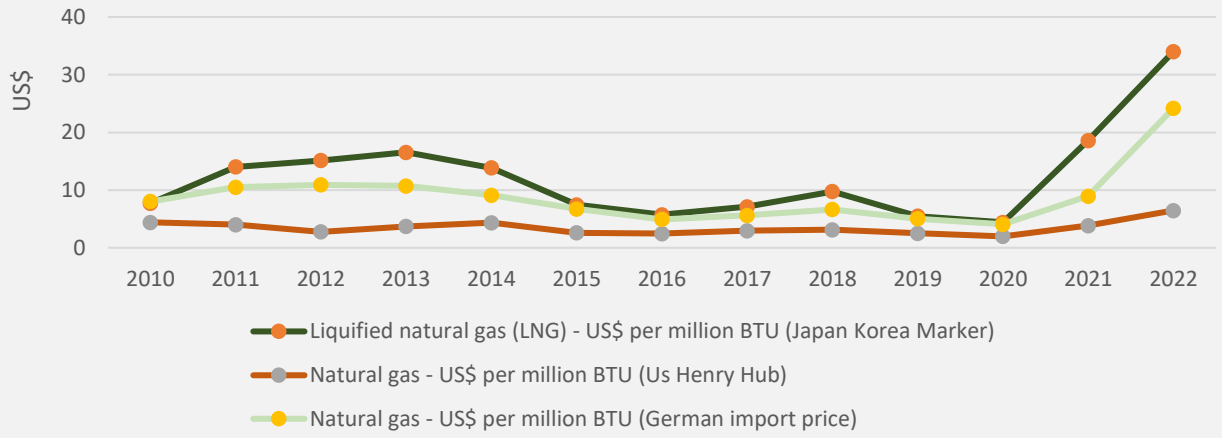
Source: energy Institute and GEMM analysis

Crude oil & Coal price price evolution (2020-2022)



Source: Energy Institute and GEMM analysis

LNG / Natural Gas price evolution (2010-2022)



Source: Energy Institute and GEMM analysis

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Clean, Green & Renewable energy outlook

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Clean, Green & Renewable energy (1/2)

General overview & statistics

In an era of accelerating change, the imperative to limit climate change and achieve sustainable growth is strengthening the momentum of the global energy transformation. The rapid decline in renewable energy costs, improving energy efficiency, widespread electrification, increasingly "smart" technologies, continual technological breakthroughs and well-informed policy making all drive this shift, bringing a sustainable energy future within reach.

The current and planned policies offer a comparatively slow path, whereby the world would exhaust its energy-related "carbon budget" in under 20 years, in terms of efforts to keep the global temperate rise well below 2°C. The budget for a 1,5°C limit, meanwhile, would potentially run out in less than a decade.

The energy system, consequently, requires rapid, immediate and sustained change. The deployment of renewables must increase at least six-fold compared to the levels set out in current plans. The share of electricity in total energy use must double, with substantial electrification of transport and heat. Renewables would then make up two-thirds of energy consumption and 85% of power generation. Together with energy efficiency, this could deliver over 90% of the climate mitigation needed to maintain a 2°C limit.

The renewable energy generation from 2015 to 2022 is illustrated in the table below:

Renewable energy generation per region								
Terawatt-hours	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
North America	372,20	432,00	483,60	523,00	562,50	633,20	719,10	817,80
South & Central America	106,10	124,50	140,60	159,60	181,60	199,10	226,30	252,80
Europe	626,10	635,50	718,30	758,40	837,80	922,70	942,90	1.040,10
CIS	1,40	1,80	2,10	2,50	3,80	6,80	10,30	13,30
Middle East	2,30	3,70	4,70	7,20	12,10	15,70	22,40	27,00
Africa	19,30	23,80	27,90	33,00	40,50	45,40	48,80	50,80
Asia Pacific	509,70	624,40	805,10	1.005,50	1.160,90	1.323,70	1.694,80	2.002,60
World	**1.637,10**	**1.845,70**	**2.182,30**	**2.489,20**	**2.799,20**	**3.146,60**	**3.664,60**	**4.204,40**
CARG								**12,51%**

Source: Energy Institute and GEMM analysis

In 2022 approximately 50% was generated from wind, 31% from solar and 18% from other types of renewable energy. The statistical analysis for the year 2022 is depicted in the table below:

Renewable energy generation by source per region					
Terawatt-hours	**2022**				
	Wind	**Solar**	**Other renewables**	**Total**	**% of total**
North America	497,00	231,50	89,30	817,80	19,45%
South & Central America	118,40	54,80	79,60	252,80	6,01%
Europe	554,50	246,40	239,20	1.040,10	24,74%
CIS	7,10	4,90	1,30	13,30	0,32%
Middle East	3,00	23,70	0,30	27,00	0,64%
Africa	23,90	18,20	8,70	50,80	1,21%
Asia Pacific	900,90	743,20	358,50	2.002,60	47,63%
Total World	**2.104,80**	**1.322,70**	**776,90**	**4.204,40**	
% of total	**50%**	**31%**	**18%**		

Source: Energy Institute and GEMM analysis

Clean, Green & Renewable energy (2/2)

Emissions

The reduction of energy-related CO2 emissions is at the heart of the energy transition.

Based on current policies (set out in the Reference Case), in under 20 years, cumulative energy-related emissions will exceed the carbon budget required to hold temperature increases below 2°C. Emission reductions of 470 Gt will be needed by 2050 to reduce warming to 2°C.

In 2022, the share of renewables in the global power mix increased again (+1,5 pt.) to 30%, i.e., 10 pts. above the 2010 level. The share of renewables in the power mix is historically high in countries with large hydroelectricity resources such as Brazil, Colombia, Canada, New Zealand, Sweden or Norway (over 2/3 of the electricity generated).

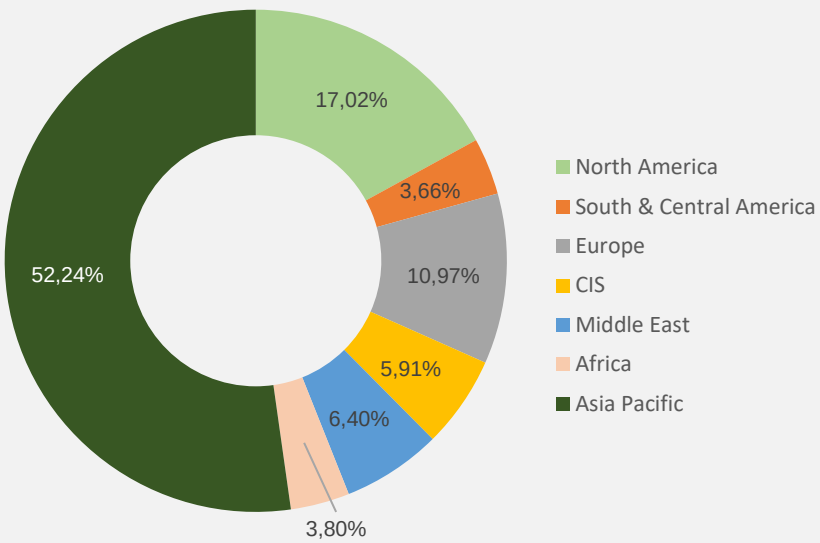
Global energy-related CO2 emissions grew by 0,9% or 321 Mt in 2022, reaching a new high of over 36,8 Gt. Following two years of exceptional oscillations in energy use and emissions, caused in part by the Covid-19 pandemic, last year's growth was much slower than 2021's rebound of more than 6%. Emissions from energy combustion increased by 423 Mt, while emissions from industrial processes decreased by 102 Mt.

The table below illustrates the carbon dioxide emission from energy for the period from 2015 to 2022

Carbon dioxide (CO2) emissions form energy								
	Millon tonned of CO2							
	2015	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
North America	6.182,70	6.075,00	6.043,60	6.193,70	6.020,40	5.380,60	5.728,40	5.851,40
South & Central America	1.356,70	1.320,90	1.310,00	1.272,30	1.244,30	1.108,60	1.247,60	1.257,90
Europe	4.212,10	4.256,30	4.304,00	4.249,30	4.077,50	3.621,30	3.845,20	3.769,80
CIS	1.995,10	2.022,90	2.026,90	2.112,30	2.092,10	1.986,00	2.142,00	2.033,00
Middle East	2.012,70	2.084,20	2.101,20	2.108,50	2.103,00	2.027,10	2.101,30	2.200,00
Africa	1.210,30	1.244,50	1.268,10	1.278,50	1.308,20	1.237,00	1.306,30	1.306,70
Asia Pacific	15.804,20	15.814,30	16.252,50	16.799,40	17.198,50	16.924,30	17.681,50	17.955,40
Total World	**32.773,80**	**32.818,10**	**33.306,30**	**34.014,00**	**34.044,00**	**32.284,90**	**34.052,30**	**34.374,20**

Source: Energy Institute and GEMM analysis

Carbon dioxide (CO2) emission per region (2022)



Source: Energy Institute and GEMM analysis

Remark:

Emissions from energy continued to rebound strongly reaching a record high of 34.3 billion tonnes of carbon dioxide representing a 0.95% increase over 2021.

Emissions from energy consumption contributed 87% of total global emissions.

Despite broad consensus on the need to reach net zero, global energy-related greenhouse gas emissions are still heading in the wrong direction.

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European Energy Directive and Strategies

General overview

The Renewable Energy Directive (Directive (EU) 2018/2001, (RED II)), which is part of the EU's Green Deal Climate Law, established a common framework for the promotion of energy from renewable sources in the EU and set a binding target of 32 % for the overall share of energy from renewable sources in the EU's gross final consumption of energy in 2030. It also established sustainability and greenhouse gas emissions saving criteria for biofuels, bioliquids and biomass fuels and lays down rules on financial support to enhance the use of renewable energy usage.

In January 2020, the European Parliament adopted its resolution on the European Green Deal, emphasizing the need for more ambitious action to address climate change and meet environmental objectives. The resolution highlighted the essential role of energy in the transition to a net-zero greenhouse gas emissions economy, and particularly the importance of decarbonising the energy system.

The revised Energy Efficiency Directive (EU/2023/1791), published in the Official Journal on 20 September 2023, significantly raises the EU's ambition on energy efficiency.

The political deal reached by the European Parliament, the EU's executive Commission and EU member states includes a legally-binding target to raise the share of renewable energy in the EU's overall energy consumption to 42,5% by 2030.

The revised directive also adds targets for buildings and seeks faster permitting processes for wind and solar projects with the introduction of dedicated "acceleration areas" for renewables.

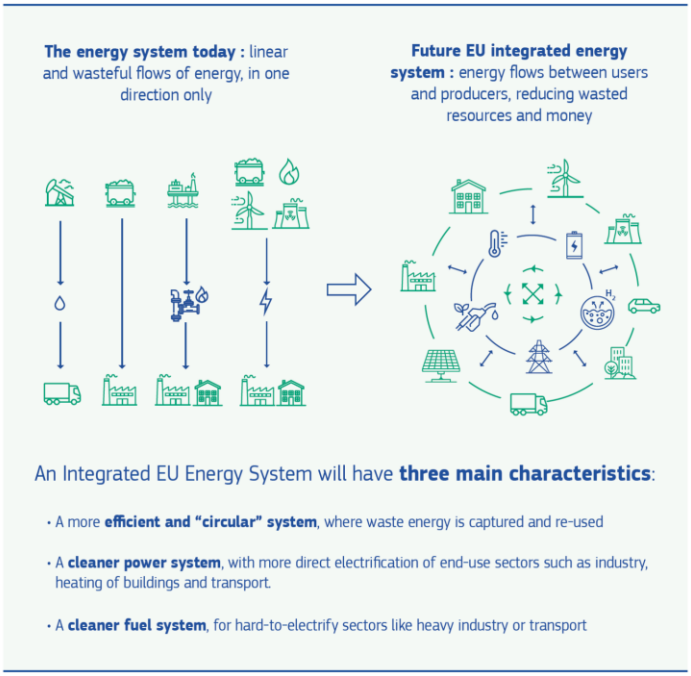
Reaching the new goals will require massive investment in wind and solar farms, scaling up production of renewable gases, and reinforcing Europe's power grids to integrate more clean energy.

The European Commission has said additional investments of 113 billion euros (US$123 billion) in renewable energy and hydrogen infrastructure will be needed by 2030, if EU countries are to end their reliance on Russian fossil fuels.

EU strategy on energy system integration

Together with the recast of the EED and the recent revisions of RED, it is also intended to increase the share of renewables in the energy mix and meet enhanced energy efficiency targets through integrated energy systems.

Sector integration means linking the various energy carriers (i.e., electricity, heat, cold, gas, liquid fuels etc.,) with the end use sectors such as buildings, transport or industry. By linking the sectors will allow the optimisation of the energy system rarher than decarbonising and making separate efficiency gains in each sector separately. The chart to the rights shows how the system is planned to be integrated.



Source: European Commission

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GEMM's tailored made solutions

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How can we help (1/2)

GEMM Business Consultants Limited portfolio of services draws on our core capabilities of research, benchmarking, modelling, analysis and strategy development to help companies determine the best way forward with precision and confidence.

Clients can rely on us to define clear, practicable solutions for their challenges and opportunities while seeking our support during their transition, ensuring they have the relevant capability and commitment to change.

Our Business and Management consultancy capabilities are briefly outlined below:

Strategy & ESG

Business valuation & appraisals

Forensic & Fraud Investigations / Expert Witness

Mergers & Acquisitions

Audit Specialist reviews

Startup advisory services

Capital advisory & Capital raising / Project & Infrastructure finance / Real Estate Solution services

Private Equity & Portfolio appraisals / External Valuers

Financial due diligence / Vendor due diligence

Restructuring & Re-organization services

For more information about GEMM Business Consultants Limited core services and capabilities please visit our website: www.gemmcy.com.

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How can we help (2/2)

GEMM has built up strong strategic partnerships with esteemed Cyprus based originations aiming to offer a full-scope services adapted to our international and local-based clients, encompassing large multinationals, banking institutions, and high-net-worth individuals. Services include, among others, Fiduciary, Company Administration, Secretarial, Accounting & Bookkeeping, Escrow, Payroll, and Fund Administration services. These include:

- Compliance advisory services (FACTA & CSR, DAC 6 & DAC 7)
- Company registration administration & secretarial services
- Banking services
- Accounting & Payroll
- Trustee services
- Fiduciary services
- Fund administration services
- Immigration services

Our credentials

Key credentials

GEMM team has completed a number of projects in the real estate, hospitality, energy sector, Healthcare, mining, manufacturing, retail, start-ups and Private Equity sectors requiring experienced advisors with extensive technical knowledge in financial feasibility studies, financial analysis, equity and portfolio valuations, market research and re-organisations & restructurings amongst others.

Details of some of our most important and key credentials are illustrated below.

Hospitality sector

Feasibility report for the development of a boutique hotel

Hospitality sector

Feasibility report for the renovation of a 5* hotel

Real Estate

Feasibility report for the development of a luxury residential complex

Private Equity

External Valuer continuous engagement for tech. start-up companies

Online Gaming

Valuation report for an online gaming start-up company

Healthcare

Feasibility report for a new Medical centre development

Healthcare

Feasibility report for an existing Hospital

Renewable Energy

Valuation of a Photovoltaic park

Mining & Recycling sector

Business plan and valuation report for a mining and recycling group of companies

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