INTERNATIONAL SOLAR ALLIANCE

WORLD SOLAR INVESTMENT REPORT 2023

Foreword

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Global investments in energy transition technologies reached $1.1 trillion in 2022, a record high. However, the current investment levels are insufficient to meet the targeted goals and need to be tripled for the rest of 2020s to achieve the net-zero target.

Global investment in the solar energy value chain has crossed the $300 billion mark in 2022, a massive increase of 36% over 2021 levels. However, this positive momentum of solar project development investment is not distributed evenly across countries. The investment is highly skewed in favor of advanced economies and China. The two regions, i.e., Asia Pacific and Europe & North America, accounted for 55% and 33% of global solar project development investment, respectively, in 2022. To achieve the economic, social, and environmental objectives set by the international community, a rapid scale-up of investments in the solar energy sector is needed, especially in emerging and developing countries.

Ongoing global energy crises present both a challenge and an opportunity for the accelerated deployment of renewable energy. Renewable energy is at the core of ensuring clean energy transition and represents an opportunity for the world to guarantee universal access through viable, reliable, and accessible sources of energy. While global investment in renewable energy, specifically, reached a record high in 2022, ~ $590 billion - it represented roughly half of clean energy sector investments.

The trend of investing in the renewable energy industry is primarily dominated by investments in the solar energy sector, driven by a strong business case and falling costs. Solar energy lies at the heart of a global energy transformation by offering an economically attractive answer to energy security and climate concerns. It has also created new opportunities for sustainable livelihoods for millions of people who lack energy access. Solar energy has progressed remarkably over the past decade to become the preferred power source for many countries. Solar sector contributed to ~52% of overall RE investments and ~12% of global investments in the energy sector in 2022.

Regarding the investor landscape, private finance significantly contributed to solar energy projects, accounting for more than 80% of total investments in 2022. More finance needs to be mobilized from public players to ensure just energy transition and inclusion, as most of the private financing is directed toward advanced economies.

The energy transition's success depends on the renewable energy sector's ability to attract unprecedented capital flows, and institutional investors can play a pivotal role in this regard. Despite managing assets worth $107 trillion, institutional investor's direct investments in renewable projects have been only 1% of their total investments between 2015 and 2020. To ensure efficient investment mobilization, cooperation between all stakeholders will significantly simplify access to climate finance.

While several different projections of investments are required to achieve net zero, one thing in common with all forecasts is the need for substantially ramping up solar energy investments. There is a need for ramping up annual investments in solar energy by up to ~200% by 2030. Most of these investments will be drawn for solar and wind technologies as they are expected to meet 70% of the electricity generation by 2050.

Through this flagship annual World Solar Investment report, ISA aims to review the investments in the solar value chain, estimate and track future capital requirements, assess the status of various finance providers, and identify innovative tools & their role in accelerating solar investments, economics driving solar investment, and investments needed to achieve net zero goals by 2050.

I congratulate the ISA team and all stakeholders for their work and support. I look forward to sharing the ISA World Solar Investment Report 2023 with the global solar community.

Abbreviations

APAC	Asia Pacific
ASEAN	Association of Southeast Asian Nations
AMER	Americas
AUM	Asset Under Management
BFRM	Blended Finance Risk Mitigation Facility
BNEF	Bloomberg New Energy Finance
BNP	Brain natriuretic peptide
BP	British Petroleum
C&I	Commercial and Industrial
CAGR	Compound Annual Growth Rate
CBI	Climate Bond Initiative
CCS	Carbon Capture Storage
CEFC	Clean Energy Finance Corporation
CEFIM	Clean Energy Finance and Investment Mobilization
CIF	Climate Investment Fund
CIP	Climate Investment Platform
CPI	Climate Policy Initiative
CRB	Climate Resilience Bond
CTF	Clean Technology Fund
DBSA	Development Bank of Southern Africa
DFI	Development Finance Institution
DISCOM	Distribution Company
DR	Democratic Republic
EIB	European Investment Bank
EMDE	Emerging Markets and Developing Economies
EMEA	Europe, Middle East, and Africa
EPE	Energy Research Office
ESG	Environmental, Social, and Governance
ETF	Exchange Traded Funds
EU	European Union

EUR	Euro
EV	Electric Vehicle
FDI	Foreign Direct Investment
FI	Financial Institution
FY	Financial Year
GCF	Green Climate Fund
GDP	Gross domestic product
GHG	Greenhouse gas
Gt	Gigaton
GW	Giga Watt
IBRD	International Bank for Reconstruction and Development
IEA	International Energy Agency
IIGCC	Institutional Investors Group on Climate Change
IPCC	Intergovernmental Panel on Climate Change
IRA	Inflation Reduction Act
IREDA	Indian Renewable Energy Development Agency Limited
IRENA	International Renewable Energy Agency
ISA	International Solar Alliance
ISGF	India Smart Grid Forum
KfW	German Development Bank
LCR	Low Carbon Climate Resilient
LUT	Lappeenranta-Lahti University of Technology
MDB	Multilateral Development Bank
MFI	Microfinance institutions
MNRE	Ministry of New and Renewable Energy
MSCI	Morgan Stanley Capital International
MSME	Micro, Small, and Medium Enterprises
MW	Mega Watt

NDB	National Development Bank
NRDC	Natural Resources Defense Council
OECD	Off-Grid Segment
OGS	Partial credit guarantee
PCG	Production Linked Incentive
PLI	Power Purchase Agreement
PPA	Public Private Partnership
PPP	Political risk guarantee
PRG	Private sector engagement
PSE	Power Sector Guarantees Project
PSGP	Photovoltaic
PV	Research and Development
R&D	Renewable Energy
RE	Renewable Energy Innovation Fund
REIF	Science-Based Targets Initiative
SBTi	Strategic Climate Funds
SCF	Sustainable Development Goals
SDG	Securities and Exchange Board of India
SEBI	Solar Energy Corporation of India
SECI	Solar Home System
SHS	Sustainability linked bonds
SLB	Transition Pathway Initiative
TPI	Tera Watt
TW	United Kingdom
UK	United Nations Development Programme
UNDP	United Nations Framework Convention on Climate Change
UNFCC	United States of America
USA	United States Dollar
USD	Viability Gap Funding
VGF	World Bank
WB	Year on Year
YoY	Potential Induced Degradation

Table of Contents

Executive Summary

The energy sector contributes around three-quarters of greenhouse gas emissions and has a key role to play in preventing the worst effects of climate change. The reduction of CO_2 emissions to a net zero level by 2050 is required to limit global warming to below 1.5 degrees Celsius, and the path to net zero emissions requires accelerated clean energy transition with immediate and large-scale deployment of available clean and efficient energy technologies across the world.

To achieve the targeted climate goals, various players including the government, financial institutions, etc. have been prioritizing clean energy sector and increasing investments in it. Global investments in energy transition technologies reached $1.1 trillion in 2022, a record high. However, the current investment levels are insufficient to meet the targeted goals and need to be tripled for the rest of 2020s to achieve the net-zero target. Moreover, policy and regulatory support are required to reduce investments made in the fossil fuel sector and divert the same towards clean energy transition.

Renewable energy (RE) is at the core of ensuring clean energy transition and represents an opportunity for the world to guarantee universal access through viable, reliable, and accessible sources of energy. The trend of investing in the RE industry is primarily dominated by investments in the solar energy sector which has seen an upward trend in the past years. Solar energy sector contributed to ~52% of overall RE investments and ~11.5% of global investments in the energy sector in 2022. Global investments in the solar energy sector surpassed the ~ $300 billion mark in 2022, registering a massive increase of 36% over 2021 levels.

Though the investments made in the solar energy sector are commendable, such investments are concentrated in select geographies. They are unevenly distributed at the regional level, with Asia Pacific region leading the way followed by Europe and North America. In 2022, Asia Pacific and Europe and North America accounted for 55% and 33% of global solar project development investment respectively. Within these regions, investments have been dominated by economies that have a mature solar PV market, such as China, United States of America (USA), Japan, Spain, Australia, Netherlands , South Korea, Brazil, Vietnam, Germany, and India. China and USA have been consistently attracting the most annual solar investments, with their combined share of about 50% of all solar investments since 2015 . Only a small fraction of global investments in the solar sector is being made in emerging and developing economies such as the Middle East and Africa, Latin America, and the Caribbean. Thus, these regions are lagging behind in the race of solar energy deployment. To accelerate global investments in solar energy, it is vital to prioritize these developing and underdeveloped regions across the world that have a huge unrealized solar potential.

With respect to the solar energy value chain, investments were dominated by solar project development, which accounted for nearly 90% of total solar investments in 2022. Segment wise, utility-scale solar segment accounted for the highest investments in solar project deployment with a share of 43% followed by residential solar segment at 39% and commercial & industrial (C&I) solar segment at 18% in 2022.

While the residential segment witnessed a record growth of more than 50% in terms of both capacity installations and investments, utility segment recorded a growth of 30% and C&I segment recorded the lowest growth of 8% over 2021. The off-grid solar segment had a record investment of $746 million in 2022, an increase of 63% over 2021. This segment has been catching interest of investors as a result of which financial commitment in the form of equity exceeded debt for the first time in 2022. The segment forms a crucial and cost-effective means for global energy access; however, access to financing continues to be a major obstacle for early stage enterprises, which needs to be addressed through low cost financing products or other innovative financial instruments to maximize business potential and advance climate and energy access goals.

Building supply chain security is essential for addressing supply chain vulnerabilities and ensuring considerable manufacturing capacity development for meeting the needs of solar capacity installations. The solar PV manufacturing capabilities have remained concentrated in select geographies, with China dominating the solar manufacturing with 80% market share across all manufacturing stages of solar PV owing to favorable policies. This geographical concentration has led to supply-demand imbalances in the PV supply chain, thereby creating potential challenges that governments need to address. New policies in the USA and India can lead to more diversified global solar PV manufacturing supply chains.

In terms of investor landscape, private finance was a major contributor to solar energy projects, accounting for more than 80% of total investments between 2015 and 2022, whereas the public sector contributed to the remaining investments during the same period. For ensuring just energy transition and inclusion, more finance needs to be mobilized from public players as most of the private financing is directed towards advanced economies. While project developers and commercial financial institutions are the main private finance providers accounting together for almost 75% of private finance for solar energy in 2022, Development Financial Institutions (DFIs) are the major source of public financing contributing to 43% of the total public finance flows. Commercial financial institutions (i.e., investment banks) continue to be key private finance providers

accounting for ~23% of total private finance in the solar sector between 2015-2022. Having said that, their investment in the solar sector is significantly lower than that in fossil fuels. Major global banks are not contributing in the way desired for achieving climate targets as only 7% of their financing for energy companies were directed to renewables between 2016 and 2022. While investments in the solar energy sector by 60 global major banks fell by 52% in 2022, their investment in the fossil fuel sector was reduced by only 17%. Though banks have been talking about contributing significantly to clean energy space, the numbers don't reflect the same, and they need to come up with strong clean energy transition commitments.

The success of energy transition depends on RE sector's ability to attract unprecedented capital flows, and institutional investors can play a pivotal role in this regard. Despite managing assets worth $107 trillion, institutional investors' direct investments in RE projects have been only 1% of their total investments between 2015 and 2020.

Activation of large pools of underutilized capital from institutional investors is necessary to transition to a more sustainable and low-carbon economy, and policymakers and governments have a critical role to play in achieving the same.

Despite the need to align investments with the Paris Agreement climate goals, fossil fuel companies have continued to attract substantial amounts of financing. It is estimated that $570 billion will be spent on new oil and gas development and exploration every year till 2030. In addition to direct investments in fossil fuel assets, the fossil fuel industry continues to receive large amounts of subsidies as well. In 2022, subsidies worldwide for fossil fuel consumption for different end-use applications skyrocketed to more than $1 trillion. The subsidies are mainly concentrated in emerging markets and developing economies, and more than half were in fossil-fuel exporting countries. With directed policy and regulatory intervention, shifting of subsidies from fossil fuel to solar energy would not only help the fossil fuel-based economies in their clean energy transition but also help them achieve energy security.

For meeting the net zero target by mid-century, there is a need to increase current investment levels in solar energy sector under different scenarios as forecasted by various studies. By 2050, almost 90% of electricity generation is estimated to be from RE sources, with solar and wind together accounting for nearly 70%. To meet the goals for annual capacity addition, a wide range of annual investment flows have been projected under various scenarios, including an increase from the current level of ~ $300 billion to ~$505 billion in 2030 and a cumulative increase of ~$10 trillion from 2030 to 2050.

As we move closer to our net-zero goals and expand solar installations around the globe, it is crucial to ensure that investments grow swiftly and are allocated fairly among different countries. This would encourage companies to build capacities in a geographically distributed manner and reduce their reliance on one country or region. There are multiple ways to mobilize investments in developing and emerging regions while aiming for an equitable distribution of resources. Private sector investment flows can be boosted by increasing banking regulations, building up a strong securities market, and enhancing policies that are favorable to economic growth. Government funding can play an important role in increasing public financing and the same can be utilized in reducing risks for private investors, thereby creating an environment for just and inclusive RE transition.

Financial innovation is another important aspect that is essential for rapid deployment of RE sources across the world. Traditional approaches to financing green energy projects, especially in developing and emerging countries, suffer from many challenges, including high direct costs, small ticket sizes, lack of buyer confidence, poor state banking, and complex paperwork, etc. Solar financing can be enabled in such regions by implementing innovative financing tools. Sustainable financing instruments such as Environmental, Social and Governance (ESG) funds, green bonds, etc. hold great potential for channelizing considerable capital into energy transition–related technologies, including solar energy. Additionally, there is also an increase in adoption of blended financing mechanisms comprising a mix of debt, equity, grants, and risk mitigation instruments that address the issue of high cost of capital in emerging and developing economies. More innovative financing options are expected to come up as the solar industry grows with time.

To ensure an efficient mobilization of investments, cooperation between all stakeholders will play a significant role. There is a need for a collaborative platform and centralized approach to mobilize investments through grouping of all stakeholders including developers, financial institutions, private sector as well as government. The platform can be leveraged to learn from the practices and approaches adopted by other countries that have had successful solar journeys in recent times which would also help other countries in solar deployment.

Through this flagship report, International Solar Alliance (ISA) seeks to closely monitor and analyze investment trends in the solar industry that can contribute towards large-scale deployment of solar energy. The report is divided into following five broad chapters:

Chapter 2 provides an overview of global energy investment trends, the challenges prevalent in mobilizing clean energy investments, and some mitigation measures for making the clean energy transition more inclusive

Chapter 3 takes a deep dive into the investments made in the solar sector

Chapter 4 talks about the investments required in the solar sector to achieve net-zero target provided by different organizations and concentration of investment in select regions

Chapter 5 highlights innovative tools and enablers that can accelerate

Chapter 6 highlights the interventions required for creating an enabling environment for accelerating solar sector investments

The data on solar energy investments included in this report has been taken from a variety of available sources, which at times may present significant differences. Secondary research was conducted to understand the key developments around the solar sector. To carry out the secondary research activities, a range of reputed databases and reports have been reviewed and analyzed. The sources include ISA, BloombergNEF (BNEF), International Renewable Agency (IRENA), International Energy Agency (IEA), Climate Policy Initiative (CPI), etc. among others. The detailed analysis is based on the available data that can help governments, policymakers, financial institutions, and developers to gain a sense of the current RE and solar sector financing landscape and thereafter take necessary actions to accelerate solar adoption and transition to cleaner energy.

REPORT SNAPSHOT 2023

Investments in the global energy sector touched

$2.6

trillion in 2022.

2021 → 2022 (13.5%)

Solar accounts for

$308

billion, a tiny

11.5%

of overall **energy investment** in **2022.**

Investments in renewables accounted for nearly

53%

($596 billion) of the global power sector investments in 2022, with solar energy share of

52%

($308 billion) in renewables.

Global solar energy investments in the last 5 years accelerate at a CAGR of

15%

55%

of the global solar investment comes from the APAC region

To meet projections under different scenarios **solar installation capacities** are to be scaled as high as **~1TW for the rest of 2020s**.

ZERO EMISSION

Solar investment needs to be increased by **2X** to meet **net – zero goals.**

2X Investment

Utility segment leads the solar energy value chain accounting for

~43%

investment.

Global **off-grid solar** segment had a record investment of

$746

million in 2022.

The **global installed solar** PV capacity **in 2030** would need to increase by

8X,

compared to the **2020** capacity.

Oil and gas companies contributed to only

4%

of renewable energy investment.

2.10%

World's largest 60 banks direct just

3.5%

of their total finances toward the solar sector.

60 largest banks continued to finance fossil fuel companies to the tune of

$669

billion in 2022 alone.

Global Investments in Energy Sector

In an era defined by rising concerns over increasing carbon dioxide emissions and impact of climate change, the transition towards clean energy sources has become a necessity for the entire world. The last few years have witnessed extreme disruption in the energy sector.

The COVID-19 pandemic and Russia-Ukraine war are some of the events of the recent past that have led to global energy crisis and supply chain constraints and realization of the need for energy security and self-reliance. These factors have ultimately provided a major boost to investments in clean energy for future security and sustainability of the energy sector.

In 2022, the investments in global energy transition reached an all-time high at $1.1 trillion[1] , an increase of 31% over the previous year. Six countries (Paraguay, Bhutan, Iceland, Lesotho, Nepal, Congo DR) were able to produce 100% renewable electricity in 2022. Yet the pace is slow, and the investments need to be increased by almost 4 times to achieve energy transition in line with the 1.5°C scenario. As per IEA estimates, global energy-related CO_2 emissions that are currently at the levels of ~37 Gigaton (Gt) need to be reduced to around 21 Gt by 2030 and to net-zero by 2050. The same can be enabled by an energy mix that is dominated by renewables and other non-CO_2 emitting technologies. The share of renewables in the total electricity generation globally would need to rise from ~29% in 2020 to ~90% by 2050[2] . According to IRENA and BNEF, worldwide investment in clean energy transition technologies would require an investment of over $5.7 trillion and $4.5 trillion respectively per annum till 2030 to meet the 1.5°C climate target[3],[4]. This will require a substantial rise in public and private sector investments and the emergence of new financial mechanisms to aid in the energy transition, along with planned and conscious phase out of investments in conventional sources of energy.

1 Energy Transition Investment Trends 2023, BNEF
2 IEA Net Zero by 2050 - A Roadmap for the Global Energy Sector
3 BNEF New Energy Outlook 2022
4 IRENA World Energy Transition- 1.5o C Pathway 2022

1.1 Energy investment overview

1.1.1 Global energy investments have increased at an average of ~2% over the last 8 years with fossil fuels still receiving a major share at nearly a trillion dollars annually

Investment in the global energy sector reached $2.6 trillion in 2022, up 13.5 percent over the preceding year. Between 2015-2022, overall investment in the energy sector has remained stagnant, increasing at an average rate of 2%. The overall energy investments were led by investments in the power sector, accounting for just over 41%. This was followed by investment in fuels at 35%, of which 98% is attributable to fossil fuels, and just over 2% to clean fuels. Investment in the power sector has increased (29% growth since 2015), driven mainly by investments in renewable energy and electricity network. Investments in energy end use and energy efficiency have grown by 57% since 2015 making it the fastest-growing sector. Although fossil fuels[5] investments have declined by 21% during the 2015-2022 period, but they are on the rise since 2020.

Clean energy investments have been boosted by a variety of factors, including improved economics, high and volatile fossil fuel prices, enhanced policy support, strong alignment of climate and energy security goals among nations, and a focus on strengthening clean energy economy. This momentum has been led by renewable power and electric vehicles, with important contributions from other areas such as batteries, heat pumps, and nuclear power. Consumers are also investing more in electrified end uses.

According to the IEA projections, investment in the energy sector in 2023 is expected to grow by 6.5%, resulting in a total investment of ~$2.8 trillion. More than $1.7 trillion is expected to be invested in clean energy, including renewable power, nuclear, grids, storage, low emission fuels(liquid and gaseous bioenergy and low-emission hydrogen-based fuel), efficiency improvements and end use renewables and electrification, as compared to slightly over $1 trillion in fossil fuel supply and power, of which around 15% will be in coal and the rest in oil and gas. Owing to geopolitical uncertainties and the need for energy security, investment in fossil fuels has increased after 2020 and is expected to increase to ~$970 billion by 2023.

5 Fossil Fuels include oil , gas and coal

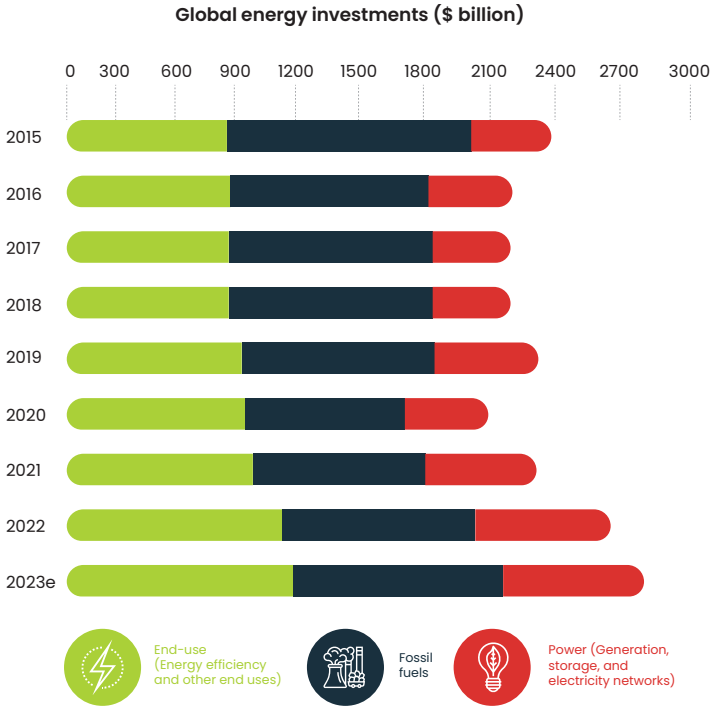


Figure 1 Global energy investments ($ billion)

Source -IEA

Key Takeaways:

- **Overall investment in the energy industry has increased by a mere 2% on an average between 2015 and 2022. While the power sector and end use sector investments have increased at an average rate of 29% and 58% respectively, investments in fossil fuels have reduced by 21% during the same period but are still high.**
- **Owing to the global energy crisis, investments in fossil fuels have been on the rise since 2020 but the need for energy security and self-reliance has led to a boost in clean energy investments and electrified end uses.**

1.1.2 Power sector investments are propelled by renewable energy technologies

Power sector investments grew by 12% in 2022, surpassing $1 trillion for the first time, with 2023 expected to see further growth to almost $1.2 trillion. Renewables and Electricity Networks[6] were the leading components of power sector investments and are expected to account for more than ~ $1 trillion in 2023. While RE investment has increased from ~$330 billion in 2015 to ~$600 billion in 2022, a growth of more than 80%, investment in coal and oil & natural gas has reduced by 60% and 25% respectively during the same period.

6 Electricity Networks include transmission and distribution

In 2022, investments in renewables accounted for nearly 54% of the global power sector investments. Thirty percent of investments in the power sector were made in electricity networks like transmission and distribution infrastructure, which had the second largest share. While fossil fuels such as coal, oil, and natural gas had 3rd highest share at ~10%, the storage sector being relatively new had a very small share of 1.8% in 2022. However, investment in the storage sector has grown by almost 80% from the preceding year seeing the need for overcoming intermittency in RE generation, supporting standalone renewable off-grid systems and providing flexibility in electricity markets and other ancillary grid services.

Within the electricity networks, global grid investments reached $274 billion in 2022, with 54% spent on upgrading distribution grids to improve digitalization, support increasing renewables integration and electrification, and the remaining on transmission infrastructure.

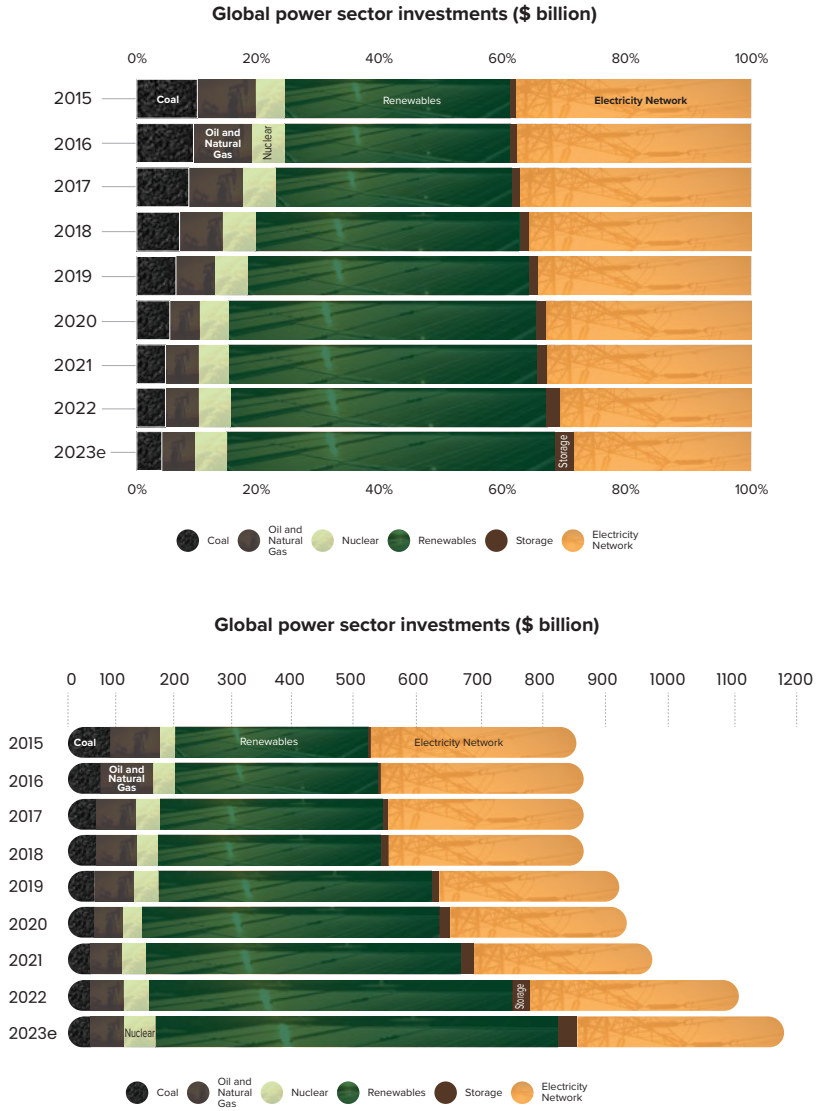


Figure 2 Global power sector investments ($ billion)

Source -IEA

Key Takeaways:

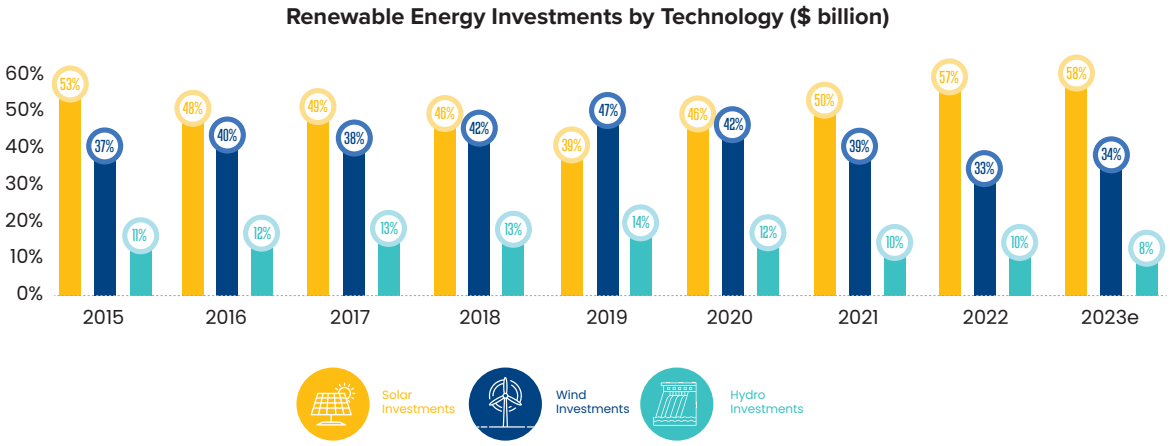
- **Total investment in the power sector exceeded $1.1 trillion in 2022 and is expected to touch $1.2 trillion in 2023, with RE technologies dominating the total power sector investments.**
- **While investments in renewables have increased in 2022 by 15%, investments in power generation by coal, oil and natural gas collectively have remained constant.**
- **To support increased RE integration and electrification, investments have also seen an upward trend in electricity networks.**
- **For addressing the challenges of intermittant RE power and supporting electricity markets, off grid RE application and other ancillary grid services, energy storage sector has seen increased investments .**

1.1.3 Owing to the technological maturity, solar energy attracts the major chunk of renewable energy investments and dominates the sector with cumulative capacity installation of ~1.2 TW in 2022, a 25% increase from 2021

RE continues to be the focus of investment in the energy sector, and within the RE sector solar energy has become one of the most attractive investments in the past years. Total solar energy installed capacity increased by 240 GW in 2022, resulting in a cumulative installed capacity of 1,185 GW. Investments in the solar sector have increased by more than 84% between 2015 and 2022, despite increased costs and supply constraints, while investments in wind and hydropower have increased by 41% and 22% respectively.

In addition, solar energy has accounted for the largest share (45-60%) of total RE investments over the last 6-7 years.

Investments in solar energy will continue to grow and are expected to top $380 billion by 2023. The major contributing factors to this solar investment trend include technological maturity and improved system performance that drove down technology cost, favorable policy and regulatory environment that worked in tandem with reduced technology risk and increased developer experience, increased manufacturing and assembling capacities, continued innovations in technologies and business models, and enhanced system integration. All these factors have increased cost competitiveness of the solar sector, thereby attracting investments from different players.



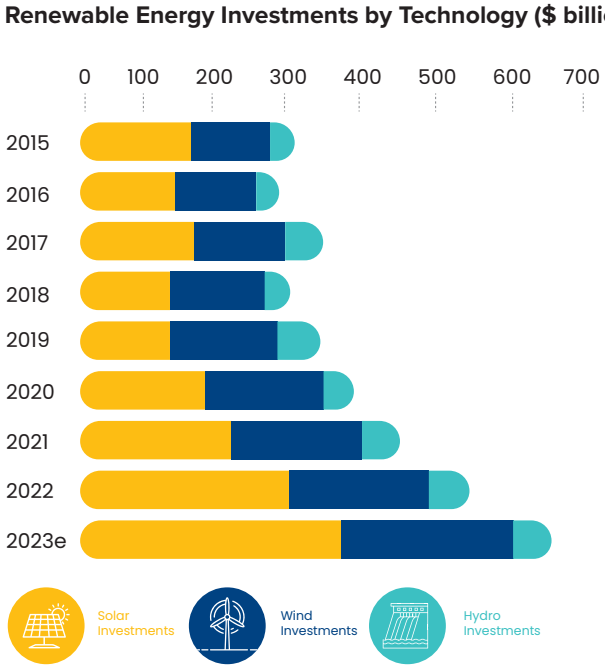


Figure 3 Renewable energy investments by technology ($ billion)

Source -IEA

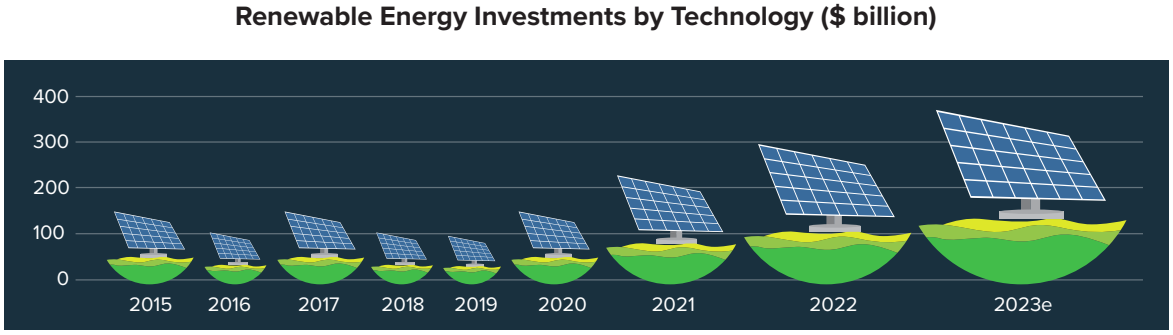


Figure 4 Investments in solar energy sector ($ billion)

Source: IEA

Key Takeaways:

- **Solar energy sector has commanded the largest share of overall RE investments (45-60%) over the last 6-7 years, due to its technological and financial maturity. Investments in the solar sector have grown over 84% between 2015 and 2022.**
- **Investments in solar energy will continue to grow and are expected to reach $380 billion in 2023.**

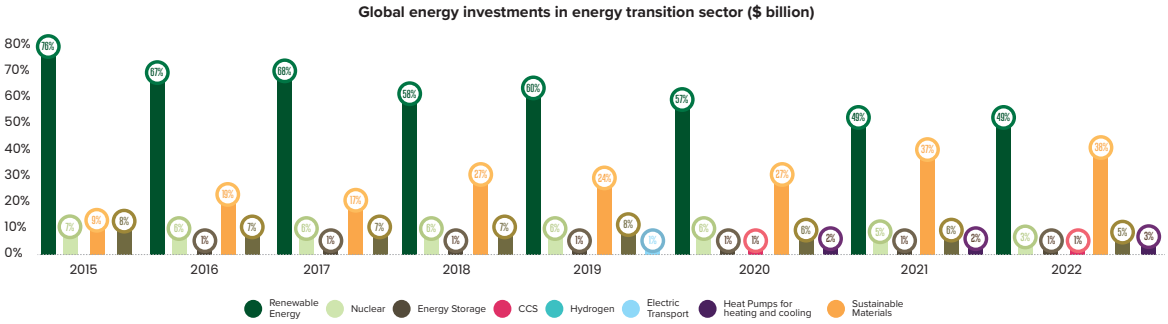
1.2 Investment in the energy transition and climate finance

Climate finance and energy transition investments cover a wide range of sectors, including renewables, energy storage, electric transport and heating, hydrogen, nuclear power, sustainable materials, and carbon capture and storage (CCS). As per the UNFCCC, climate finance refers to local, national, or transnational financing—drawn from public, private, and alternative sources of financing—that seeks to support mitigation and adaptation actions for addressing climate change. RE sector is an important component of climate financing, with solar energy being the most preferred technology option.

1.2.1 Energy transition investment hit a new record in 2022 dominated by renewable energy investment that was followed closely by investment in electric transport

Annual global investment in energy transition technologies has exceeded $1 trillion for the first time, hitting a new record level of ~ $1.1 trillion in 2022 [7]. These investments have been dominated by renewable energy, closely followed by investments in electric transport, and new investment opportunities are rapidly emerging as well. RE which includes wind, solar and other renewables, retained its position as the largest sector and achieved a new record of ~ $600 billion (up 17% year-on-year) in new project investments. Electric transport, which tracks spending on passenger electric vehicles (EVs) and charging infrastructure, is now a very close second. The sector grew to ~ $470 billion (up 54%) as the EV market continued to accelerate globally. Moreover, while investment in new technologies such as hydrogen and CCS is still low, it is likely to increase in the coming years as commercial feasibility and technical capabilities evolve.

7 Energy Transition Investment Trends 2023, BNEF



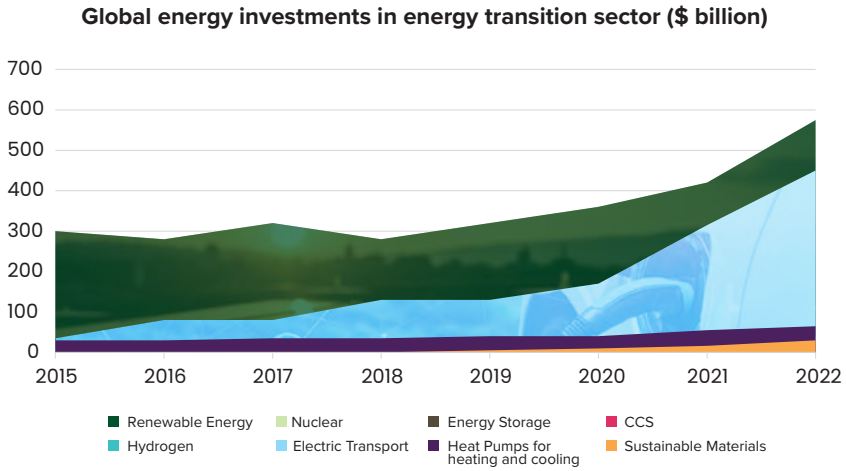


Figure 5 Global energy investments in energy transition sector ($ billion)

Source -BNEF

	2015-2022 growth	last year growth rate (2021-2022)
Renewable Energy	92%	37%
Nuclear	48%	0%
Energy Storage	1500%	45%
CCS	NA	133%
Hydrogen	NA	267%
Electric Transport	1186%	43%
Heat Pumps for Heating and cooling	117%	18%
Sustainable Materials	NA	88%

Source -BNEF

Some of the newer technologies have been briefed below:

Carbon capture and storage (CCS): Carbon capture and storage (CCS) is a method of lowering carbon emissions that might be critical in combating global warming. It is a three-step process that involves absorbing carbon dioxide produced by electricity generation or industrial activity such as steel or cement production, transporting it, and storing it deep below.

Electric transport: The term "electrification" refers to the process of replacing fossil fuel that is used to power light-duty vehicles, medium- and heavy-duty trucks, and buses with electricity. It includes home and public charging investments as well hydrogen fuel cell vehicles and refueling stations.

Heat Pumps for heating and cooling: Using heat pumps for heating and cooling is more efficient than heating and cooling with fossil fuels directly and emit no CO_2 if they use RE or nuclear electricity.

Sustainable materials: To assist the economy's overall decarbonization, material security, and environmental sustainability, circular economy concepts can prolong the circulation of materials and products throughout several lifecycles with lesser environmental impact.

Key Takeaways:

- **Annual global investment in energy transition technologies has exceeded $1 trillion for the first time, recording a 31% yearly gain.**
- **Except for investment in nuclear energy, investment in all other clean energy transition technologies have increased significantly over the last years.**
- **New technologies for the energy transition such as Hydrogen and CCS currently account for just a few billion dollars of funding but are expected to grow rapidly in coming years.**
- **Growing policy and regulatory support and the rising competitiveness of RE technologies continue to support the energy transition's rapid acceleration. While supply chain disruption and inflation have been concerns, investment in clean energy transition have held ground.**

1.2.2 Current pace of investment is insufficient to achieve the energy transition in line with the 1.5°C scenario

An increasing trend in clean energy transition technologies is a welcome achievement. Global climate finance flows have been steadily increasing in the past decade. Climate finance increased at 7% (CAGR) on an annual basis reaching $850 billion in 2021. This was driven primarily by growth in the renewable energy and transport sectors. However, the current pace of investment is not sufficient to meet the climate targets. For keeping the nations on track to achieving the energy transition in line with the 1.5°C scenario, investments must be scaled up to more than $5 trillion on average between 2023 and 2030[8]. This necessary scale-up presents significant opportunities for solar energy, since solar PV is still the cheapest option for

8 *Global Landscape of Renewable Energy Finance 2023, IRENA and CPI*

generating clean energy in many countries and has attracted investment from multiple stakeholders. The transition to clean energy by increasing the production of hydrogen, carbon capture and storage, and electric transport can be achieved by leveraging low-cost solar technologies, providing a pathway to increased adoption of solar technologies and investment in solar energy.

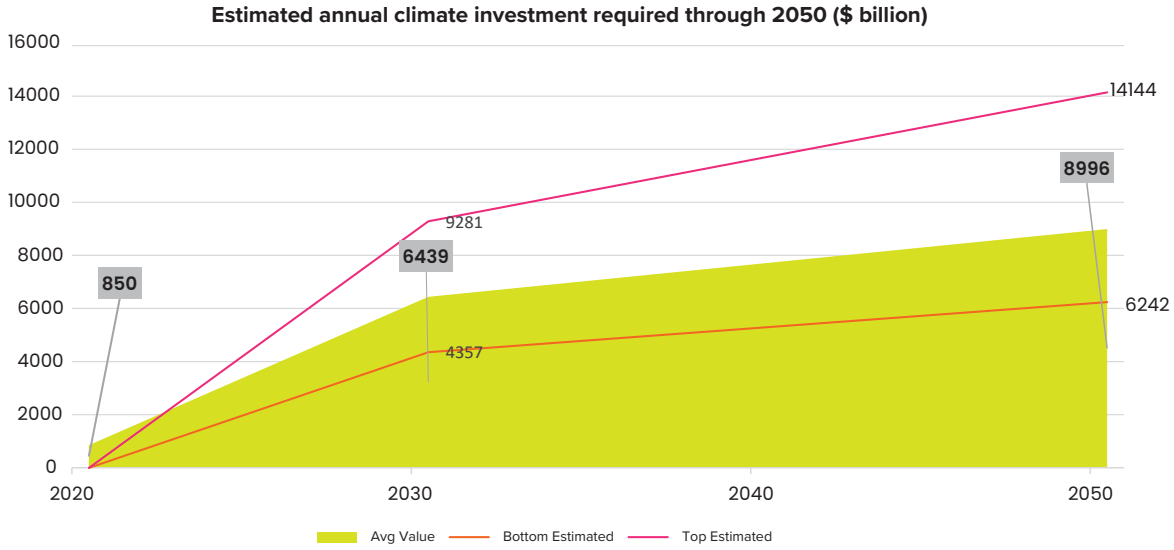


Figure 6 Estimated annual climate investment required through 2050($ billion)

Source -Climate Policy Initiative

Key Takeaways:

- At least $4.3 trillion in annual finance flows or a 20% year-on-year increase by 2030 is required to avoid the worst impacts of climate change as per the bottom estimated figures. The figures need to be increased by a minimum of ~ $6 trillion by 2050.
- Despite the seemingly dramatic scale of the funding gap, climate finance represents less than 5% of the global GDP.
- Solar energy's potential and suitability for sector coupling with other clean energy sectors such as electric transport or green hydrogen production can significantly scale up solar energy investments.

1.2.3 Challenges in clean energy investment need to be addressed for more inclusive and accelerated clean energy transition

Despite some promising developments in clean energy investments, such investments have been uneven and remain far from sufficient. Many risks have been identified that might hamper this progressive growth. With large scale integration of RE technologies, increased investment is required in technologies that provide greater flexibility to power systems. Also, there is a lack of robust supply chain systems and skilled manpower in many areas. Some of the key challenges include investments in select geographies and technologies, continued subsidies and investments in fossil fuels, and insufficient private financing.

More than 50% of the world's population, residing in developing and emerging countries, received only 15% of global investments in RE in 2022

Though RE investments are at an all-time high, these investments are mostly focused in select regions and countries. The Asia Pacific continued to receive the largest share of RE investment in 2022, a total of $340 billion, representing a 39% increase over the preceding year. China received roughly half of global RE investments, a whopping $274 billion in 2022[9] . On other hand, regions home to about 120 developing and emerging markets continued to receive comparatively much lower investments. More so, the share of RE investments to these regions has been progressively declining year on year. Countries defined as "least developed" by the Intergovernmental Panel on Climate Change (IPCC) attracted only 0.84% of RE investments on average between 2013 and 2020[10].

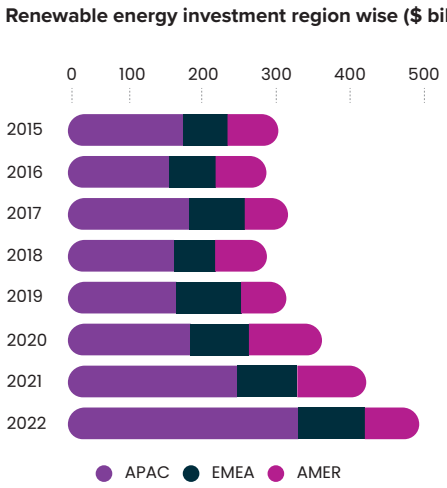


Figure 7 Renewable energy investment region wise ($ billion)
Source : BNEF

9 Energy Transition Investment Trends 2023, BNEF
10 Global Landscape of Renewable Energy Finance 2023, IRENA and CPI

Despite record investment in clean energy transition, fossil fuel investments and subsidies increased in 2022 due to rising concern about energy security

The preliminary data for investment in fossil fuels in 2022 suggest that the said investment have bounced back to almost its pre-pandemic levels as most nations have resorted to increasing their energy security. More than 40 GW of coal fired plants were approved in 2022[11]. Despite the need to align investments with the Paris Agreement climate goals, fossil fuel companies have continued to attract substantial amounts of financing. It is estimated that $570 billion will be spent on new oil and gas development and exploration every year till 2030.

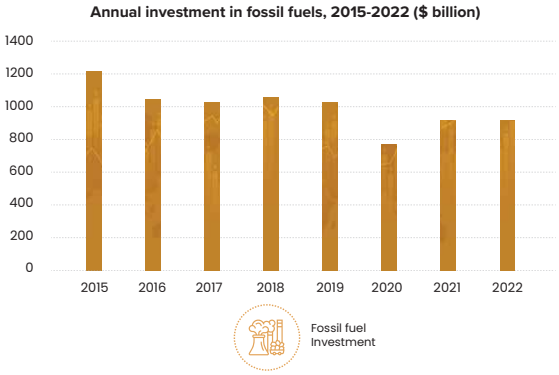


Figure 8: Annual investment in fossil fuels, 2015-2022 ($ billion)

In addition to direct investments in fossil fuel assets, the fossil fuel industry continues to receive large amounts of subsidies as well.

11 World Energy Investment 2023

Fossil fuel subsidies for electricity production from fossil fuels doubled from $200 billion in 2021 to $399 billion in 2022 and accounted for the largest share at 36%. Natural gas accounted for 2nd highest share of subsidies in fossil fuel (32%) in 2022 which grew by almost 150% over 2021, followed by oil at 31% which grew by more than 80% over 2021.

Fossil fuel consumption subsidies for different end-use applications, 2010-2022 ($ billion)

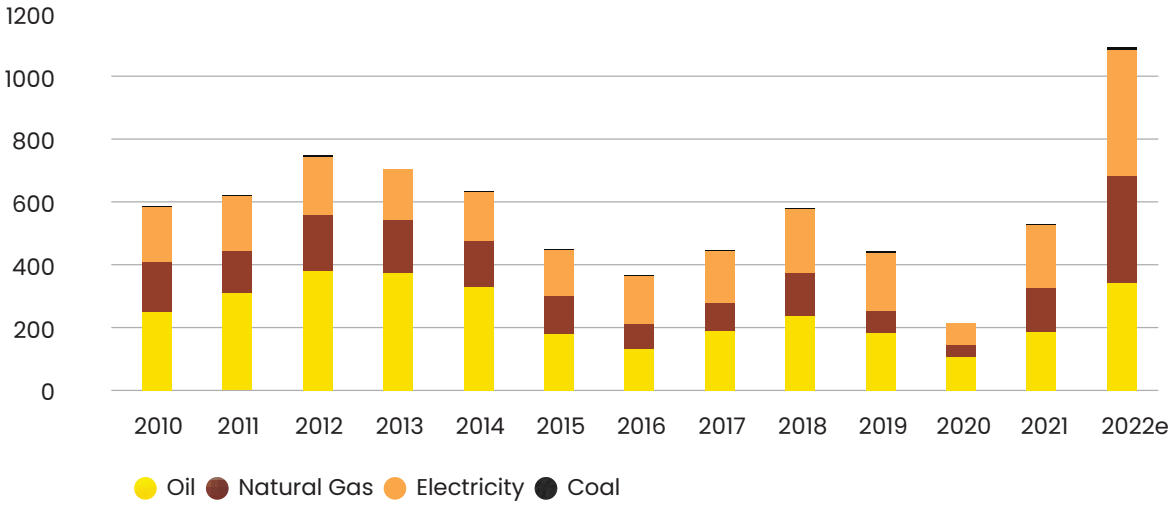


Figure 9: Fossil fuel consumption subsidies for different end-use applications, 2010-2022 ($ billion)

Source -IEA

Large multinational banks have mostly maintained their investment in fossil fuels, reducing their total fossil fuels investments by only 17% in 2022 over the preceding year

The world's largest banks continue to invest heavily in fossil fuels. The 60 biggest commercial and investment banks in the world spent $5.5 trillion on fossil fuels between 2016 and 2022[12], and continued to finance fossil fuel companies to the tune of ~$660 billion in 2022 alone. In absolute numbers, U.S. banks remained the most significant global financiers of fossil fuels with JPMorgan Chase, Citi, Wells Fargo, and Bank of America dominating the overall fossil fuel financing.

Fossil fuel investments by worlds largest banks ($ billion)

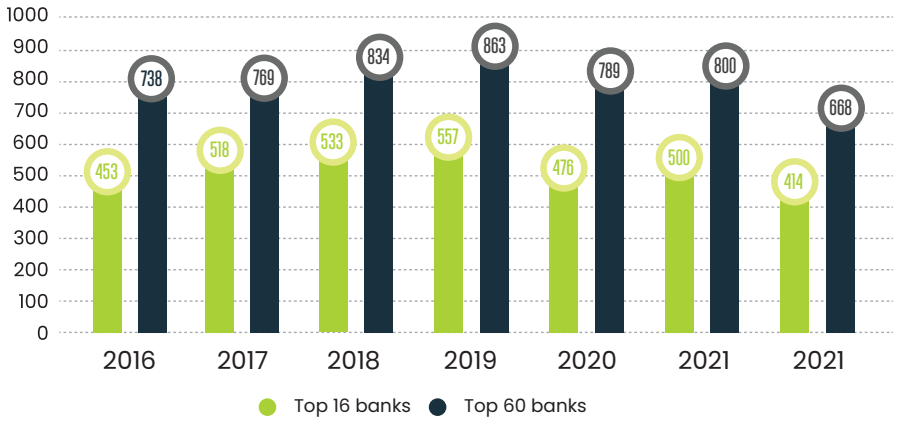


Figure 10 Fossil fuel investments by world's largest banks ($ billion)

12 Banking on Climate Chaos, Fossil Fuel Finance Report 2023

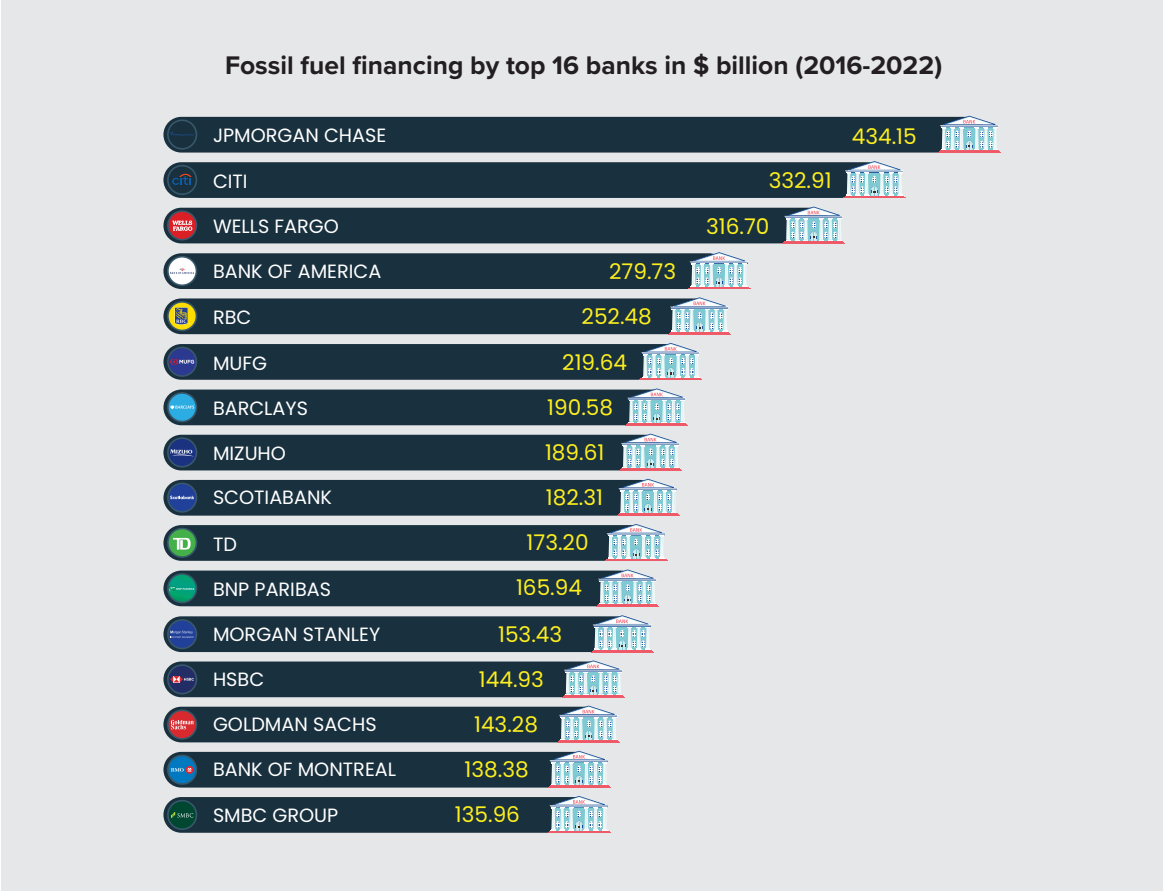


Figure 11 Fossil fuel financing by top 16 banks in $ billion (2016-2022)
Source -Fossil Fuel Financing Report

Investment in fossil fuels is driven by the entire financial sector. Hence, despite growing support for the clean energy transition, the fossil fuel industry reaps the benefits of billions of dollars in investments and subsidies each year. It is important to point out that even though present energy investments are being considered from the perspective of energy security, progress towards climate change mitigation in reducing global warming cannot be ignored.

Private actors need to step up and play a more active role in expediting clean energy transition across the globe

Private sector investment is increasing, but not at the scale and speed necessary for the clean energy transition. Moreover, these investments are primarily targeted to the technologies and countries with least risk. Private sector actors, particularly financial institutions with trillions of assets under management, are announcing commitments to net zero and sustainable finance practices. However, it is not clear how fast these commitments are translating into changes and investment on the ground. The growth rate of private climate finance was slower (4.8%) than that of the public sector (9.6%) between 2011 and 2021 and must increase rapidly at scale. There still is room for public finance to take more risks and a clearer mandate to mobilize both public and private capital, and to create enabling environments necessary for unlocking further pools of capital.

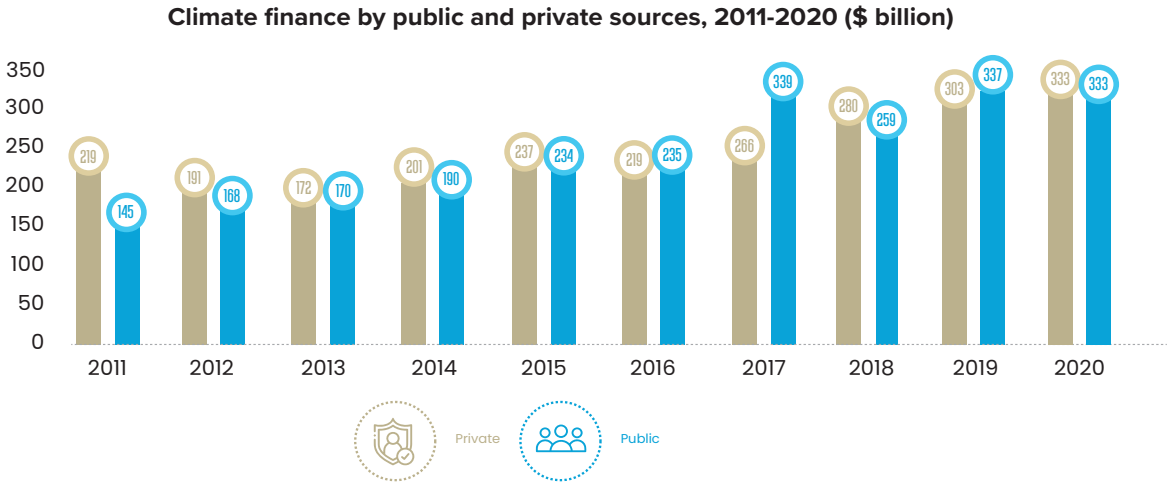


Figure 12 Climate finance by public and private sources, 2011-2020 ($ billion)

Source -Climate Policy Initiative

Key Takeaways:

- The shift of investments in fossil fuels to clean energy technologies is necessary to reach the $5–6 trillion investment needed annually for climate financing to keep global temperatures from rising.
- As per IEA estimates, global fossil fuel consumption subsidies doubled from the previous year to an all-time high of ~ $1 trillion in 2022 (up by more than 100%).
- The fossil fuel subsidies are mainly concentrated in emerging markets and developing economies, and more than half were in fossil-fuel exporting countries
- Investments in fossil fuels by the world's top 16 banks have remained strong ($400 billion -$550 billion) between 2016-2022, and banks' lending for fossil fuel expansion continues to be high. In absolute numbers, U.S. banks remain the most significant global financiers of fossil fuels.
- The public and private sectors provided $4.8 trillion in climate finance in total between 2011 -2020, with the private sector responsible for about half of the investments.
- Although private sector contributions are increasing, their CAGR was only 4.8% compared to that of public sector which was 9.6% between 2011-2021. Private institutions need to play a substantial role in the growth of clean energy sector.

1.2.4 Innovative, context-specific financing instruments and financing structures are required to address investment barriers and accelerate investments in clean energy, especially in Emerging Markets and Developing Economies (EMDEs)

Clean energy investments are highly focused in technologies and regions that are mature and are perceived as less risky, reflecting prioritization of financial returns over social, environmental, and climate related goals. This results in a large population of the world remaining underserved and devoid of reliable and clean electricity, which is a necessity. For making energy transition inclusive and accessible to all, innovative and relevant financing instruments are required that can mitigate the financing risks and help increase clean energy penetration across the world, especially in EMDEs.

Sustainable financing instruments such as ESG Funds, green bonds, etc. hold great potential for channeling considerable capital into energy transition–related technologies, including renewable energy. The sustainable funds have proved their resilience against the market conditions and have witnessed less volatility than all funds globally [13]. Fixed income offerings such as Green Bonds, Sustainability Linked Bonds (SLBs), etc. are also gaining prominence in the financing market. Additionally, there is an increase in blended financing mechanisms comprising a mix of debt, equity and grants, and risk mitigation instruments that addresses the issue of high cost of capital in EMDEs. Green Bonds, Sustainability Linked Bonds (SLBs), Exchange Traded Funds (ETFs) and Infrastructure Investment Trusts (InvITs) and blockchain as well as other financial sources can help overcome some of the barriers to investing in the sector. This will be discussed in detail in chapter 5.

Key Takeaways:

- **Active and continuous involvement of government and development banks in kickstarting green financing instruments in markets lagging in adoption of clean energy can help in low cost and easy financing for such regions.**
- **Blended financing mechanism provides low-cost financing option while addressing different investment-related risks and have great potential to attract private financiers.**

13 Global Landscape of Renewable Energy Finance 2023, IRENA and CPI

1.2.5 Increasing investment in off-grid renewable energy technologies can help in closing the access deficit and providing clean energy to millions in developing and under developed economies

Under current and planned policies, nearly 670 million people are expected to be without electricity and 2.1 billion without access to clean cooking by 2030[14] . Adopting off-grid RE technologies, both stand-alone systems and mini grids can be a cost-effective solution for accelerating electricity access for households and businesses in regions with inadequate power and grid infrastructure. The sector has been rising continuously, and between 2012-21, the population served by these technologies increased from 35 million to 213 million, an increase of more than 500%. The numbers reduced thereafter owing to improved grid access rates in South Asia and reduced replacement rates of solar lights and solar home systems (SHSs).

Population served by off-grid renewable power in developing and emerging economies, 2012-2021

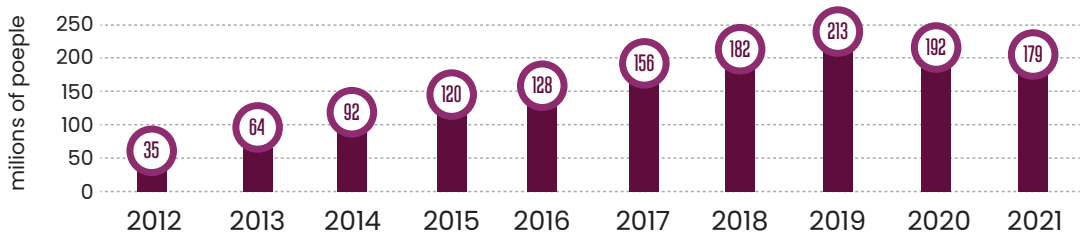


Figure 13 Population served by off-grid renewable power in developing and emerging economies, 2012-2021

Source: IRENA

Between 2010 and 2021, the off-grid RE sector attracted more than $3 billion, and despite COVID-19 pandemic annual investments in the sector reached a record high of $558 million in 2021. However, the investment is far short of $2.3 billion required annually in off-grid solar products alone, excluding mini grids. Also, despite a diverse set of investors entering the investment landscape, majority of investments are made by only a few major players with increasing average ticket size. Most investments between 2010 and 2021 were made in residential category (54%) followed by commercial and industrial (C&I)category (14%). Solar PV products dominated the off-grid space, attracting about 92% of total investments between 2010-2021. Amongst all the products, SHSs are the most funded technology as it goes beyond lighting to power appliances such as fans, televisions, etc. The investments are concentrated in select regions such as Africa with less access to low cost financing solutions, and other regions such as the Pacific.

14 Global Landscape of Renewable Energy Finance 2023, IRENA and CPI

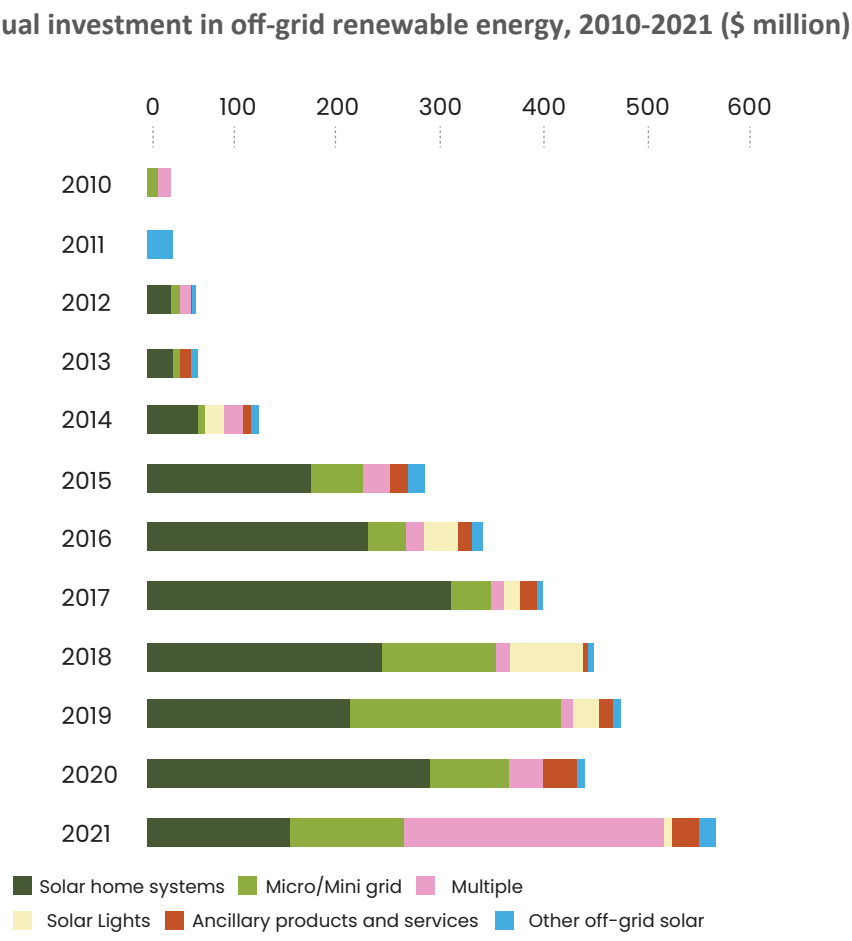


Figure 14 Annual investment in off-grid renewable energy, 2010-2021 ($ million)

Source: IRENA

Key Takeaways:

- Despite representing a small portion of overall energy investment landscape, the off-grid RE sector investment has enabled access to electricity for more than 200 million people and has the potential of bringing new electricity access to 580 million people by 2030.
- The average ticket size of investment has been increasing thereby posing challenges for enterprises looking for smaller investments
- Solar products form the majority of off-grid technology solutions owing to the modularity and distributed characteristics of solar PV technology
- Venturing into new markets and providing low-cost financing options in other regions apart from Africa and Asia can help in increasing uptake of solar off-grid products thereby closing the energy access gap.

Global Investments in Solar Sector

More than 80% of all investments in the power sector for the year 2022–2023 went towards renewables, grids, and storage.

Nearly half of the new investments in renewable energy have been made in solar PV, with almost equal investments directed to utility-scale and distributed solar PV installations. Investment in solar energy increased by nearly 40% in 2022 over 2021, and global investments in solar projects reached a record high of ~$300 billion in 2022[15].

15 BNEF Energy transition report 2023

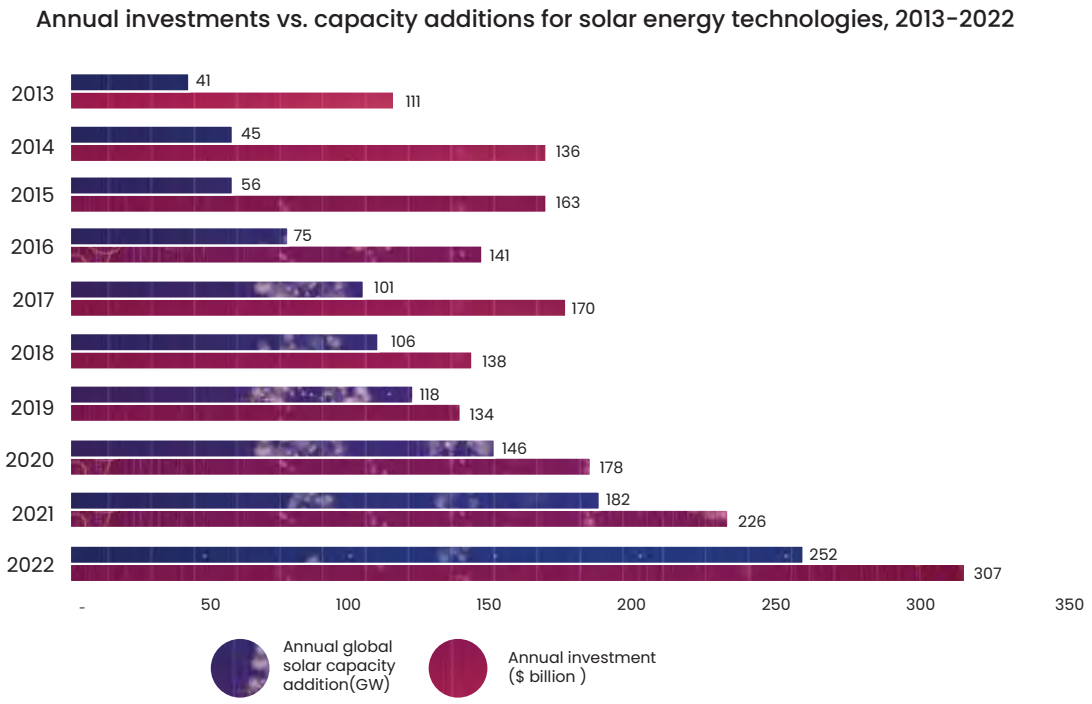


Figure 15 Annual investments vs. capacity additions for solar energy technologies, 2013-2022

Source: BNEF, IEA

Note: Decline in investments may not always be accompanied by a decline in capacity installed each year; for instance, in 2016, investments declined but capacity addition increased. Cost reductions and the time elapsed between project finance and completion both play a role in this.

Solar PV generation increased by a record 270 TWh (up 26%) in 2022, reaching almost 1,300 TWh. It demonstrated the largest absolute generation growth amongst all renewable technologies in 2022, surpassing wind for the first time in history[16] .

2.1 Global investments in solar energy value chain have crossed $300 billion mark

Investments in solar PV value chain have crossed $300 billion in 2022, reaching $307.5 billion, **witnessing a growth of 36% from the preceding year**. Solar PV value chain consists of distinct segments starting from solar manufacturing stage up to the project's end-of-life stage, ensuring circularity in the entire solar ecosystem. Manufacturing, solar project development, and research and development (R&D) are the three main investment avenues throughout the solar value chain.

- Research and Development, and Innovation focus on improving efficiency and system performance.
- The manufacturing stage focusses on producing various products such as polysilicon, wafers, cells, modules, and arrays along with different equipment for project development such as mounting and tracking systems and various electrical components. The manufacturing stage under the solar PV value chain is interlinked with other sectors/ value chains.
- The project development stage is more focused on delivering services

16 Tracking Clean Energy Progress 2023 – Analysis - IEA

for commissioning and maintenance of the projects, and includes project development, design, engineering, construction, operation, and maintenance as well as asset management.

- Lastly, the end-of-life stage is an upcoming area of work wherein stakeholders are working towards ensuring circularity within the entire solar PV eco-system by following the principles of 3Rs, i.e., Reduce, Reuse and Recycle.

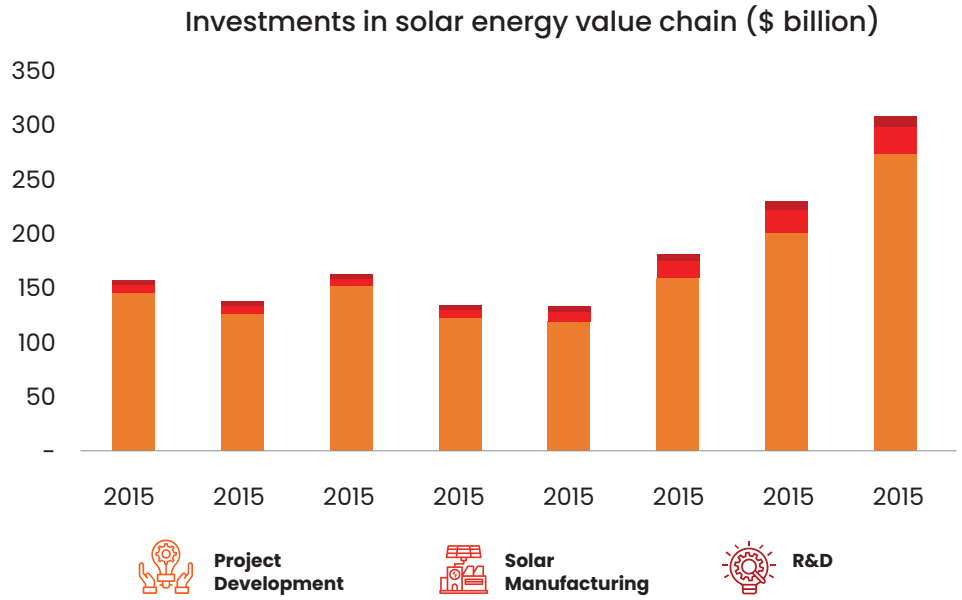


Figure 16 Investments in solar energy value chain ($ billion)
Source -BNEF, IEA

Investment in project development activity forms the major chunk of total investments in solar value chain. In 2022, project development occupied ~88% of the total investments in solar value chain. While investments in R&D stage picked up in 2022, showing an increase of 25% over 2021, increase in solar manufacturing stage witnessed a growth of merely 14% in 2022, which is the lowest growth in percentage terms since 2019.

Key Takeaways:

- **Increasing technological maturity and declining costs have helped attract investments in solar sector particularly in solar project development, which accounted for ~88% of total solar investments between 2015 and 2022.**
- **Given that secure transition to clean energy hinges on resilient and diversified clean energy technology supply chains, investments in solar manufacturing stage need to be increased substantially to meet the clean energy transition goals. This stage forms only 8% of the total solar value chain investments.**

2.1.1 Asia Pacific region dominates the investment in solar project development with more than 50% share

Global investment in solar project development reached a record of around $270 billion in 2022, with an average growth rate of ~14% over the past 5 years. However, this positive momentum of solar project development investment is not distributed evenly across countries. The investment is highly skewed in favor of advanced economies and China and these economies mostly lie in the regions of Asia Pacific[17], Europe and North America. The two regions i.e., Asia Pacific, and Europe and North America, accounted for 55% and 33% of global solar project development investment respectively in 2022. China alone witnessed investment worth $164 billion in solar projects. On the other hand, developing regions of the Middle East, Africa, Latin America, and the Caribbean continue to lag in the race for solar adoption. For more inclusive energy transition, investments need to be more universal.

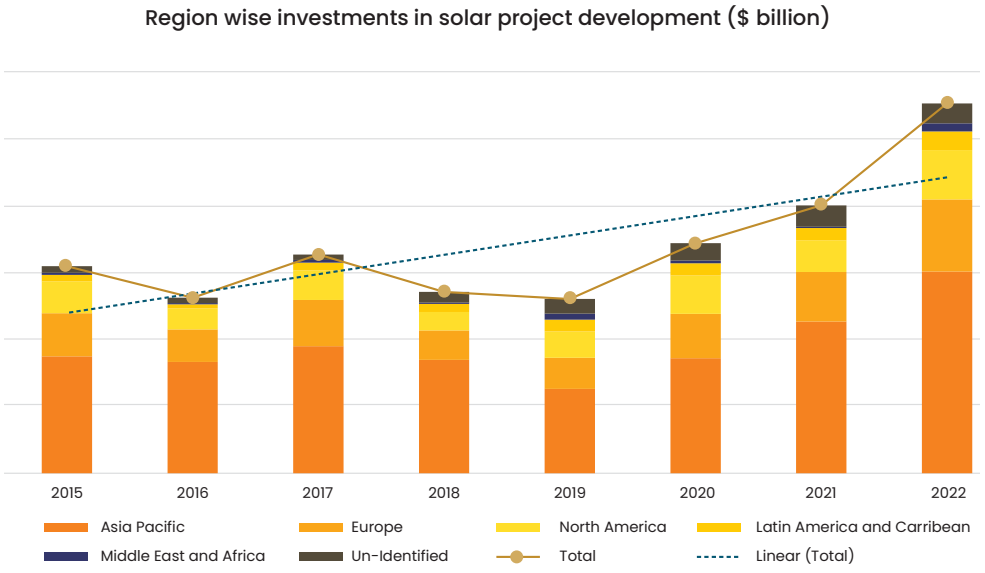


Figure 17 Region wise investments in solar project development ($ billion)

Source -BNEF, IEA

17 List of countries in Asia -Pacific regions can be found here .

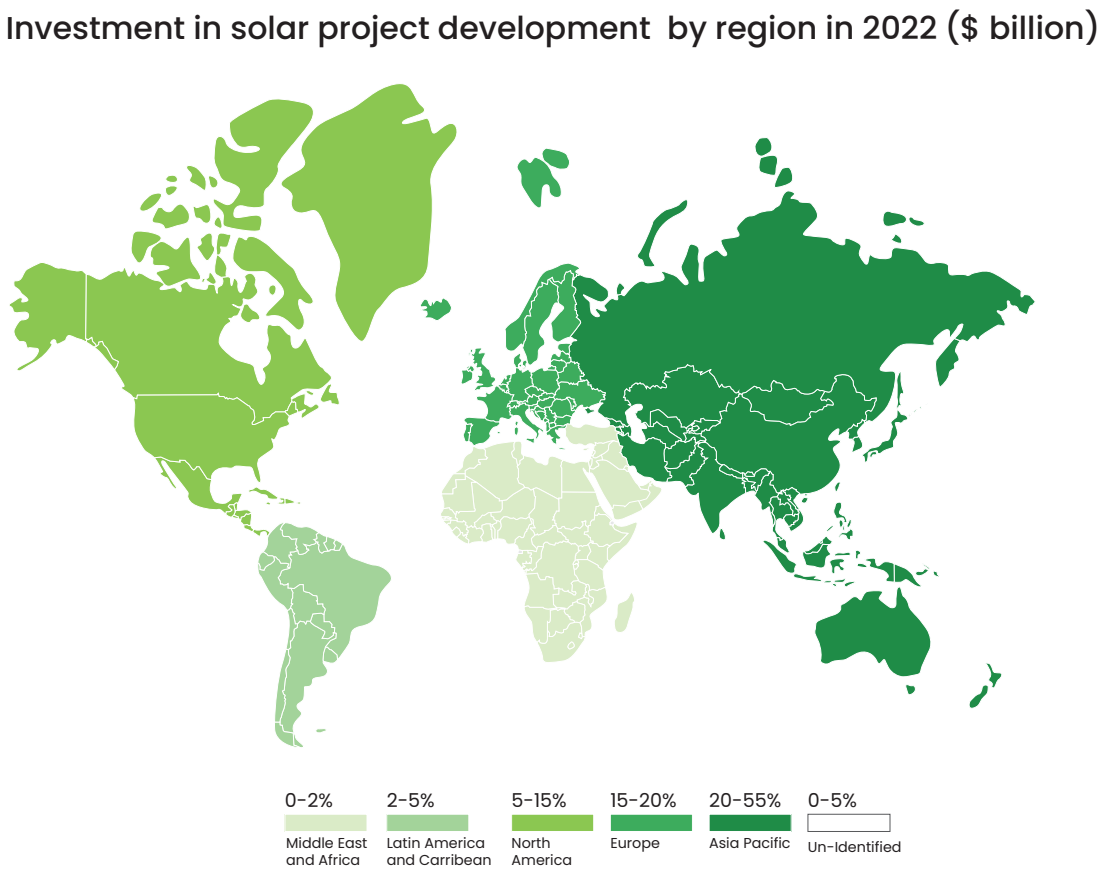


Figure 18 Investment in solar project development by region in 2022($ billion)
Source -BNEF, IEA

2.1.1.1 China and United States of America lead the solar investments in Asia-Pacific and Europe and North America region

The Asia-Pacific solar energy market is expected to grow further in the coming years. The prominent factors driving the growth are the issues related to elevated grid electricity prices and increasing regional solar energy investments. The overall growth in solar investments has been mainly driven by the growth of solar investments made in the Asia and Pacific region, contributing nearly 50% since 2015, with an average growth rate of about 13% over the past 5 years. However, the increase in investments is mostly in two countries, India and China, primarily because of a suite of favorable policies and regulations such as tax exemptions and central financial assistance. Vietnam saw investment in solar PV grow by an average of 219% per year between 2013 and 2020, driven mainly by feed-in tariffs.

Investments in Europe and North America grew by ~16% annually in the last five years. No longer constrained by severe supply chain bottlenecks and COVID-19 related restrictions, investment in Europe and North America reached all-time high in 2022. North America excluding Mexico attracted the second-largest share of investment in 2022, mainly driven by the production tax credit in the United States, followed by Europe, where net-zero

commitments and extensive policies to phase out fossil fuels were the major growth drivers. In Europe, solar PV investment has grown nearly 11% in the last five years to ~$54 billion. North America solar PV investment increased by 14% YoY to $37 billion in 2022. Solar energy in the United States is booming representing almost 80% of the America's solar investment. However, there was a dip in 2021, primarily due to disrupted supply chains. Complex permitting rules and procedures also hamper both solar PV and other renewable energy investments including wind.

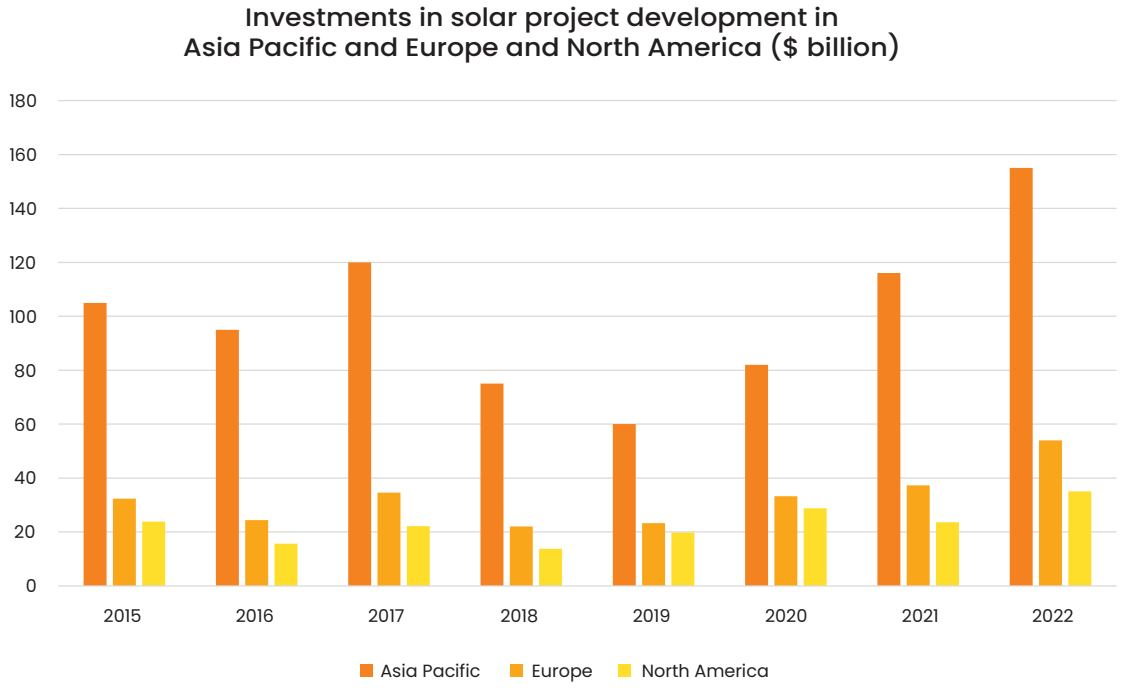


Figure 19 Investments in solar project development in Asia Pacific and Europe and North America ($ billion)

Source -BNEF

Key Takeaways:

- **The investments in solar project development are dominated by economies that have a developed solar PV market, such as China, USA, Japan, Spain, Australia, Netherlands, South Korea, Brazil, Vietnam, Germany, and India. These economies together accounted for ~80% of the total solar investments in 2021[18].**
- **China and the United States consistently attract the most annual solar investments, with their combined share of about 50% of all the solar investments since 2015.**

18 Bloomberg New Energy Finance (BNEF), 2023

2.1.1.2 Middle East & Africa and Latin America & Caribbean region are lagging in the renewable space

Emerging and developing economies currently account for two-thirds of the world's population, but only one-tenth of the world's financial wealth. Africa possesses some of the world's greatest potential for solar power generation. The developing regions in Africa, the Middle East, Latin America, and the Caribbean are lagging in the race to deploy solar energy systems. This is primarily due to lack of adequate investment in solar technology and its implementation in these economies. The share of renewable energy investments have been declining precipitously in these regions, and countries defined as least developed (by the Intergovernmental panel on climate change) attracted only 0.84% of renewable energy investments on average between 2013 and 2020[19]. Despite the skewness, the Middle East and North Africa regions have ambitious energy investment and diversification plans in place, driven by the need to meet growing energy demand, promote economic growth, maximize socioeconomic benefits and meet decarbonization objectives. For the Middle East and Africa regions, the solar investments grew by ~15% in the last five years. On the other hand, investments in Latin America and the Caribbean grew by ~18% in the last five years with flat growth in 2021[20]. Country wise investments are difficult to track as there is a lack of data captured in the solar PV sector, especially for the economies in the developing regions of the Middle East and Africa as well as Latin America and the Caribbean.

19 Global Landscape of Renewable Energy Finance, 2023
20 Bloomberg New Energy Finance (BNEF), 2023

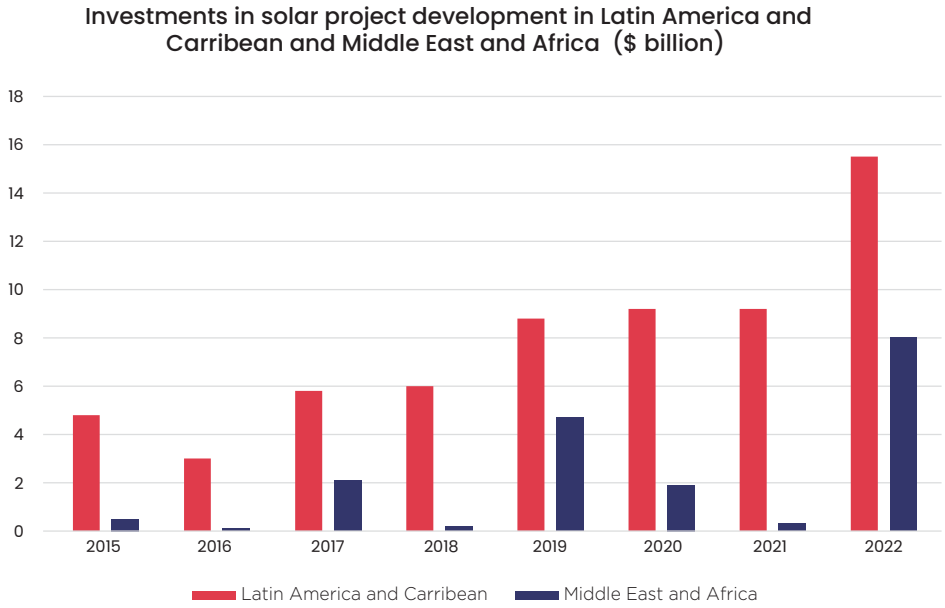


Figure 20 Investments in solar project development in Latin America and Carribean and Middle East and Africa ($ billion)

Source -BNEF

Key Takeaways:

- The skewness of the investments can be witnessed by the fact that Africa, which is home to 18% of the world's population, has only about 2% of the global solar installed capacity despite having the richest solar resources in the world21.
- In Africa, one of the key obstacle hampering the investments in off-grid, especially solar mini grid is due to lack of regulation clarity on integration of mini grids with main supply grid. Regulations needs to focus on protecting investments by providing a guideline focusing on technical and financial elements ensuring the sustenance of solar mini grids in the electricity supply area to improve investor confidence22.
- Solar energy's potential in Africa could not only be a solution to many of the continent's issues, but it could also help the continent's economy thrive.
- Developing regions in the Middle East and Africa as well as Latin America and the Caribbean account for only a small fraction of the global investments in solar energy.
- Emerging and developing countries around the world, whose potential has not yet been realized, should be given top priority to increase investment in solar energy. This is essential to achieve the global climate goals.
- Capturing country level data in the developing and underdeveloped economies can help in assessing the ground reality and facilitate investments in those regions.

21 Climate action: Prospects of solar energy in Africa - ScienceDirect
22 Benchmarking-and-comparing-effectiveness-of-mini-grid-encroachment_2022_Sola.pdf

2.1.2 Investments across four major solar segments, led by utility

Solar project development can be broadly classified into four key segments a) Utility-scale, b) Commercial & Industrial (C&I), c) Residential, and d) Off-grid. Among the 4 segments the utility, C&I, and residential segments are grid-connected. In these segments the system is connected to the utility's power grid allowing for a bi-directional flow of power. Excess power is exported to the utility grid when the entity requires less power than generation and power is imported from the grid when more power is needed. An off-grid solar system is one that generates its own electricity, and uses storage to operate independently from the grid. These systems promote an off-grid lifestyle, one that focuses on energy independence and self-reliance, especially in areas that lack proper grid connectivity and power reliability. Off-grid systems can be residential as well as C&I. The pie chart below highlights the segment-wise investments in solar project development activities in 2022.

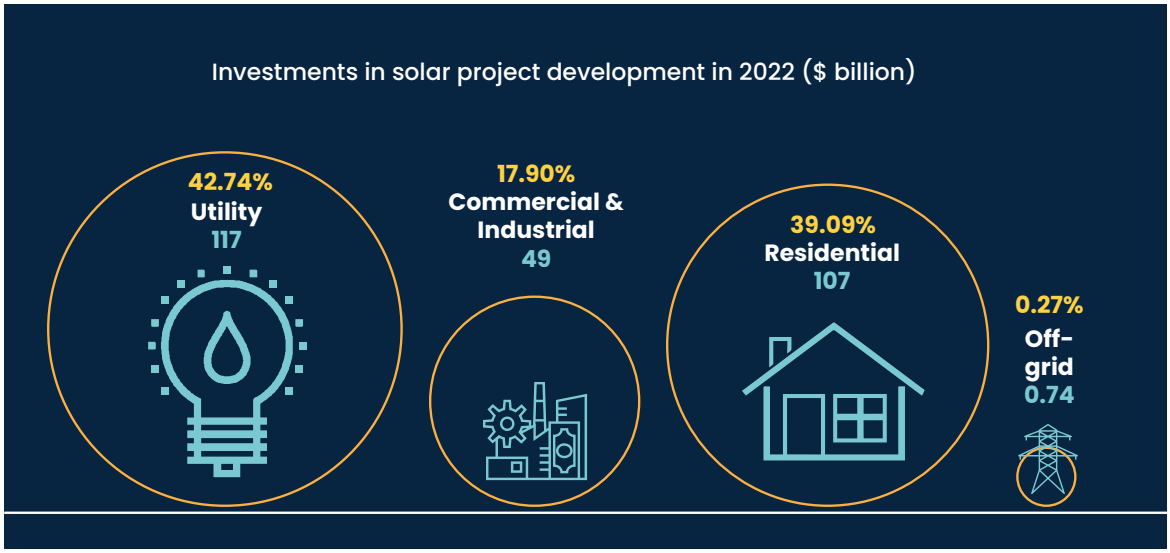


Figure 21 Investments in solar project development in 2022($ billion)

Source: BNEF, ISA Analysis

Investments in the utility segment account for the highest investment ~43% in solar project deployment in 2022 while residential and C&I account for approximately 39% and 18% respectively. Though investments in the utility segment have been leading the total solar development investments over the years, investments in the residential segment have shown tremendous growth and are reaching almost parity with the utility segment investments. Since 2015, investments in the utility segment secured the lowest share among total solar project development activities , whereas investment in the residential segment secured the highest share.

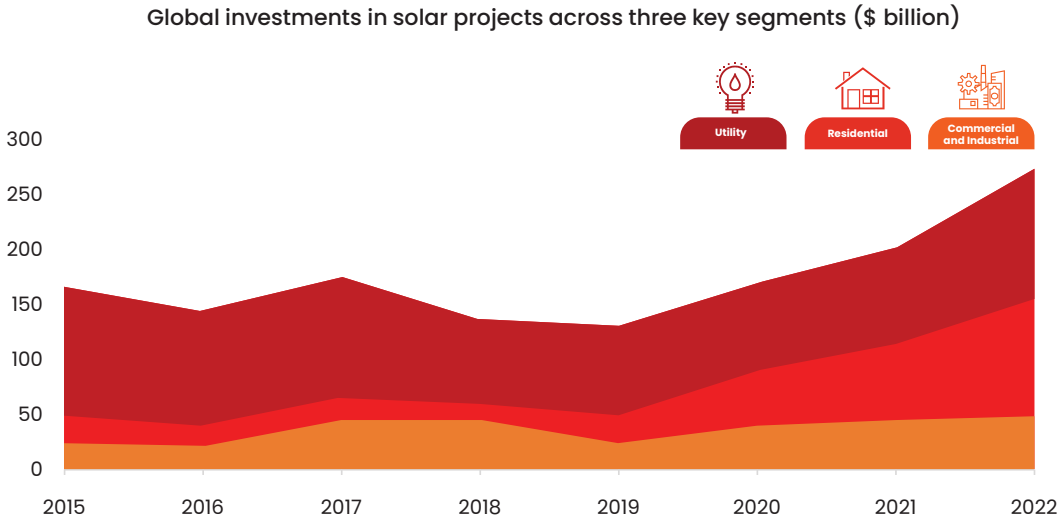


Figure 22 Global investments in solar projects across three key segments ($ billion)

Source -BNEF, ISA Analysis

The rapid expansion of solar capacity across different segments can be attributed to various technical, financial, political, and social factors. The global push for clean energy adoption has increased solar energy demand. Along with technological advancements, solar PV systems have become more efficient and lower cost, leading to increased adoption by individual households.

2.1.2.1. Utility segment witnessed a decent growth of ~30% in 2022 in terms of both investments and installed capacity over 2021

Among grid-connected systems, the adoption of solar energy has been driven by utility-scale segment over the past decade. However, the share of utility-scale investments in the entire solar project development in 2022 was the lowest since 2015, primarily because of generous policy incentives that drove record distributed PV capacity additions in countries such as China, the United States, and the European Union in 2020-2021. Solar installations in Utility segment grew by 29% in 2022, while investments in this segment saw a similar growth of 30% in that year.

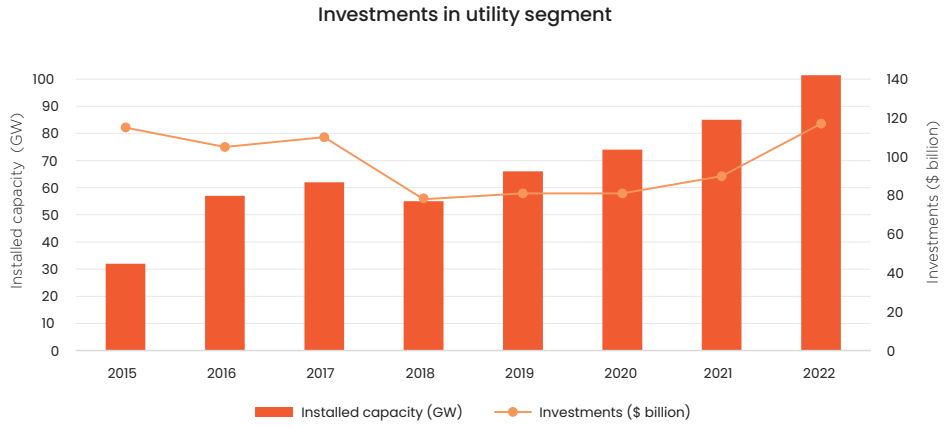


Figure 23 Figure 9 Investments in utility segment

Source -BNEF, ISA Analysis

2.1.2.2. Investments in C&I segment had the lowest growth of 8% in 2022 among all three grid connected segments

The commercial solar market segment is expected to witness a steady growth in the coming years, driven by factors such as increasing demand for energy-efficient buildings and decreasing costs of solar installations[23]. The average growth rate of solar installations in the C&I segment stood at 12% during 2018 to 2022, while investments grew at an average rate of 5% during the same period. There has been a slow increase in demand for solar systems from the C&I segment over the last few years.

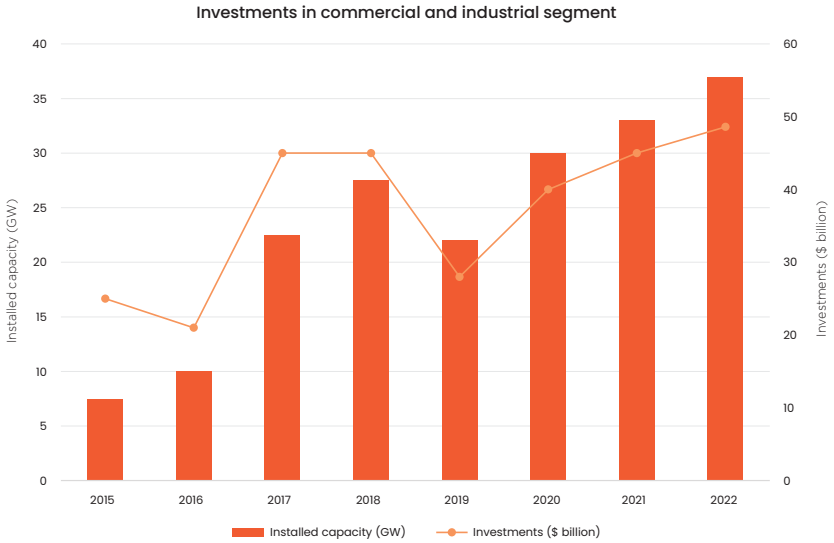


Figure 24 Investments in commercial and industrial segment

Source -BNEF, ISA Analysis

2.1.2.3. Residential segment witnessed a record growth of more than 50% in 2022 in terms of both capacity installations and investments

Solar energy adoption across residential segment has seen a steady growth and is increasing primarily due to increased energy demand and high and/or rising residential electricity prices. As public awareness of renewable energy sources for residential purposes is increasing, the residential segment has shown an increased growth as compared to C&I segment. The reason is that financial considerations for a household are quite different from a business. Households are less dependent on economic incentives since a substantial section of this segment can be driven by various motives (e.g., energy independence, climate concerns, etc.) rather than purely financial considerations. Therefore, cumulative residential PV capacity has grown more than tenfold between 2015 and 2022. Residential segment solar installations (GW) have seen an average growth rate of 52% in the last 5 years, while investments in the segment have seen an average growth rate of 45% within the same period. Residential segment is expected to witness significant growth in the coming years primarily because of favorable government incentives, increasing cost-effectiveness of solar panels, innovative business models, and various metering mechanisms such as net metering and gross metering.

23 Solar Panel Market Projected to Grow at CAGR of 18% by (globenewswire.com)

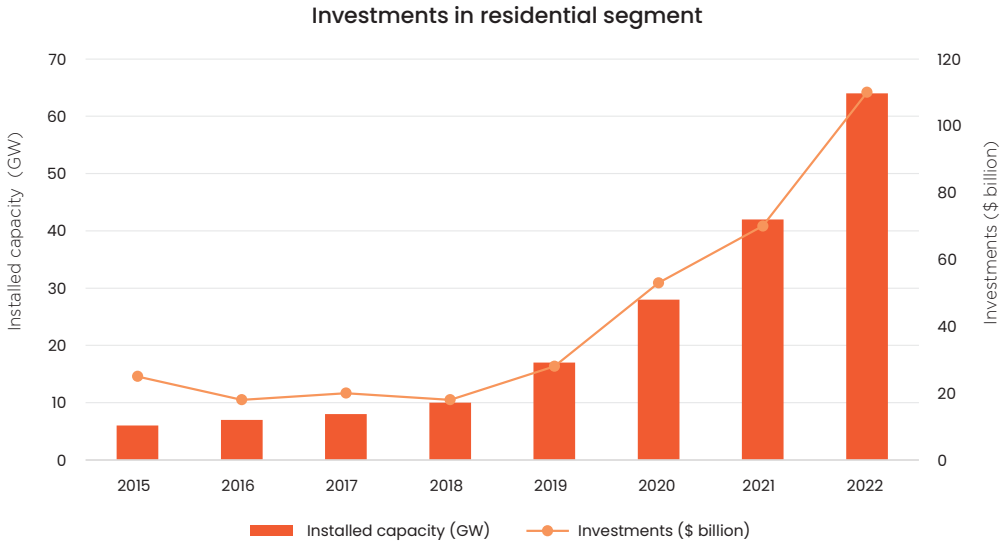


Figure 25 Investments in residential segment

Source -BNEF, ISA Analysis

2.1.2.4. Investment in the solar off-grid segment is picking up pace but more investments are required to meet the goal for global energy access

The off-grid solar (OGS) industry holds great promise around the world and has potential for continued growth having reached 490 million users[24] mostly in the developing regions of Sub-Saharan Africa and South Asia over the past ten years. Between 2015 and 2022, OGS segment has attracted investments of more than $3 billion with ~$740 million in 2022 alone, resulting in a growth of 63% over 2021. Though the figures represent a small portion of total solar energy investments, the segment forms a crucial and cost-effective means for global energy access. It has the potential to bring new energy access to 580 million people by 2030[25]. The instruments used for financing the OGS segment are debt, equity, and grants, with debt and equity almost reaching parity in 2022 and grants forming a small part of the total investments. Financial commitments in the form of equity have seen a growth of more than 200% in 2022 over the preceding year reaching $394 million, driven by the success of large incumbent companies in their scale-up phase and increased equity investors in the form of individual households and small business holders. With the investments in the off-grid space reaching an all-time high in 2022, there is an increased confidence among investors. However, access to financing continues to be a major obstacle for early stage enterprises, which needs to be addressed through low cost financing products or other innovative financial instruments to maximize business potential and advance climate and energy access goals. The current investment levels fall far short of the $2.3 billion required annually in the off-grid solar products alone between 2021 and 2030, and steps are needed to route the required financing to the OGS segment.

24 Off-Grid Solar Market Trends Report 2022: State of the Sector
25 Global Landscape of Renewable Energy Finance 2023

Annual trend of the grant, equity, and debt in the off-grid solar energy space ($ million)

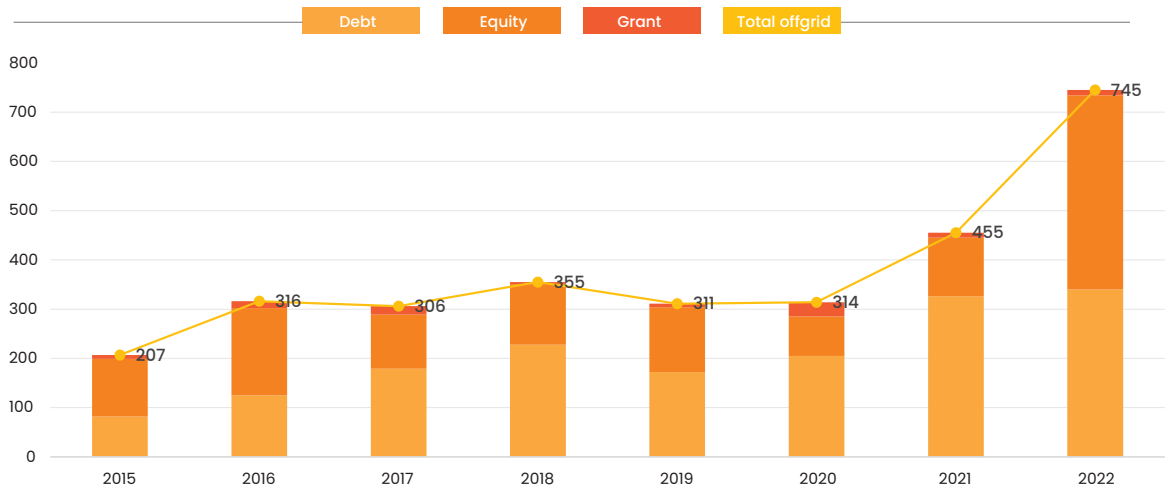


Figure 26 Annual trend of the grant, equity, and debt in the off-grid solar energy space ($ million)

Source: GOGLA

Key Takeaways:

- Global off-grid solar segment had a record investment of ~$740 million in 2022 over $455 million in 2021, resulting in growth of 63% year-on-year.
- While equity contribution increased by over 200% in 2022, debt contribution increased by only 4%. Financial commitment in the form of equity exceeded debt for the first time in 2022. This success was largely driven by successful scale-up strategies of few large companies, led by Sun King's equity raise[26].
- The segment saw yearly investment volumes plateauing around $300 million to $350 million during 2016-2020 before reaching ~$740 million in 2022.
- Debt and equity continue to be key financing instruments for off-grid players, and contribution from grants is minimum.

26 Off-grid solar investment boomed in 2022, but the sun did not shine on all companies equally | GOGLA

2.1.3 Investment and favorable policies are needed to scale up and diversify solar PV manufacturing capacities, hence ensuring supply chain security

In recent years, solar energy has experienced a boom in global adoption due to various factors such as optimization of manufacturing processes, reduced labor costs, and enhanced module efficiency. While increasing solar installations are crucial for addressing climate targets, it is also important to ensure well-sequenced growth of new supply chains, especially when various supply chain disruptions have been witnessed owing to geo-political issues and the COVID-19 pandemic. With production costs falling by more than 90% in the last 10 years globally, solar manufacturing space has grown in the past, but not at the pace required as shown in the figure below.

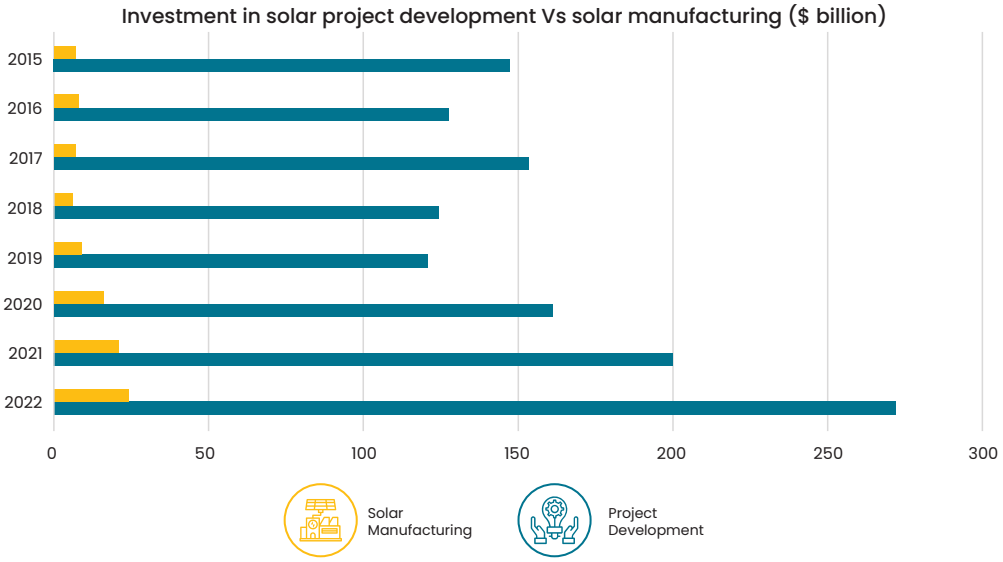


Figure 27 Investment in solar project development Vs solar manufacturing ($ billion)

Source: BNEF

Global cumulative investment in solar PV manufacturing facilities has reached $100 billion in 2022. While annual solar PV installations have increased consistently, yearly investment for manufacturing solar PV products have been volatile, ranging from $4 billion to as high as $12.5 billion between 2015 and 2022. This inconsistency is the result of periods of overinvestment followed by years of underinvestment, widening the supply and demand balances of several products in the PV supply chain[27]. This inconsistency can be seen across the manufacturing stages of solar panels i.e., polysilicon, ingots, wafers, cells, and modules. As per IEA estimates for net zero, new solar PV manufacturing facilities along the supply chain could attract $120 billion investment by 2030, and global production capacity for polysilicon, ingots, wafers, cells, and modules would need to more than double by 2030 from today's levels.

27 Special Report on Solar PV Global Supply Chains 2022, IEA

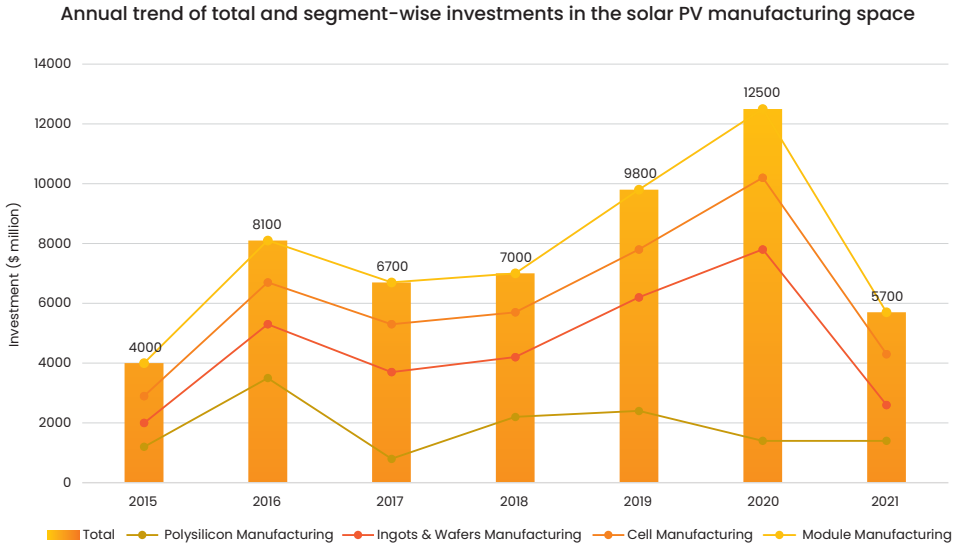


Figure 28 Annual trend of total and segment-wise investments in the solar PV manufacturing space

Source: IEA

Moreover, the manufacturing capabilities have remained concentrated in select geographies. China continues to dominate solar manufacturing, as the country holds over 80% of the manufacturing market share across all the manufacturing stages of solar PV. In terms of segment wise market share in 2021, China was home to 79% of global polysilicon capacity, 97% of global wafer capacity, 85% of cell production, and 75% of module manufacturing capacity. Based on manufacturing capacity under construction, China's share of global polysilicon, ingot and wafer production will soon reach almost 95%.

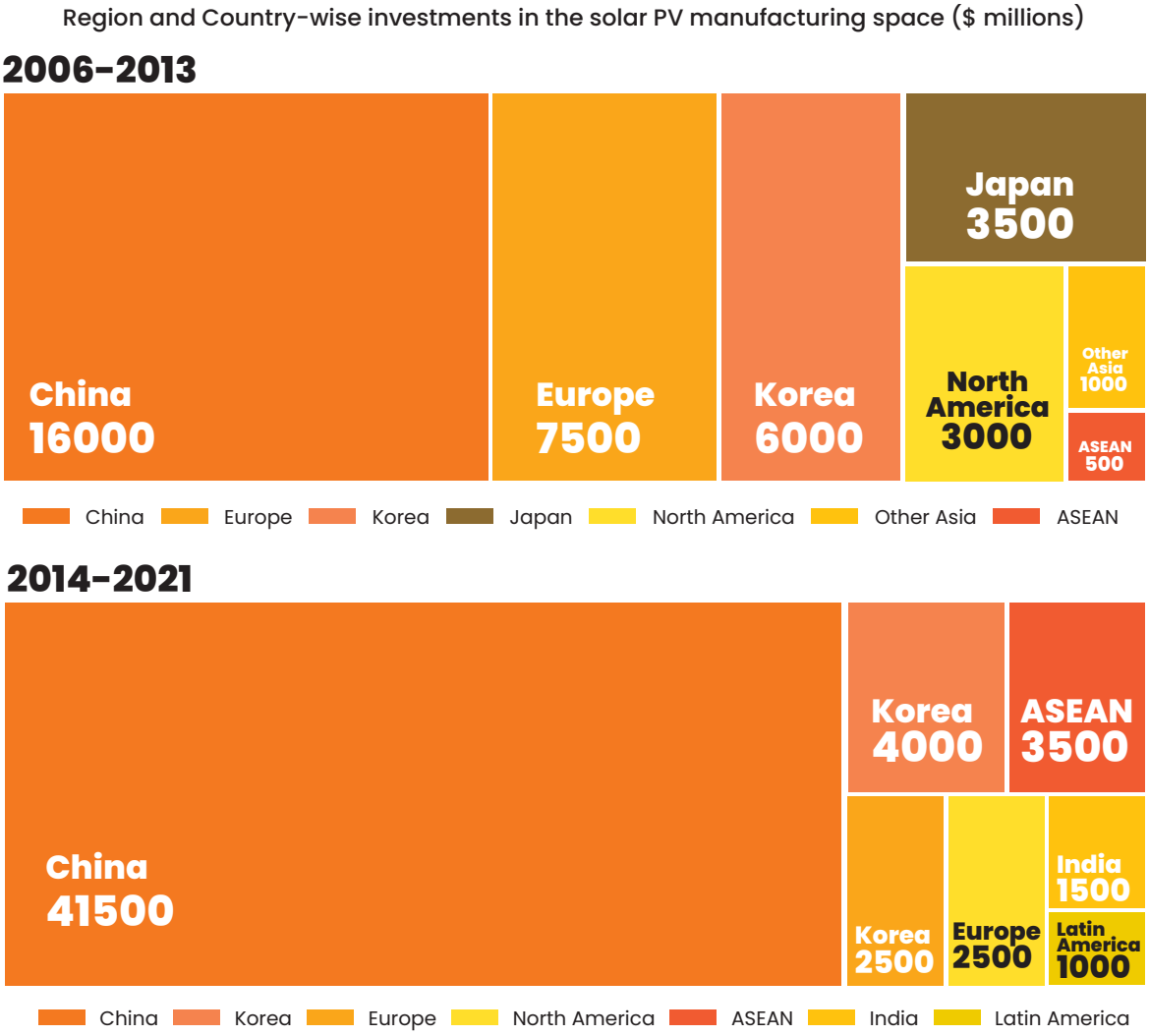


Figure 29 Region and Country-wise investments in the solar PV manufacturing space ($ millions)

Source -IEA

Government policies in China have shaped the global supply, demand, and price of solar PV over the last decade. Other countries such as USA and India are also following suite to make domestic manufacturing more competitive by introducing new policies. Production Linked Incentive (PLI) program in India and the Inflation Reduction Act (IRA) in the USA provide support to manufacturers in several ways. In addition to manufacturing subsidies, tariffs on imported PV equipment and local-content premiums encourage project developers to purchase domestically manufactured products. Favorable solar manufacturing policies and subsidies in India and the United States have prompted the announcement of several new projects in 2022[28].

28 Will new PV manufacturing policies in the United States, India and the European Union create global PV supply diversification? – Analysis - IEA

Key Takeaways:

- **Building supply chain security is essential for addressing supply chain vulnerabilities and ensuring considerable manufacturing capacity development for meeting the needs of solar capacity installations.**
- **Meeting international energy and climate goals requires the global deployment of solar PV to grow on an unprecedented scale. This in turn demands a major additional expansion in manufacturing capacity.**
- **China has been instrumental in bringing down costs worldwide for solar PV. However, it has also led to supply-demand imbalances in the PV supply chain. The level of geographical concentration in global supply chains creates potential challenges that governments need to address.**
- **Supply chain resilience and energy security requirements should push companies to build capacities in a geographically distributed manner and reduce the reliance on one country.**
- **Government policies are vital to build a more secure solar PV supply chain. New policies in the USA and India can lead to more diversified global solar PV manufacturing supply chains. Solar PV manufacturing investment in India and the USA is expected to reach almost $25 billion over 2022-2027, a sevenfold increase compared with the last five years.**

2.1.4 Research and development (R&D) spending on solar energy is steadily increasing, resulting in more efficient and cheaper solar PV systems

R&D is a key driver in solar energy cost reduction and its widespread adoption. Since 2010, solar PV cells have become nearly 60% more efficient and generation costs have fallen by almost 80% owing to the technological advancements as a result of R&D. Without public and private investments in R&D, solar PV would not be the most affordable electricity generation technology in many parts of the globe. The strategic importance of energy innovation, including R&D and demonstration remains as high as ever. Without a substantial increase in energy innovation spending, climate goals, and the long-term economic outlook are at risk. In 2022, R&D investment increased to ~$10 billion, an increase of ~25% compared to 2021. R&D spending has resulted in consecutive annual improvements in the energy conversion efficiency as well as reductions in material use, reducing manufacturing costs significantly. R&D investment plans support overall mid-century clean energy plans and demonstrate consistent alignment between technology readiness levels, and types of capital support allocated.

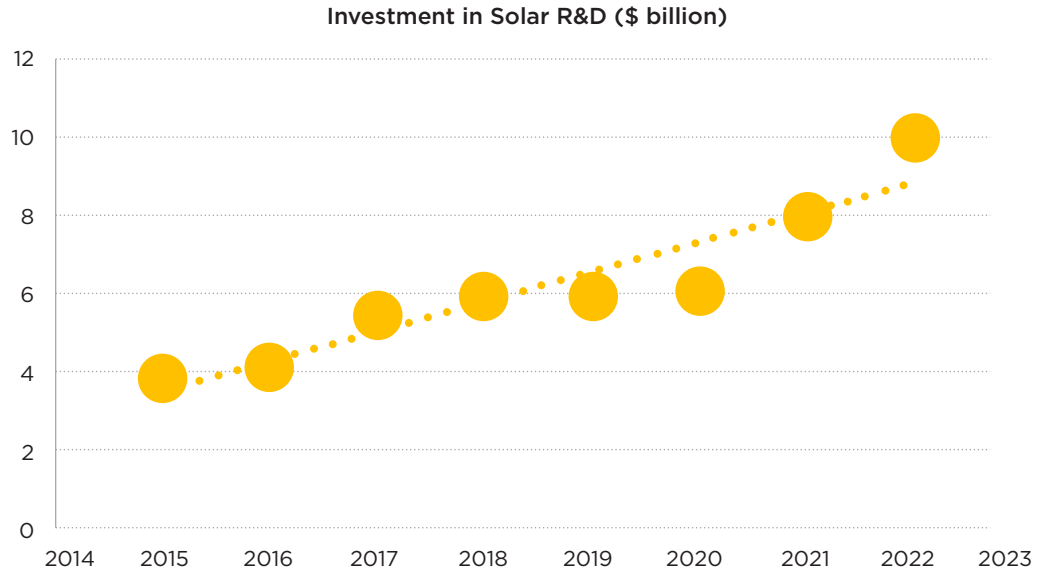


Figure 30 Investments in solar R&D ($ billion)

Source: BNEF, IEA

2.2 Landscape of solar energy finance

There are various sources as well as financing instruments available that enable the scaling up of adoption of various renewable energy technologies, including solar. The investments in a particular technology heavily rely on the project's location, project's stage of development, as well as maturity of the technology deployed. These instruments can be broadly grouped based on their characteristics. While finance from public sources such as government and development finance institutions (DFIs) are mostly directed towards new technologies for supporting their R&D and scale up, finance from private sources such as banks and corporations are mostly devoted to technologies that are commercially viable and highly competitive such as solar. The diagram below depicts various solar financing instruments along with sources of financing and regions where financing flows.

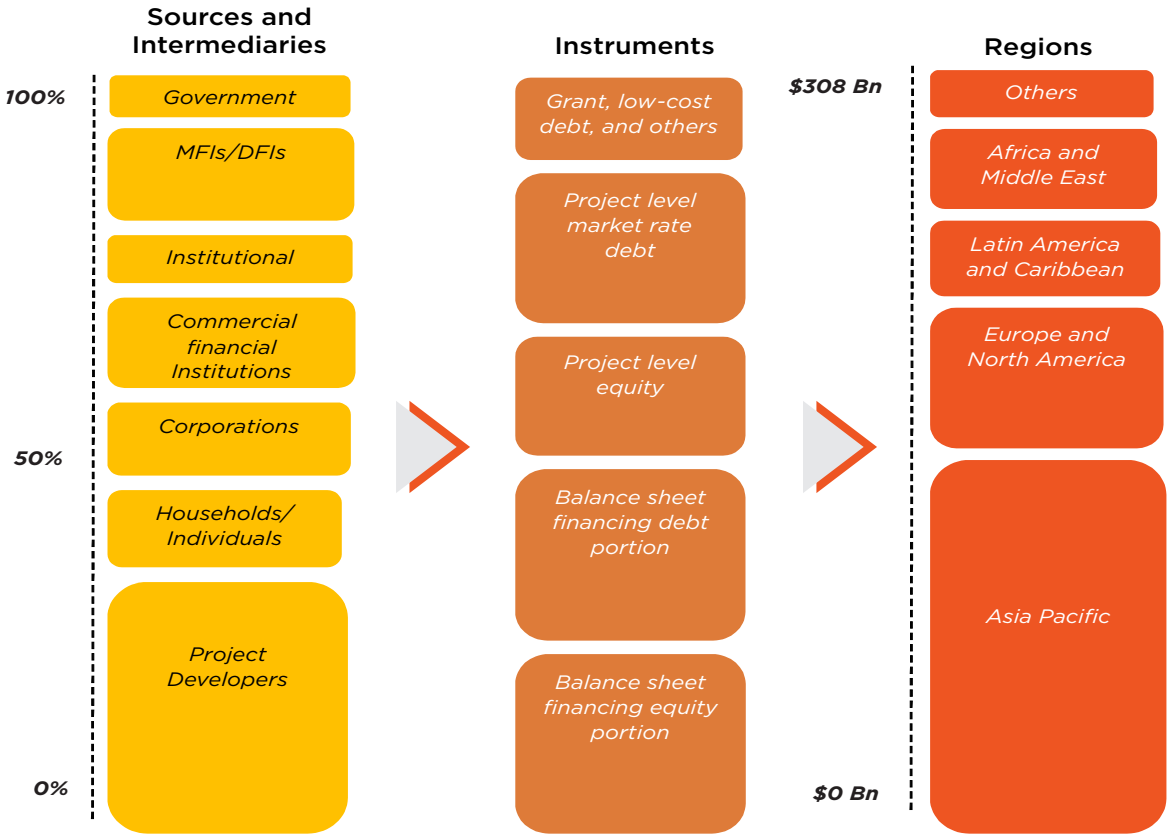


Figure 31 Global landscape of solar energy finance

Source -IRENA, CPI

2.2.1 Though the private sector continues to provide the majority of solar energy investment, public sector has a critical role to play to achieve inclusive energy transition

Public and private actors have different goals when investing in renewable energy projects. Typically, a lower proportion of public funding goes to commercially viable and competitive renewable energy technologies, making them more attractive to private investors. Solar sector having achieved a mature stage, the investments are by the private sector. Private finance was a major contributor to solar energy projects, accounting for more than 80% of the total investments between 2015 and 2022, whereas public sector contributed to the remaining investments. Financing from public players needs to be increased in the developing economies for a just energy transition as most of the private financing is directed to advanced economies. Due to various global events, many countries in the developing and underdeveloped regions cannot access affordable capital in the international financial markets or provide sovereign guarantees to mitigate risk. Hence, public funding is required to flow through existing or newly designed innovating instruments to fund projects in developing and underdeveloped economies.

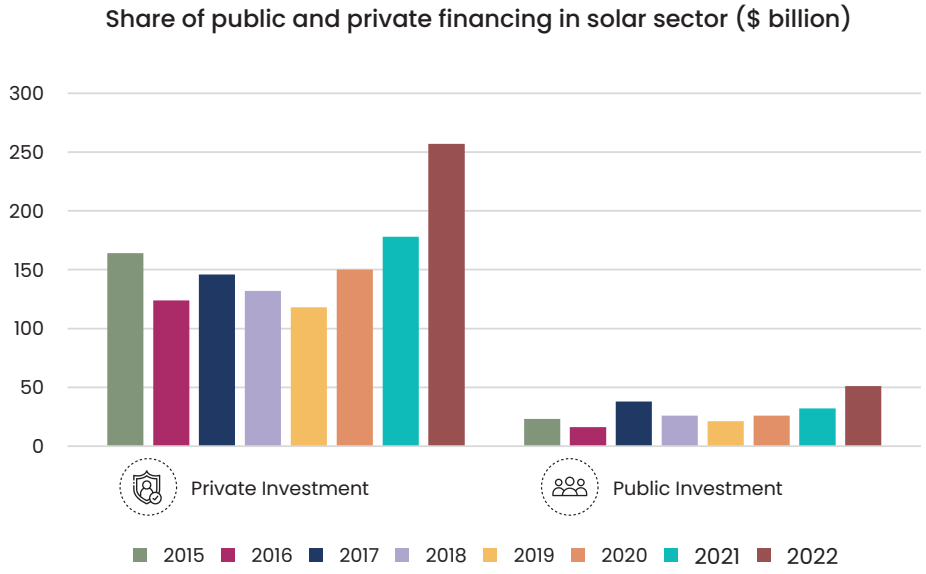


Figure 32 Share of public and private financing in solar sector ($ billion)

Source - ISA Analysis

Private investment players include project developers, non-energy producing companies (corporate actors), commercial financial institutions, households, institutional investors and private equity, venture capital, and infrastructure funds. Public finance includes funds provided by governments, their agencies and companies, state-owned entities and financial institutions, climate funds, and DFIs. While project developers and commercial financial institutions are the main private finance providers, accounting together for almost 75% of private finance for solar energy in 2022, DFIs are a major source of public financing contributing to 43% of the total public finance flows.

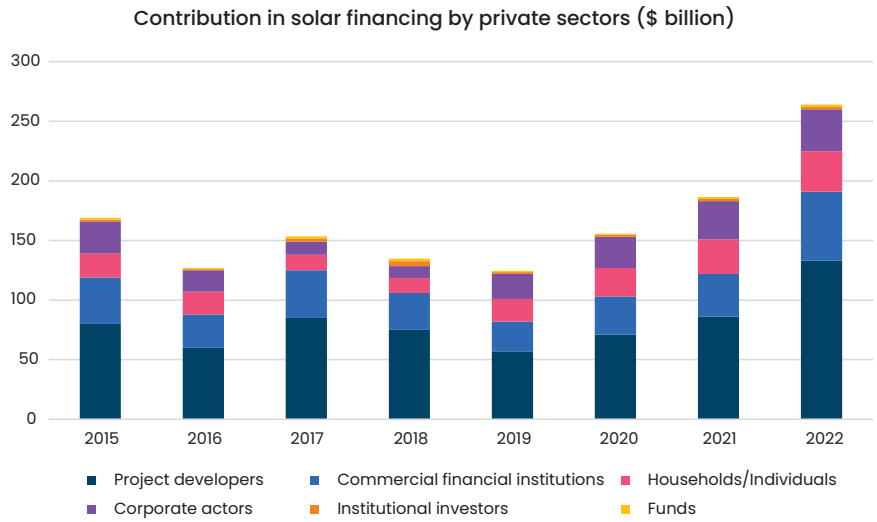


Figure 33 Contribution in solar financing by private sectors ($ billion)

Source -ISA Analysis

Key Takeaways:

- **Private capital flows form a majority of the solar sector investments and are mostly directed to countries with the least risks.**
- **Among the private players, project developers are the major contributors followed by corporate financial institutions. Investments from individuals/households and corporate actors contribute almost equally to the private finance flows in the solar sector.**
- **Though public finance has helped in creating an enabling environment for private investors in solar space, more needs to be done to facilitate uptake of solar in the underdeveloped and developing regions by innovative policies, developing infrastructure and addressing the risks and barriers that deter private capital in these regions. Public finance and policy should continue to be used to crowd in private capital for such regions.**
- **Governments from developed and developing countries will play a central role in providing an enabling environment for both public and private investments in regions that are perceived as risky investments.**
- **There is a need to track investments specific to the solar sector and enhance data transparency to understand the progress and bottlenecks hampering the sector. Due to lack of data, assumptions have been made to arrive at the solar investment figures.**

The sub-sections below highlight investments of key public and private actors and how their contributions play a significant role in increasing solar adoption.

2.2.2 Commercial financial institutions spend substantially more on fossil fuels than on solar energy and need to deploy strong fossil fuel exit strategies

Commercial financial institutions (i.e., investment banks) continue to be key private finance providers accounting for ~23% of total private finance in the solar sector between 2015-2022. However, their investments in the solar sector are significantly lower than that in fossil fuels. Major global banks are standing in the way of climate targets, as just 7% of their financing for energy companies went to renewables between 2016 and 2022[29], solar sector being a part of the same.

Investments in the solar energy sector by 60 global major banks fell by 52% in 2022. On the other hand, their investments in the fossil fuel sector reduced by only 17%. Though banks have been talking about contributing significantly to clean energy space, the numbers don't reflect the same. Inflation, oil and gas shortages, and higher interest rates are some of the factors that have created unique market conditions for fossil fuel companies and their bankers. As per a study by the environmental organization[30], banks have raised ~$1.5 trillion for coal companies and have given around $400 billion in loans to them directly in the past 3 years. The progress for increasing investments in solar energy by these institutions has remained virtually stagnant since the Paris Agreement.

29 Just 7% of global banks' energy financing goes to renewables, new data shows - Climate Action
30 Climate: Research shows how banks, investors finance the coal industry (cnbc.com)

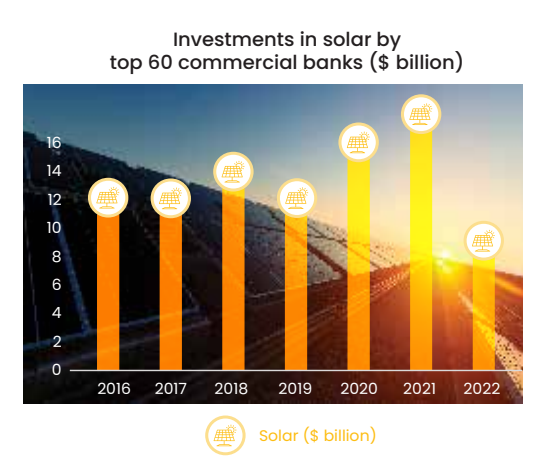


Figure 34 Investments in solar by top 60 commercial banks ($ billion)
Source - CarbonTracker, ISA Analysis

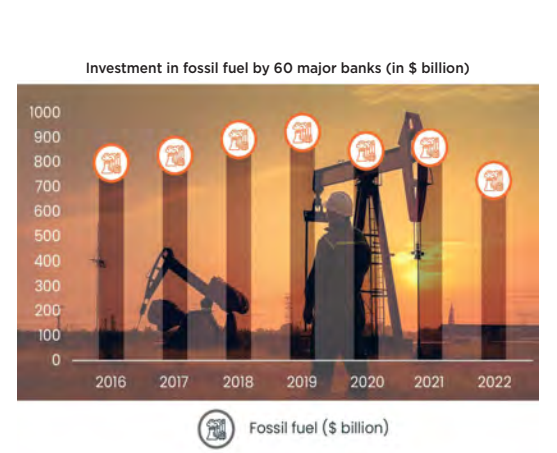


Figure 35 Investment in fossil fuel by 60 major banks (in $ billion)
Source: Fossil fuel financing report

The banking industry has been widely criticized for helping oil, gas, and coal companies raise more than $5.5 trillion since the Paris climate agreement of 2015. Financial institutions from just six countries, USA, China, Japan, India, Canada and UK, were found to be responsible for over 80% of coal financing and investment since 2019[31]. The figure below draws out a comparison between investments in fossil fuels and investments in solar sector by few prominent commercial banks over the last 7 years. The numbers are nowhere near promising a clean energy transition.

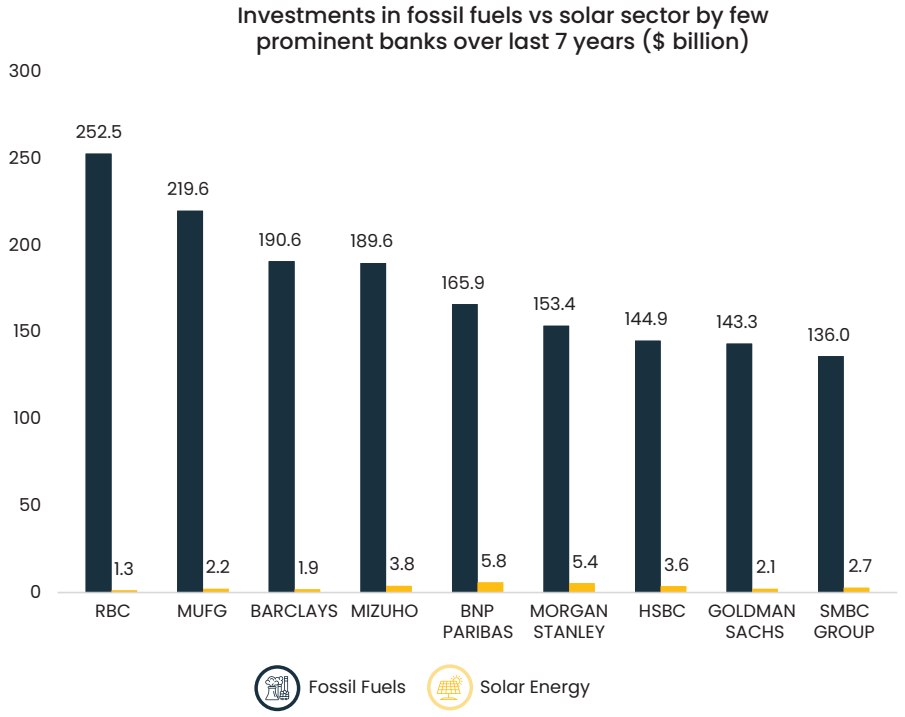


Figure 36 Investments in fossil fuels vs solar sector by few prominent banks over last 7 years ($ billion)

Source - ISA Analysis

The Institutional Investors Group on Climate Change (IIGCC), in consultation with the Transition Pathway Initiative Global Climate Transition Centre (TPI Centre), has launched a net zero standard in 2021 for banks setting out investor expectations on the transition to net zero. The standard is intended to support constructive engagement with banks to aid the ongoing implementation of climate commitments. The TPI centre will use the net zero banking assessment framework to assess 26 global banks across Europe, North America, and Asia annually, with the inaugural assessments due for publication in summer 2023.

31 Climate: Research shows how banks, investors finance the coal industry (cnbc.com)

There has been slow progress from banks in taking strong steps towards their financial commitments. Some major banks have published their fossil fuel exit strategies and working towards achieving their clean energy commitments. Banks coming up openly with such strong commitments will help in faster transition towards clean and sustainable energy. More than 2,000 companies and financial institutions are currently working with Science Based Target Initiative (SBTi) to make net-zero a reality.

In October **2021**, La Banque Postale became one of the first financial institutions to set a validated science-based target. The bank committed to ensure that its banking activities achieve net-zero carbon emissions by **2040**. According to Science Based Target Initiative (SBTi) La Banque Postale also became the first bank to publish a fossil-fuel exit strategy. It has committed to a complete withdrawal from coal as well as conventional and unconventional oil and gas (upstream and midstream activities) by **2030**. It has decided to refrain from financing oil and gas energy projects, not provide any financial services to the sector, and end legacy services by **2030**. It has also stated to discontinue support to businesses that are actively involved in lobbying on behalf of fossil fuel industry.

Deutsche Bank aims to publish net zero pathways for at least four more CO_2-intensive sectors in **2023** in addition to the net zero targets already defined for the carbon-intensive sectors of oil & gas (upstream), power generation, steel, and automotive, aiming to reduce the emissions that the bank indirectly finances in its lending business. The bank now intends that at least **90%** of its high emitting clients in the most carbon-intensive sectors that engage in new corporate lending transactions shall have a net zero commitment in place from **2026** onwards, from the current **50%**.

BNB Paribas stopped oil project financing in **2016** and has made a commitment to reduce outstanding financing for oil extraction and production by **25%** by **2025**. Its outstanding loans for low-carbon energy production were at more than 28 billion euros at the end of September **2022**, already close to **20%** higher than those for fossil fuel production. It also has a coal exit strategy well underway, which will be completed by **2030** in Organization for Economic Co-operation and Development (OECD) member states

When it comes to local financial institutions, investments have been minimum in terms of solar lending because of institutional challenges, risk of payment defaults, bad debt, etc. The development of small-scale solar projects such as rooftop solar projects has not picked up the required pace as local FIs have not been very keen to lend money. In the absence of affordable financing options by the local banks, uptake of solar systems has been slow, especially in rural and developing regions. In India, local banks have been financing large commercial solar projects but their lending to the residential rooftop segment is minimal owing to small ticket sized loans, lower risk appetite, and policy and regulatory challenges. Some local banks such as Canara bank and Union bank of India have come up with dedicated solar loan products, but the interest rates offered are not attractive and often require home mortgage as a guarantee.

Key Takeaways:

- **World's largest 60 banks direct just 3-4% of their total finances towards solar sector.**
- **Large global banks continue to invest huge sums in fossil fuels. They should come up with strong fossil fuel exit strategies to scale up their financing for renewable energy and phase out their financing for fossil fuels sustainably.**
- **Banks coming up openly with strong clean energy transition commitments will help in faster transition towards clean and sustainable energy deployment. To reach the goals of the Paris Agreement, investments in renewable energy, and particularly solar energy must dramatically increase in this decade.**
- **Local financial institutions need to step up for providing affordable solar loans to consumers, especially in developing and underdeveloped regions, to facilitate penetration of solar energy.**

2.2.3 Investments from Development financial institutions (DFIs) are required to be stepped up for ensuring all-inclusive clean energy transition

DFIs play a major role in enabling investments in the solar sector, especially in developing and underdeveloped countries, where perceived risks contribute to the high cost of financing or prevent projects from seeing the light of the day. They also support the use of solar energy through technical assistance programs and work closely with the state and other local governments on implementation. The strategic use of DFIs is still essential to carry out projects necessary for socio-economic development in contexts where private investors do not venture. DFIs were the main source of public investments in the solar sector with average solar investments at 43% per year between 2015 and 2022. However, their rate of contribution is decreasing year on year. This decline is largely attributable to a 96% decline in international commitments by the German development bank (KfW). This drop is remarkable, especially given the need for a steep increase in international collaboration to achieve a just transition.

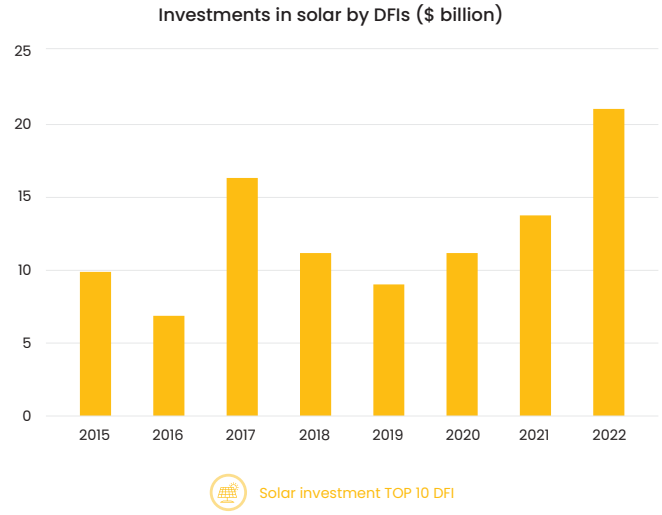


Figure 37 Investments in solar by DFIs ($ billion)

Source – IRENA, ISA Analysis

Key Takeaways:

- **Investments from the top ten DFIs in solar have shown an inconsistent trend and the rate of solar investments has been reducing year on year.**
- **Developing and underdeveloped economies require financial support from DFIs to increase solar penetration and capacity building.**
- **Given the urgent need to step up the pace and geographic spread of the energy transition, and to capture its full potential in achieving socio-economic development goals, more flows of international funds are needed that can help underinvested countries participate in the energy transition without putting their fiscally constrained economies at a further disadvantage.**

2.2.4 Institutional investors have a huge opportunity to accelerate the transition to clean energy and direct the much-required finances to clean energy transition

The success of the energy transition depends on the renewable energy sector's ability to attract unprecedented capital flows. Institutional investors can play a pivotal role in this regard. Institutional investors including pension funds, insurance companies, sovereign wealth funds, foundations, and endowments, manage assets worth $107 trillion. In terms of their direct financing of renewable energy projects and solar projects, activities have remained relatively subdued. While annual investment in solar energy projects has hit one record after another in recent years, reaching over $270 billion in 2022, direct institutional investments in renewable energy projects altogether has been hovering around $1 billion per year between 2015 and 2020, which is less than 1% of their total investment. These investors do not disclose their investments individually in various clean energy sectors, which is a huge challenge. The figure provides the estimates of solar energy made by institutional investors between 2015 and 2020.

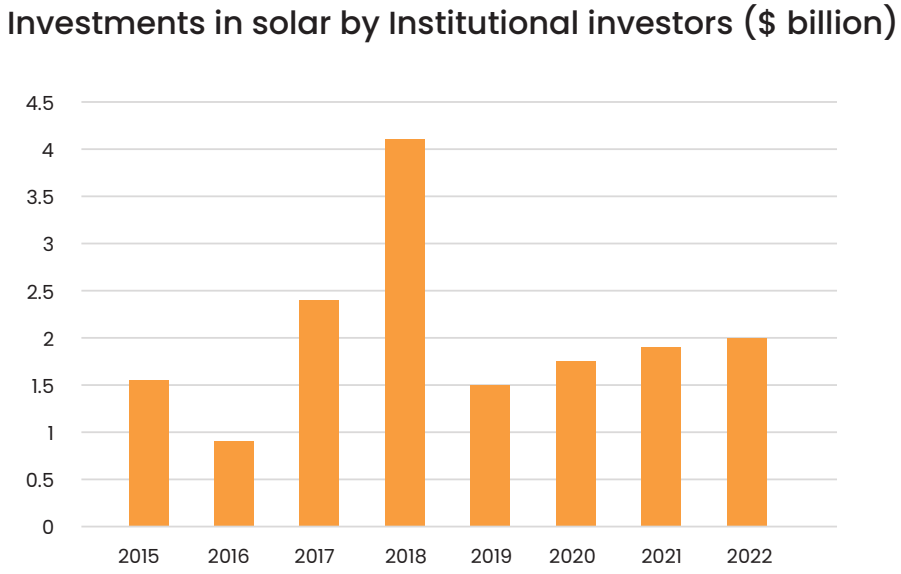


Figure 38 Investments in solar by Institutional investors ($ billion)
Source: ISA Analysis

According to an analysis by IRENA, only 20% of the 5,800 institutional investors have made indirect investments via renewable-focused bonds over the past two decades, and only 1% have invested directly in renewable energy projects. These investors mostly invest in tried and tested modes of operation and most of the investments flow into developed economies of North America, Europe, and East Asia and Pacific, where real or perceived risks regarding investment are low. Moreover, they seek large transaction sizes to lower overall transaction costs, and prefer project level debt financing followed by project level equity financing.

Key Takeaways:

- **The activation of large pools of underutilized capital from institutional investors is necessary to transition to a more sustainable and low-carbon economy.**
- **Lowering barriers to investing which include asset liquidity, regulatory constraint, energy price uncertainties, and a lack of expertise in the area could help unlock institutional investment capital for renewable energy projects, according to a study conducted by Octopus Energy based on responses from 100 institutional investors. Policy makers and governments have a critical role to play in achieving the same[32].**
- **Continuous creation of bankable green asset pipelines and truly green market instruments can channel institutional capital towards renewable assets.**

32 OG126-OR-Institutional-Report-final.pdf (octopusgroup.com)

2.2.5 Oil and gas companies are well positioned to play a meaningful role in clean energy transition owing to their cash position and need to significantly increase their clean energy investments

Oil and gas companies made huge profits to the tune of $4 trillion in 2022 due to rising fuel prices amidst various geopolitical events and demand shocks. The surge in oil and gas company profits has opened up the possibility for accelerated spending on clean energy transitions that involves investment in renewable energy technologies and also boosting investments in technologies that reduce the emission intensity of existing fuel production process. However, investment by the industry in low emission sources of energy is less than 5% of its total investment. Having said that, some major oil and gas companies have committed to investing significantly in renewable energy to enhance their market share in the years to come. The investments by oil and gas companies in renewable energy increased by 27% in 2022 hitting a new record of $32 billion.

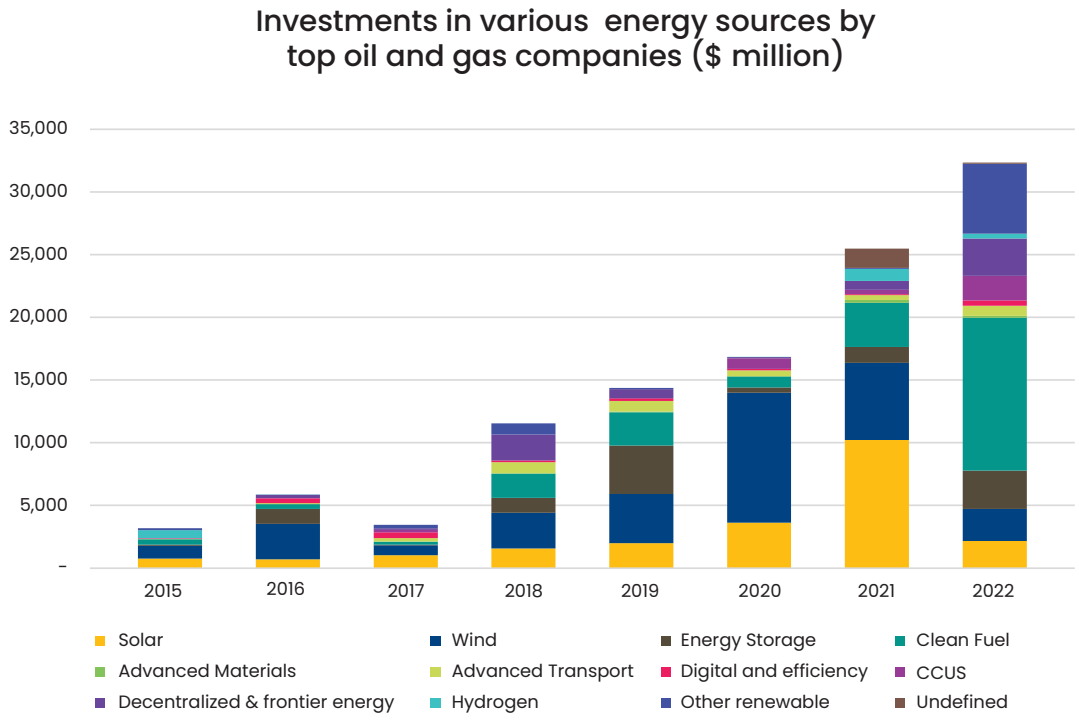


Figure 39 Investments in various energy sources by top oil and gas companies ($ million)

Source: BNEF

The investments made so far, are insignificant compared to the profits made by these companies. Year 2022 marked the first year since 2015 when solar and wind no longer dominated companies' spending – with investments falling by ~70%. As per IEA estimates, oil and gas companies contributed to only 4% of the renewable energy investments and roughly 2.1% of the solar investments in 2022[33]. Investments in clean fuels[34] dominated the clean energy spending. This was underscored by some mega deals

33 World Energy Investment 2023, IEA
34 Clean fuels means bio-fuels

including BP's acquisition of renewable natural gas provider, Archaea group, and Chevron's purchase of renewable energy group. Some large oil and gas companies are set to make a switch to "energy" companies that supply a diverse range of fuels, electricity, and other energy services to consumers. The figure below shows investments in solar energy sector by some of the world's major oil and gas companies.

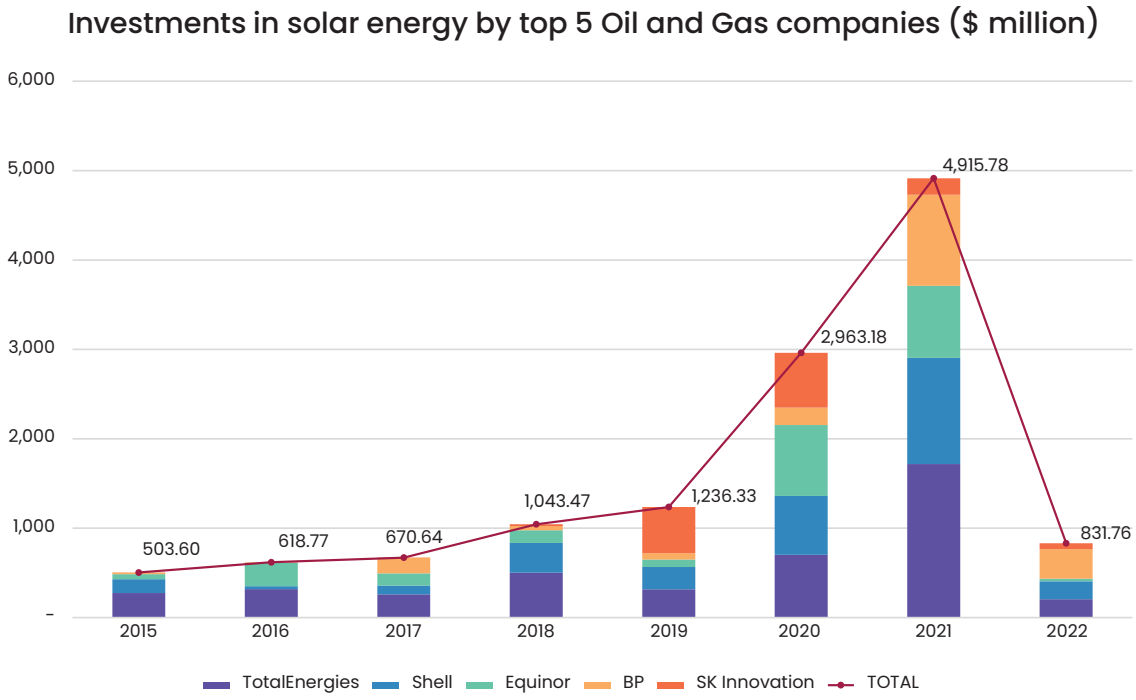


Figure 40 Investments in solar energy by top 5 Oil and Gas companies ($ million)

Source -BNEF

The urgent need to switch to clean and renewable energy becomes more apparent every day. However, companies[35] which are partly state-owned and partly privatized Norwegian and Italian oil and gas companies, Equinor and Eni respectively, continue to prioritize oil and gas investments that fuel climate crisis. In February 2023, both Eni and Equinor announced record 2022 revenues ($1.4 billion and $28.7 billion, respectively), more than triple their 2021 revenues. Companies used these profits primarily to increase fossil fuel investments and dividends to shareholders, rather than to accelerate a justifiable transition to renewable energy[36].

On the other hand, British oil giant[37] profits have doubled to record $40 billion in 2022. Company invested around $3.5 billion in its renewable energy business in 2022, only 14% of its capital expenditure of $24.8 billion. As Shell has no target of reducing overall CO_2 emissions this decade, which is necessary to reach Paris agreement, most of its investments are concentrated on fossil fuel businesses[38].

35 Equinor and Eni
36 IN Intranet - Home (priceofoil.org)
37 Shell
38 Shell earnings: Oil giant reports record annual profits (cnbc.com)

Key Takeaways:

- Oil and gas companies' investment in clean energy is increasing but not at the pace required.
- In 2022, investments by oil and gas companies reduced significantly that had attracted majority of the clean energy investments in solar and wind sectors.
- In 2022, major investments were made in the sector of clean fuels.
- With increased pressure from various investors to move out of high-carbon activities and transition to clean energy, several oil and gas companies have made renewable energy and solar energy commitments. However, many oil and gas companies focus on investing more in fossil fuels.
- Major oil and gas companies have large profitable core operations but need to increase solar investments and diversify their portfolio to minimize energy transition risk to meet their RE targets, and to contribute largely to the clean energy transition.


CO2

Solar investments required for meeting net zero targets

Clean energy investments need to be tripled for the rest of 2020s

To meet net zero target by 2050[39]. To fulfill the Intergovernmental Panel on Climate Change (IPCC) objective, renewable energy sources are required to drive the transformation, accounting for 65% and 90% of total electricity generation in 2030 and 2050, respectively, with solar PV and wind together accounting for a proportion of over 70%[40]. Owing to its versatility, solar and its various applications are expected to witness increasing adoption in the future. To meet the net zero target, global installed solar PV capacity would need to reach 551GW/year from 2023 to 2030 and by 615GW/year from 2023 to 2050[41].

Between 2018 and 2022, solar capacity additions have seen an average growth rate of 21% while solar investment has seen an average growth rate of 15%, lagging way behind the target growth rates required to meet net zero by 2050. Along with the urgent need to guarantee an exponential increase in solar capacity expansion, it's also important to ensure that the solar industry expands equitably, particularly in regions with the highest rates of energy poverty.

39 BNEF New Energy Outlook – Net Zero Investment
40 IEA Net Zero by 2050 - A Roadmap for the Global Energy Sector
41 World Energy Transitions Outlook 2023, IRENA

3.1. Solar capacity estimates for achieving net zero target vary significantly among different organizations

A total of roughly $600 billion in investments were made in the renewable energy sector in 2022, of which ~ $300 billion went towards the adoption of solar energy. But to achieve the net-zero target by the middle of the century, it is necessary to scale up present investment levels even more, as predicted by several studies under various scenarios[42]. Various organizations have come up with solar capacity installation estimates required by 2050. A wide range of annual investment flows are projected, including an increase from the current level of ~ $300 billion to ~$505 billion in 2030 and a cumulative increase of ~$10 trillion from 2030 to 2050[43]. The scaling of investments is predicted to progressively slow down or reach saturation after 2040 because of the market maturity along with a decrease in the cost of renewable energy technologies[44]. An analysis of different sources estimating annual solar investments until 2050 is highlighted in the table below:

Organization	Year	Title	Goal	Solar PV capacity projections by 2050 (GW)
British Petroleum (BP)	2023	Energy Outlook	Net Zero as per 'Paris consistent' IPCC scenarios	11,600
IRENA	2023	World Energy Transitions	Meet Paris agreement at 1.5°C by 2050	18,200
IEA	2021	Net Zero by 2050	Net-zero emissions	15,400
BNEF	2022	New Energy Outlook 2022	Meet Paris Agreement net-zero emissions by 2050 emissions by 2050	20,000
Rethink Technology Research	2022	Global Solar Forecast 2050	-	22,900
Stanford University	2022	Low-cost solutions to global warming, air pollution, and energy insecurity for 145 countries	100% RE by 2050	25,579
LUT University	2021	Low-cost renewable electricity as the key driver of the global energy transition towards sustainability	100% RE by 2050	63,377

42 World Energy Investment report 2023
43 ISA Analysis
44 Global Solar Forecast 2050, Rethink Technology Research

Organization	Year	Title	Goal	Solar PV capacity projections by 2050 (GW)
3rd Terawatt Workshop[45]	2023	Photovoltaics at multi-terawatt scale: Waiting is not an option	Next decade decisive for PV growth on the path to 2050	75,000

Note –

BP- Three scenarios were explored due to the uncertainties surrounding the speed and shape of the energy transition to 2050. Solar installed capacity increases by around 15-fold over the outlook in net zero scenario.

IRENA– Under 1.5oC scenario, solar installed capacity would exceed 18,200 GW by 2050.

IEA- Solar PV capacity increases 20-fold between 2020 and 2050.

BNEF- Solar capacity reaches 20 terawatts in 2050, or average of 632 gigawatts is to be installed per year to 2050.

Rethink Technology Research- Rethink Energy's new report predicts global installed cumulative solar PV capacity reaching 22.9 TW by 2050, with **over 1 TW peak installation rate sustained through 2038 to 2041**.

Stanford University– To reach 100% of RE generation by 2050, global solar capacity should be 25,579 GW.

LUT University- Total installed solar capacity achieve a base of 63,380 GW in 2050 for 100% RE generation.

3rd Terawatt workshop- Assuming a future population of 10 billion, further decreases in PV costs, and increased energy consumption in the Global South, the experts at 3rd Terawatt workshop suggest that about 75 TW or more of globally deployed PV will be needed by 2050 to meet decarbonization goals.

45 The workshop was led by representatives from the Fraunhofer Institute for Solar Energy Systems ISE, the National Renewable Energy Laboratory (NREL) and the National Institute of Advanced Industrial Science and Technology (AIST) and gathered PV experts that are affiliated with 41 institutions in 15 different countries. The consensus reached by participants in the 3rd Terawatt Workshop, held in Freiburg, Germany 2022, follows increasingly large projections from multiple groups around the world on the need for large scale PV to drive electrification and greenhouse gas reduction.

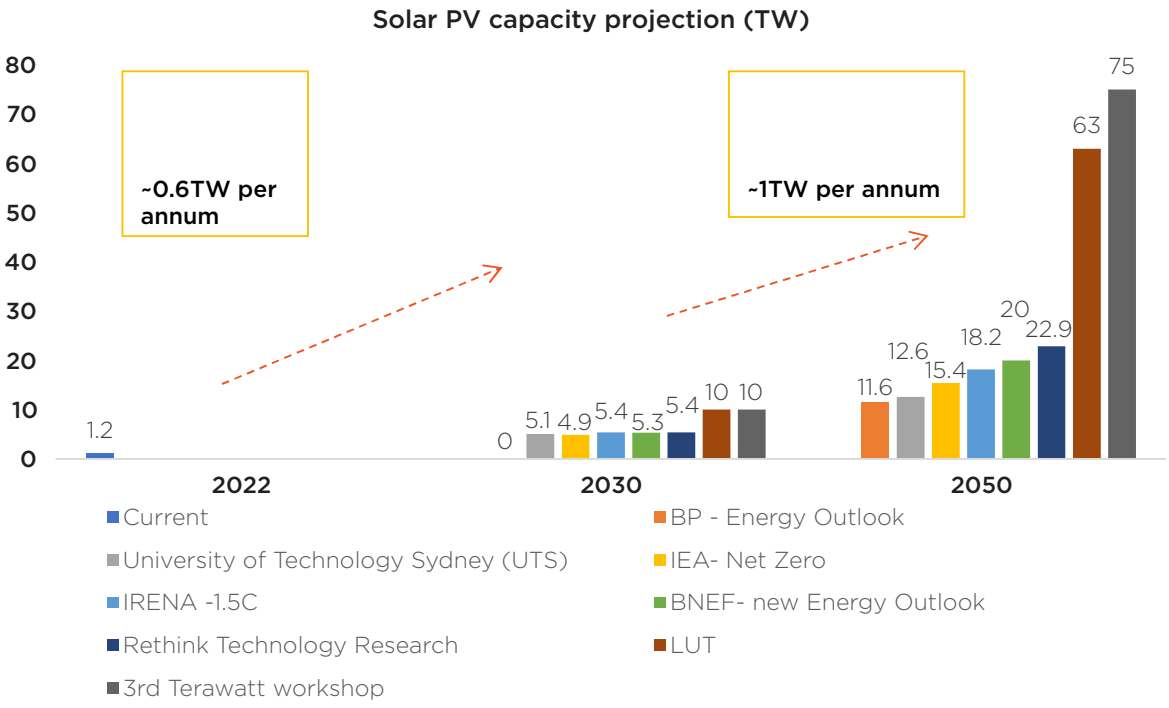


Figure 41 Solar PV capacity projection (TW)

Source: ISA Analysis

Note BNEF and ISA analysis - Annual investment requirements are estimated based on forecasted average capex (utility, residential, and commercial & industrial segment) of $ ~ 0.74/W for 2030 and $ ~0.58/W for the 2030 to 2050 period.

Key Takeaways:

- **Among the projected clean energy transition investment requirements, solar is expected to attract the majority of investments, as solar and wind technologies are expected to meet 70% of the electricity generation needs of the world by 2050.**
- **Solar energy will play an important role in the energy transition with several long-term energy transition scenarios predicting terawatt-scale solar installations for achieving net zero target by 2050.**
- **All predictions and scenarios for achieving the net-zero target point to inadequate solar capacity addition emphasize the need to significantly increase investment in solar sector.**

3.2 Asia and China dominate the solar sector and the solar landscape calls for more equitable capacity addition and increase in solar investment

Asia will continue to dominate the solar PV industry. In 2030, Asia will be responsible for almost 50% of the world's installed solar PV capacity. Through 2030, roughly 200 GW of yearly additions of solar PV is anticipated, with China contributing most to this growth followed by India. By 2030, it is anticipated that Europe and North America would account for 19% and 14% of the world's solar PV installations respectively. By 2030, North America will need installations of 90 GW per year, whereas Europe will need installations of 55 GW annually.

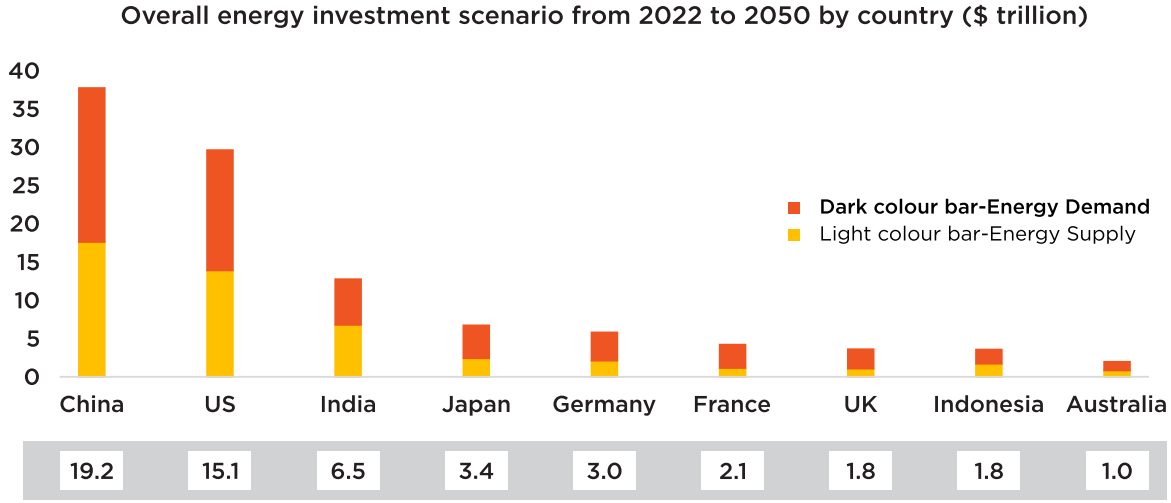


Figure 42 Overall energy investment scenario from 2022 to 2050 by country ($ trillion)

Source: BNEF

As we move closer to net-zero goals and expand solar installations around the globe, it is crucial to ensure that investments grow swiftly and are allocated fairly among countries. An unprecedented increase in solar energy spending is needed to put countries, especially developing and emerging economies, on a path to net zero emissions. The availability of bankable solar projects and the risk-adjusted returns for investors, both are compromised in these countries due to several complex issues including political, climate, and economic, etc. Nominal financing costs for solar in these countries are up to seven times higher than in the United States and Europe. This points to a relatively high barrier for projects to raise debt finance and offer sufficient returns on equity[46].

46 IEA-Financing clean energy transitions in emerging and developing economies

Key Takeaways:

- Solar sector investments are quite skewed towards certain regions, especially China. More equitable distribution of investment is required for sustainable growth of the solar sector and inclusive solar energy transition.
- Increased investment in the solar sector will be enabled by investments in emerging and developing countries like Africa and the Middle East etc. While the major economic and social benefits of mobilizing investments are well-known, significant efforts will be required to improve the domestic environment for clean energy investment, especially within developing and underdeveloped economies.

3.3 Unleashing potential solar applications will bolster investments in solar value chain

Although solar energy applications are currently limited to electricity generation, the synergy of the solar industry with other sectors cannot be ignored, as they are expected to play an important role in the path to net zero. From its application in various end-use sectors to providing clean energy for electric vehicle charging, producing hydrogen fuel and for industrial process heat, there are various applications to ensure the efficient use of solar energy. Charging electric vehicles using clean energy will help decrease carbon emissions and improve air quality while producing green hydrogen using solar energy provides opportunities for large-scale clean energy access and energy transformation. These applications will require significant investments to ensure widespread adoption as well as cost reduction, which will further drive investment and cost reduction in solar itself. Hence, we need to forecast and plan for growth and cost reduction in solar along with innovative applications like green hydrogen and electric mobility.

For the large-scale implementation of solar projects across regions, the adoption of innovative financing instruments will also be required that can address the challenges of financing in the sector. The next chapter highlights the various financing instruments that can be adopted for equitable addition of solar capacity.

Innovative Tools and Enablers to Accelerate Solar Financing

While the acceptance of solar energy has been a success in recent years, it is important to further accelerate investments in solar energy solutions to reach climate goals. Financial innovation is essential for the rapid expansion of renewable energy sources around the world.

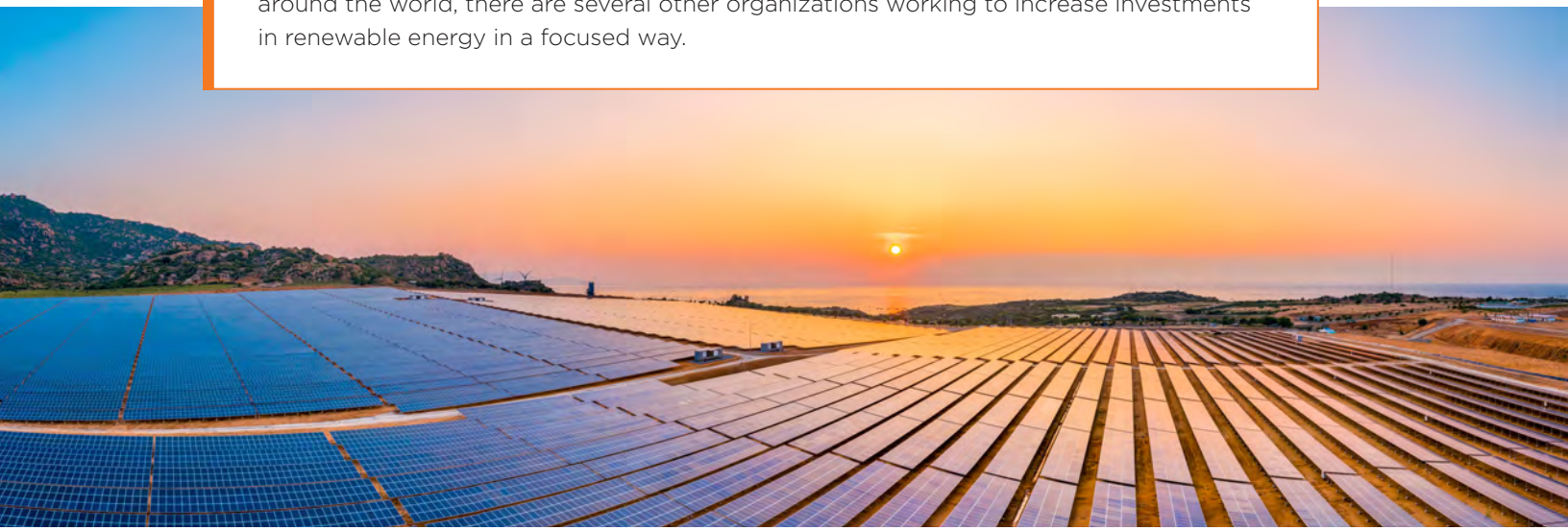
Traditional approaches to financing green energy projects, especially in developing and underdeveloped countries, suffer from many challenges, including high direct costs, small ticket sizes, lack of buyer (power off-taker) confidence, access to affordable finance, unfavorable regulations and complex paperwork, and require extensive improvements.

To tackle some of the above challenges, innovative tools and enablers are being adopted globally to enhance the uptake of clean energy finance and make finance more accessible and affordable. As the solar industry expands, the need for innovative instruments is expected to increase manyfold. This chapter also highlights the ISA flagship initiatives for innovative solar financing. Below are some of the innovative tools and methods for solar energy financing discussed in the next section.

Brief explanation of Innovative tools	And their objectives
A **green bond** is a type of fixed-income instrument in which the issuer commits to investing the proceeds raised by the bond issuance to investments in projects with environmental benefits, also referred to as green projects.	The money raised from investors is used exclusively to finance projects with the objective of creating a positive environmental impact, such as renewable energy and green buildings.
A **sustainability-linked bond** is a borrowing instrument where financial and structural characteristics are based on whether the issuer achieves sustainability or ESG metrics within a given timeframe. If the company doesn't meet those goals, there's a penalty, higher interest paid to investors. SLB is a forward-looking performance-based instrument.	This type of bond aims to further strengthen the important role of debt markets in financing and inspire companies to contribute to sustainability from an ESG perspective.
Exchange traded funds are a type of pooled investment security that operates much like a mutual fund. Typically, ETFs will track a particular index, sector, commodity, or other assets, but unlike mutual funds, ETFs can be purchased or sold on a stock exchange the same way that a regular stock can. ETFs can even be structured to track specific investment strategies	A clean energy ETF aims to diversify an investor portfolio by investing in stocks of companies in the alternative energy sector, such as hydro, geothermal, solar, and wind power.
An **Infrastructure Investment Trust (InvITs)** is a collective investment scheme like a mutual fund, which enables direct investment of money from individual and institutional investors in infrastructure projects to earn a small portion of the income as return.	The objective of InvITs is to facilitate investments in the energy infrastructure sector.
Blockchains are an emerging technology that has drawn considerable interest from energy supply firms, technology developers, financial institutions, and national governments. Blockchain as a digital pioneer through the infrastructure value chain has the potential to open new resources of financing and gather existing industry efforts to reduce carbon by establishing new funding platforms.	The goal is to reduce the capital cost of solar infrastructure projects while improving liquidity, transparency, and access to finance.
Credit enhancement is a technique for improving the credit risk profile or the creditworthiness of a business or a structured financial transaction. It may involve internal or external actions, such as obtaining insurance, surety bonds, additional collateral, or sinking funds, that reduce the default risk for lenders or investors.	The main aim is to improve the credit quality of projects that have reached a certain minimum threshold, to attract more private capital for the project.
Crowdfunding: Crowdfunding will attract implementable, cost-effective, scalable, and innovative solutions to some of the persistent challenges faced by the solar energy sector.	The core objectives of the program are to identify innovative solar solutions, promote the local start-up ecosystem and catalyze growth potential for the African nations.
Blended finance is the strategic use of development finance for the mobilization of additional finance towards sustainable development in developing countries can help mobilize commercial investment towards clean energy, whilst preserving scarce public resources for wider climate and development objectives.	Blended finance plays an important role in bridging the clean energy funding gap by providing an improved risk-return proposition for the private sector.

Other miscellaneous ways to enhance solar financing

Apart from the innovative tools mentioned above to finance renewable energy projects around the world, there are several other organizations working to increase investments in renewable energy in a focused way.



4.1 Green bonds issuance experienced its first YoY drop for a decade reaching ~$487bn in 2022

The use of bonds to finance large-scale low carbon climate resilient (LCR) infrastructure directly or to fund lending is not new. The very first green bond was issued in 2007 with the AAA-rated issuance from multilateral institutions European Investment Bank (EIB) and World Bank. The market started to kick off in 2014 and since then each year has closed at record all-time highs[47].

Green bonds are fixed-income instruments or debt securities that are earmarked to raise money for environmentally beneficial projects and encourage sustainability. These bonds help bridge the gap between capital providers and green assets by providing issuers access to long-term capital and investors with greater visibility over the usage of funds.

Green bond issuance has grown exponentially over the past decade, reaching $582 billion globally in 2021 alone and ~$2.1 trillion since the market began in 2007. Hence, green bonds have become an essential tool for mitigating the impacts of climate change. Green bonds have shown a record growth of 95% between 2020-21.

In 2022, green bond issuance experienced its first YoY drop for a decade, reaching $ 487 billion (16% lower than 2021 volumes). Global green bond issuance is expected to rebound in 2023 amid supportive policies, a more certain interest rate environment and a catch-up of postponed issuances from last year. Green bonds as a percentage are still around 2% of the global bond market[48].

47 Explaining green bonds | Climate Bonds Initiative
48 Sustainable Debt, Global State of the Market 2022, Climate Bonds Initiative

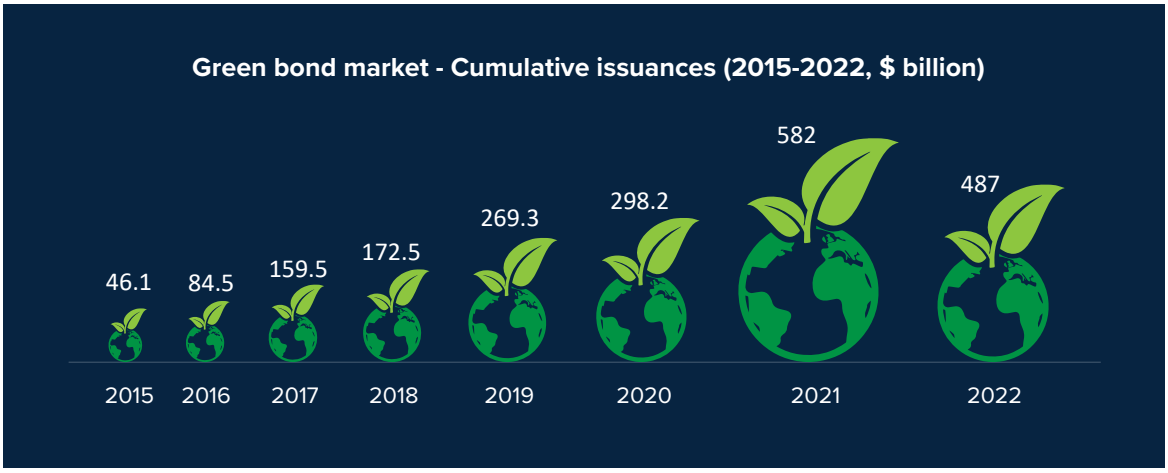


Figure 43 Green bond market - Cumulative issuances (2015-2022, $ billion)
Source: Climate Bond Initiative

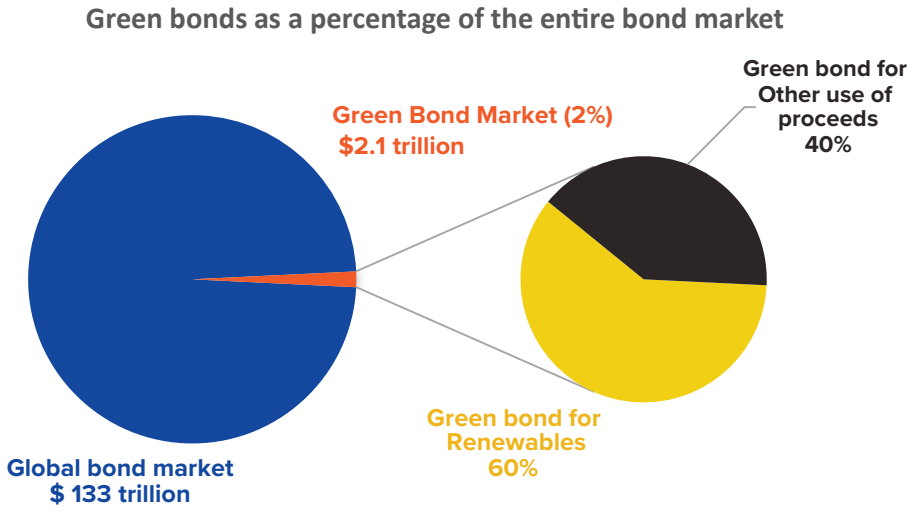


Figure 44 Green bonds as a percentage of the entire bond market
Source: Environmental Finance database 2022

The green bond market has experienced tremendous growth over the past decade, with Europe leading region-wise issuance and corporates dominating the type of green bond issuer

Europe accounted for almost half of global green bond issuance in 2022, followed by Asia Pacific, and Africa and Latin America. Cumulative issuance of green bonds since 2007 was also led by Europe accounting for 46% and Asia Pacific for 24%[49].

At the country level, China led the global green bond issuance in 2022 with $85 billion, followed by the USA with $64 billion. USD and EUR were the two most important issuance currencies, but green bonds are now issued in over 30 currencies. France, the fourth-largest green-issuing nation in 2021, has fallen to fifth place in 2022[50].

49 Sustainable Debt, Global State of the Market 2022, Climate Bonds Initiative
50 Green bonds issued globally by country 2022 | Statista

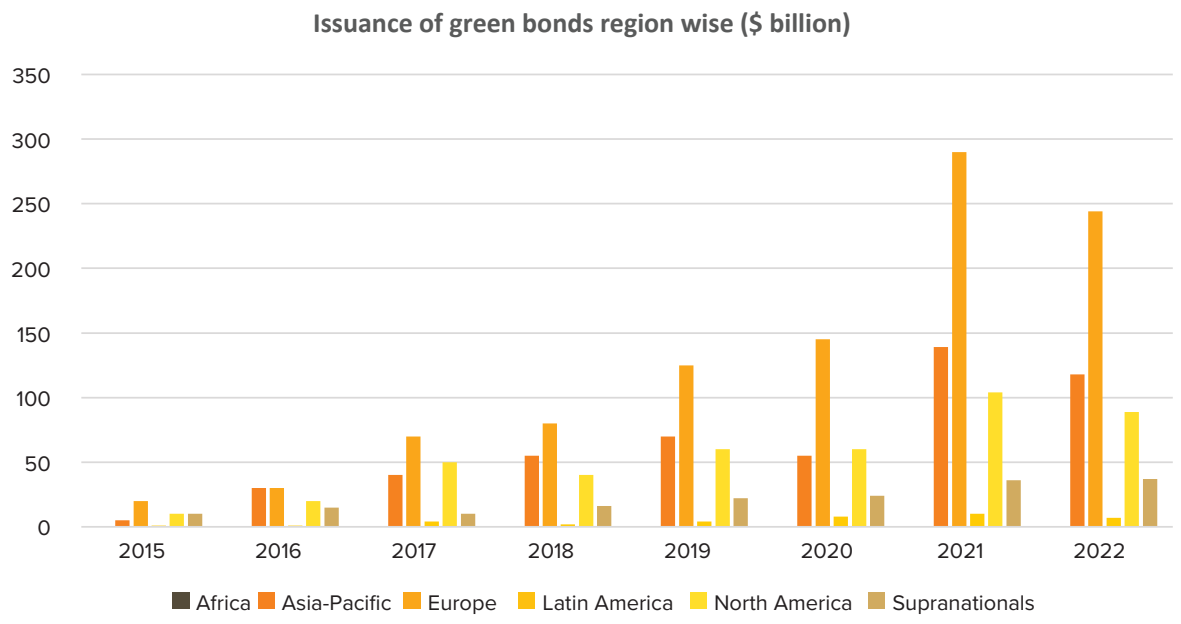


Figure 45 Issuance of green bonds region wise ($ billion)

Source: Statista

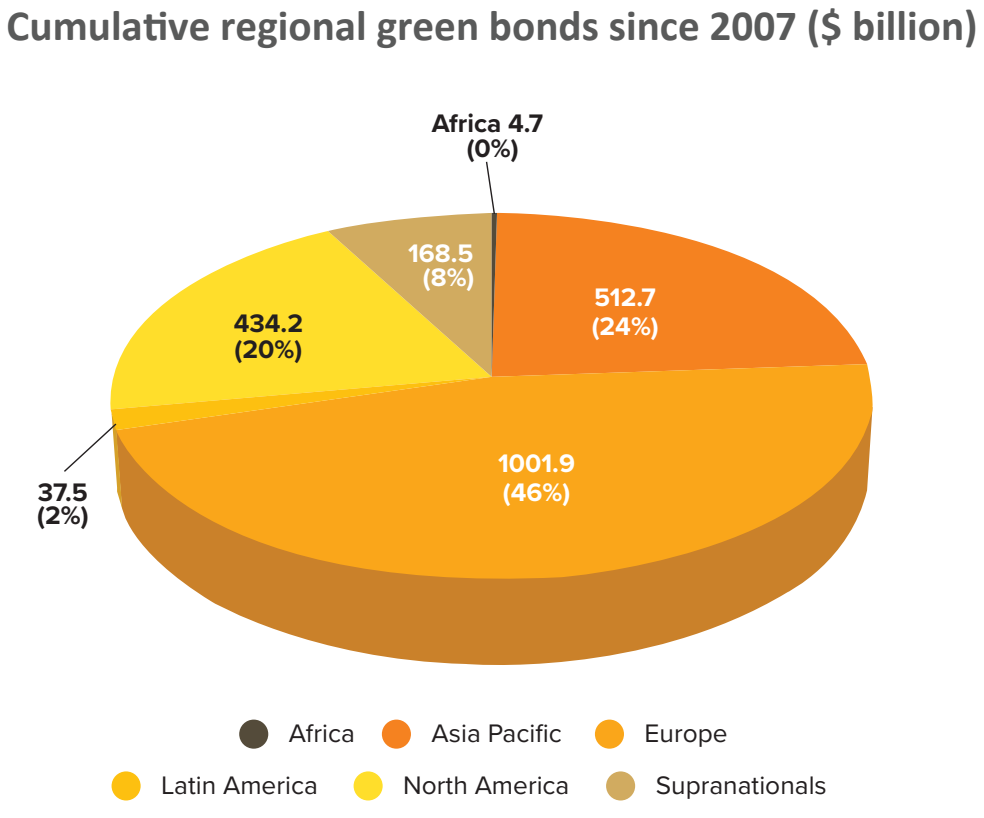


Figure 46 Cumulative regional green bonds since 2007 ($ billion)

Source: Climate Bond Initiative

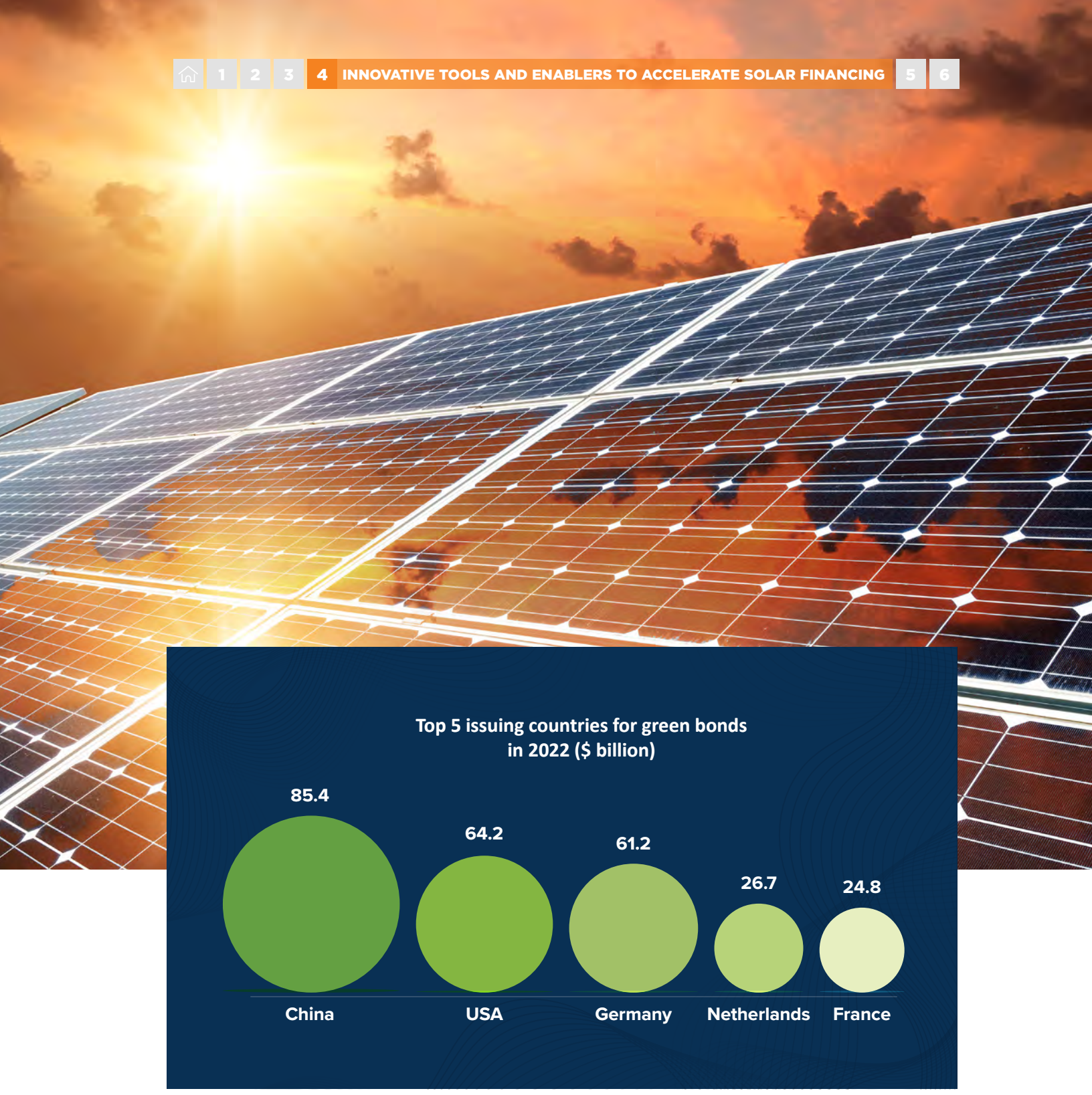


Figure 47 Top 5 issuing countries for green bonds in 2022 ($ billion)

Source: Statista

Over the years, many private and public institutions, including governments, government agencies, large corporations, and financial institutions, have issued green bonds, overtaking the once market-leading multilateral financial institutions. In 2022, corporations contributed to ~ 54% of global green bond issuances by value[51].

51 Sustainable Debt, Global State of the Market 2022, Climate Bonds Initiative

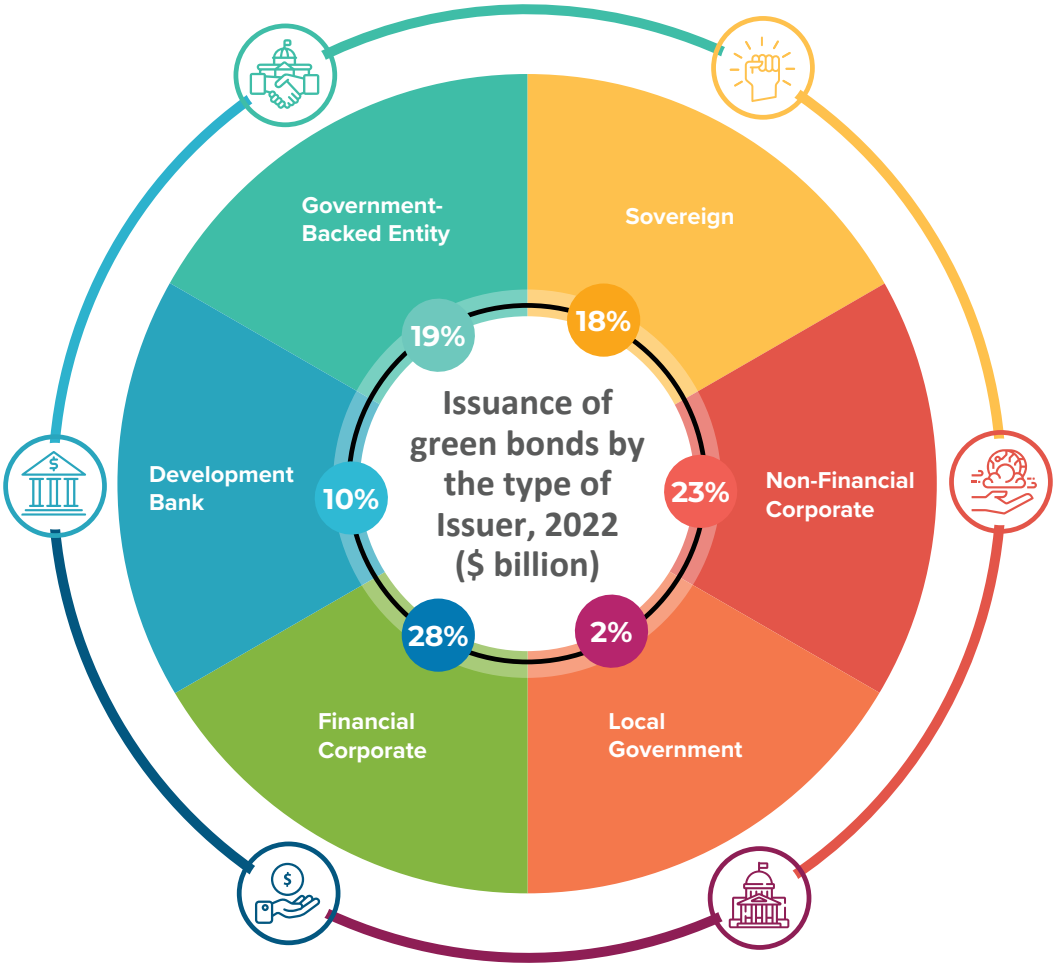


Figure 48 Issuance of green bonds by the type of Issuer, 2022 ($ billion)
Source: Climate Bond Initiative

Renewable projects attract a majority of the use of proceeds of green bonds

Most green bonds finance multiple categories such as renewable energy, energy efficiency, clean transportation, etc. In **2021**, the renewable energy category records the largest share of green investment across all sectors and issuer types, followed by investment in low-carbon buildings and clean transport. Renewable energy dominated the green bonds market while accounting for **42%** of the use of proceeds, followed by green building projects at **30%** share[52].

52 Green Bonds for Renewable Energy 2022, IRNEA

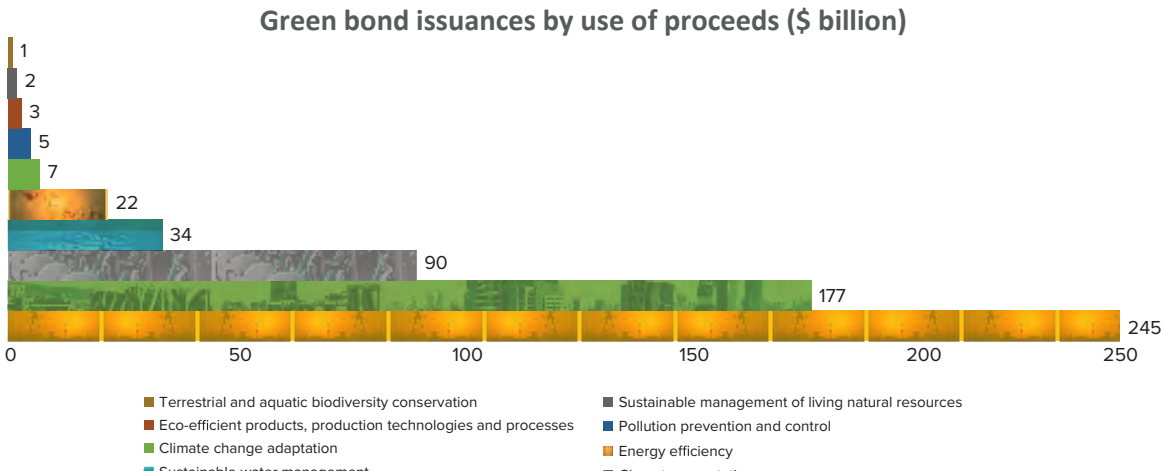


Figure 49 Green bond issuances by use of proceeds ($ billion)

Source: Green bonds for Renewable Energy 2022, IRENA

Key Takeaways:

- **Investing in green bonds provides a way for the corporates and institutions to signal their green energy commitments and provide adequate financial returns.**
- **Green bonds are particularly important for mobilizing institutional investors because they manage about $ 107 trillion of assets and still do not contribute significantly to clean energy transition projects. Also, such institutions have indicated a strong preference for indirect investments in RE assets through funds or bonds.**
- **Developing countries are increasingly raising money for climate action by issuing green and sustainability bonds.**
- **Colombia, Egypt, India, and Indonesia are among 19 emerging-market countries funding renewable energy and mass transit from the proceeds of green bonds.**
- **Average size of green bonds issued in the 2007-2019 period was $180 million whereas that of green bonds dedicated to renewables had an average issuance size of $364 million (IRENA)**

4.1.1 Climate Resilience Bonds

Resilience bonds is a sub-set of green bonds, seek to raise funds precisely for climate resilient investment. These investments improve the ability of assets and systems to persist, adapt or transform in a timely, efficient, and fair manner that reduces climate risk and unlocks broader development benefits. While green bonds support projects with a wide range of environmental benefits, climate bonds support investments in new and existing climate change-related projects. Most climate-themed bonds are use-of-proceeds bonds issued by governments or multinational banks. The Climate bonds standard issued

by the Climate Bonds Initiative(CBI) are voluntary guidelines for the structuring and management of these bonds[53].

In 2019, the CBI launched the "Resilience Bond Principles", highlighting an opportunity for the creation of a new resilience bond market. The principles focus on investments that deal with physical climate risks either by increasing the climate resilience of hard infrastructure or by advancing soft processes (e.g. operational improvements, technology development). The principles require that the issuer/borrower demonstrate that they understand the climate risks faced by the asset, activity, or system in question; have addressed those risks through the design and implementation of the project, and are regularly monitoring and making adjustments to maintain the asset and/or systems resilience over time.

European Bank for Reconstruction and Development Climate Resilience Bond

The European Bank for Reconstruction and Development issued the first-ever dedicated climate resilience bond in 2019. The 5-year bond raised $700 million at issuance. The proceeds are to finance the bank's existing and new climate-resilience projects in a manner consistent with the CBI "Climate Resilience Principles". These projects included climate-resilient infrastructure, agriculture, and ecological systems in addition to climate-resilient business and commercial operations[54].

4.2 Europe emerged as a leader in sustainability-linked bonds (SLBs) with 68% global share in 2022

SLBs provide companies or governments with a flexible way to access the green debt market, especially sectors those that are difficult to decarbonize or areas where decarbonization measures are needed at the organizational scale. These bonds resemble traditional bonds but have a distinctive structure in which the interest paid to bondholders can vary based on whether the issuer achieves certain sustainability goals, such as reducing emission intensity or absolute emission reduction[55].

Unlike green bonds, SLBs do not need severe reporting on the use of proceeds, making them available to a wider range of companies and governments who may have difficulty identifying enough projects that would meet the use of proceeds constraints. SLBs has been used by many industries, including fossil fuel operators, especially in China, and utilities in Europe. Chile and Uruguay have piloted the issuance of sovereign SLBs tied to GHG reduction targets. SLBs can be a valuable source of transition funding, although there are occasional circumstances that raise concerns about the perceived justification of financial benefits to an issuer, for example, such as when specific sustainability goals have been achieved at the time of issuance or when companies with higher emissions profiles use these bonds while having less ambitious decarbonization targets than their peers[56].

53 What are resilience bonds and how can they protect us against climate crises? - Global Center on Adaptation (gca.org)
54 Innovative Financial Instruments for Climate Adaptation - Innovative Financing For Adaptation (iisd.org)
55 Energy Transition Investment Trends 2023, BNEF
56 World Energy Investment Report 2023, IEA

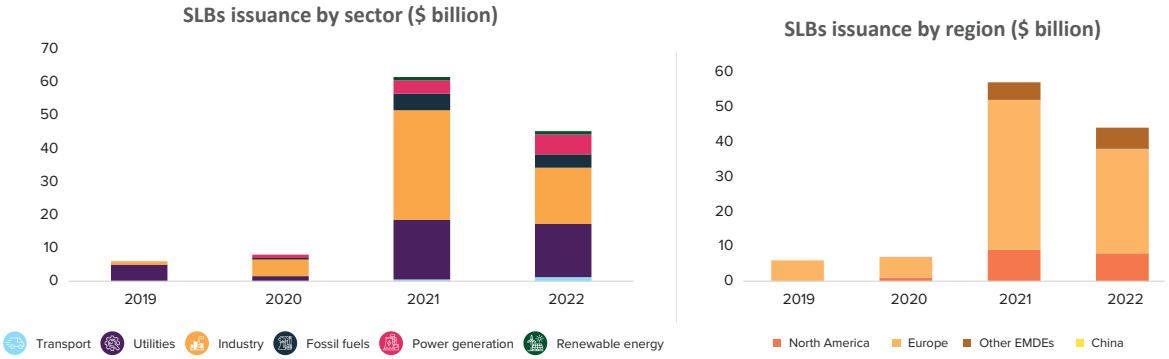


Figure 50 SLB issuance by sector and country , 2019-2022

Source: IEA, BNEF

Case study: Agricultural Development Bank of China

The Agricultural Development Bank of China introduced its sustainability bond framework in 2018. The framework outlined eligible project categories such as sustainable water and wastewater management, sustainable management of living natural resources and land use, and renewable energy. The framework states that net proceeds associated with issuing a sustainability bond will be used to finance green assets (e.g., sustainable water, wastewater management, agriculture, and forestry projects) and social assets (e.g., affordable housing, basic infrastructure, and education for impoverished populations).

4.3 Global Exchange Traded Funds saw its first decline of 5% in 2022

ETFs were first evolved in the 1990s in the USA to give admittance to uninvolved, filed assets to individual financial backers. The SPDR S&P 500 ETF (SPY), which State Street Global Advisors launched in 1993, is credited as the first ETF. The ETF market has grown dramatically and the most disruptive trend in the wealth management industry over the past two decades has been the rise of exchange-traded funds (ETFs). Since 2015, total ETF assets have grown at an annual rate of approximately 22%[57].

Traditionally, ETFs have been associated primarily with passive investing as they typically track the performance of a wide range of stock indices. The ETF landscape is just beginning a new phase of growth fueled by the rise of active ETFs. Last year (2021), global exchange-traded funds (ETFs) saw record inflows of $1.2 trillion, up nearly 70% year-on-year. Net worth has increased to a record ~ $10 trillion. US ETFs were the largest beneficiaries at $901 billion, while European and Asian ETFs received about $190 billion and $88 billion respectively[58].

The value of assets of exchange-traded funds (ETFs) worldwide grew markedly during the period from 2003 to 2022, reaching almost $10 trillion in 2022. However, a volatile year marked by bear markets, rising inflation, and soaring interest rates have affected the global exchange-traded fund industry, leading to a decline in investment. The global ETF market has decreased by around 5% YoY in 2022. The number of ETFs worldwide grew as well during the period, from 276 in 2003, to 8,754 in 2022[59,60].

57 A Brief History Of Exchange-Traded Funds (investopedia.com)
58 Global ETFs saw record inflows in 2021 | Reuters
59 Assets of global ETFs 2022 | Statista
60 Number of ETFs worldwide 2022 | Statista

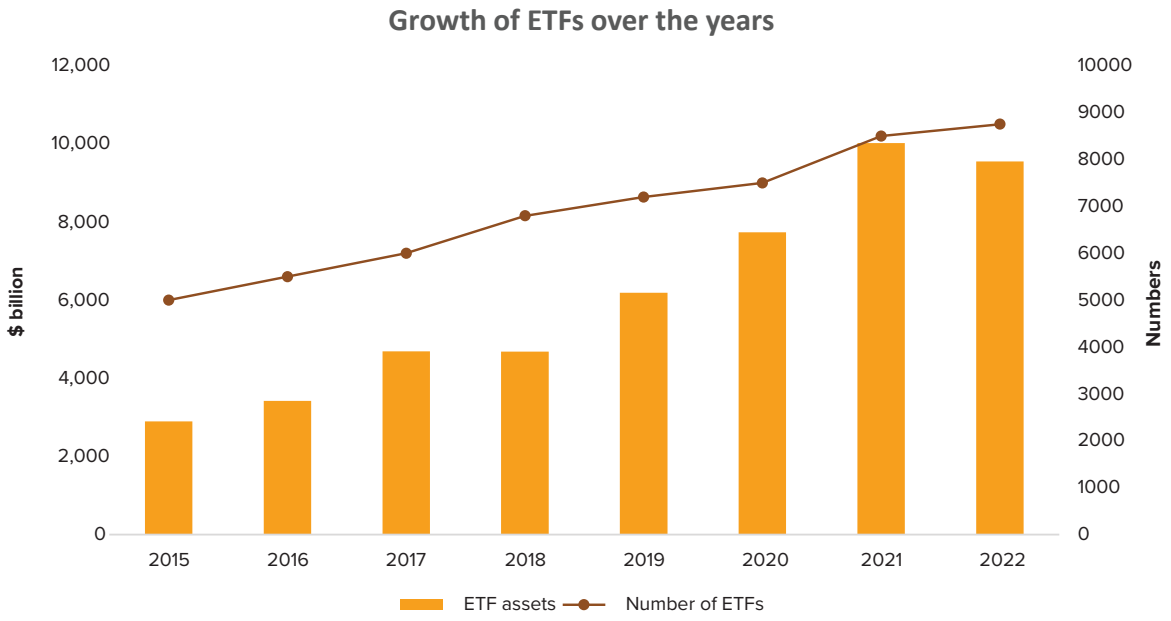


Figure 51 Growth of ETFs over the years

Source: Statista

Clean energy and Solar ETFs are now popular assets with high returns.

A clean energy ETF is an exchange-traded fund that invests in stocks of companies in the alternative energy sector, such as hydro, geothermal, solar, and wind power can diversify an investor's portfolio. Solar ETFs, on the other hand, provide investors with access to investing in the solar industry. However, many solar stocks fall within a broader range of renewable energy ETFs. The top-performing clean energy ETFs are shown along with their total market value i.e., assets under management (AUM) value[61].

61 Alternative Energy Equities ETFs (etfdb.com)

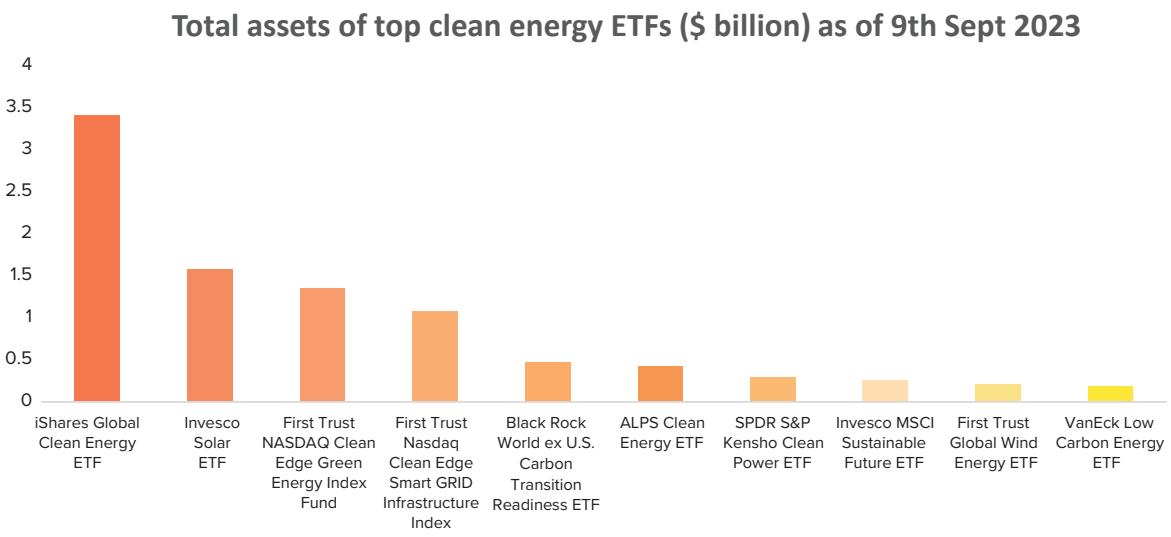


Figure 52 Total assets of top clean energy ETFs ($ billion) as of 9th Sept 2023

Source: etfdb.com

Best-performing clean energy ETFs

Here are the top 5 clean energy ETFs over a 5-year period and their performance since August 2019. Invesco Solar ETF has the highest return among clean energy ETFs with a return of 22.17% while it is down 24% YoY as of August 31, 2023[62].

Top 5 Clean Energy ETFs Return

Symbol	Fund name	5-year return
TAN	Invesco Solar ETF	22.17%
QCLN	First Trust NASDAQ Clean Edge Green Energy Index Fund	19.15%
ICLN	iShares Global Clean Energy ETF	14.99%
SMOG	VanEck Low Carbon Energy ETF	14.46%
ACES	ALPS Global Clean Energy ETF	11.08%

Invesco Solar ETF (TAN) trend during the last 5 years

The performance of a fund system is expressed in terms of net asset value per unit. Net asset value per unit is the market value of securities divided by the total number of units on a given date.

On April 15, 2008, Invesco launched its first solar exchange-traded fund (ETF), the Invesco Solar ETF. Its goal is to replicate the MAC Global Solar Index. The index is comprised of a variety of companies engaged in the solar power industry, including companies that manufacture parts for solar power equipment, companies engaged in the installation or infrastructure of providing solar energy, and companies that market solar energy to power companies and the public[63].

62 6 Best-Performing Clean Energy ETFs for July2023 - NerdWallet
63 Solar Energy ETFs - Overview, Examples, Components (corporatefinanceinstitute.com)

Symbolized as TAN, this ETF offers targeted exposure to the solar sector. There are about 35 individual components of TAN (including US and international equities). Its highly targeted focus is on those who invest in the solar energy sector. For $55.73 as of September 1, 2023, the company has approximately $1.63 billion in total assets under management and an expense ratio of 0.69%.

As observed in the graph, TAN performance decreased by almost 24% over the period 2022-2023. Solar energy stocks have struggled over the past year for a variety of reasons. Earnings are sluggish, rising interest rates are reducing the viability of solar energy and commodity prices are falling but ETFs are expected to continue to grow as countries increase focus on Solar Energy quantity and assets[64].

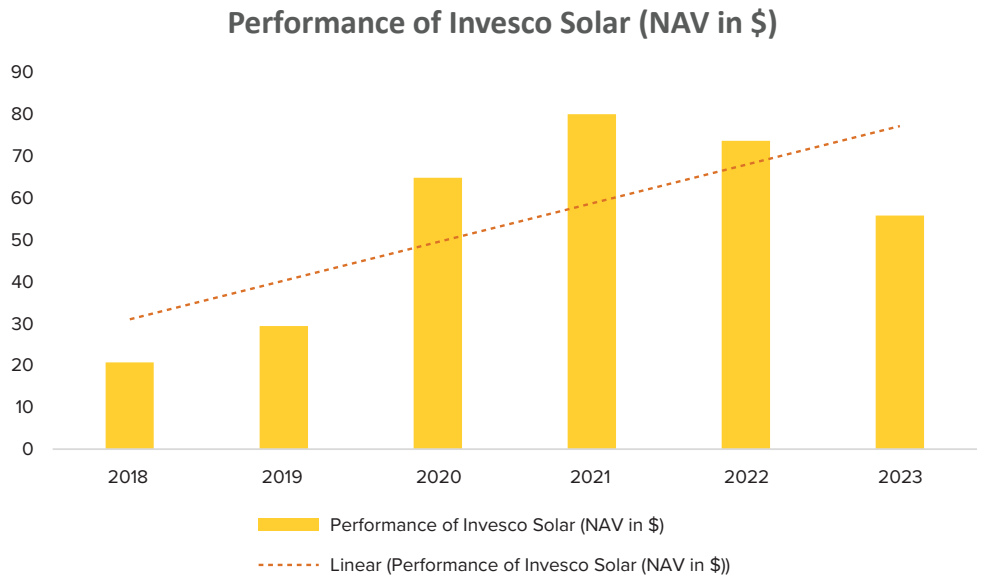


Figure 53 Performance of Invesco Solar (NAV in $)

Source: etfdb.com

Key Takeaways:

- **ETFs are a great tool for investors to diversify their portfolio as they are simple marketable tools and can either be used for long-term investment purposes or short-term market.**
- **Clean Energy ETFs and Solar ETFs are gaining momentum.**
- **There are only 3 ETFs dedicated to solar energy - Invesco Solar Energy ETF ($1.63 billion), iShares MSCI Kuwait ETF ($58 million), and Global X Solar ETF ($7.2 million) as of September 1, 2023.**
- **iShares MSCI Kuwait ETF and Global X Solar ETF are relatively new and introduced in 2020 and 2021 respectively.**
- **With countries increasingly focusing on solar, the ETF is expected to further grow in volumes and asset value.**

64 Solar Energy ETF List (etfdb.com)

4.4 Renewable Energy assets in the Yieldcos gained momentum as InvITs since 2015

An Infrastructure Investment Trust (InvIT) is a collective investment scheme that facilitates individual and institutional investors to directly invest money in infrastructure projects to earn a small income as a return. Once a project is complete and ready to generate a profit stream for an extended period, a developer can deposit the project into an InvIT, thereby unlocking capital for the next project. These structures are not new to solar power—in the United States, they are known as "YieldCo".

NextEra Energy, TerraForm Power, and Atlantica Yield are among them. Yieldcos are a financial innovation in the United States, and they have proven effective in attracting and drawing low-cost capital to term-finance working sustainable energy resources[65].

Risks associated with individual assets, such as payment defaults, are reduced when renewable energy assets are combined under a yieldco, possibly in conjunction with other contractual agreements. This can help bring in new investors, including those who may not have the interest, capacity, or channels to invest in renewable energy projects individually.

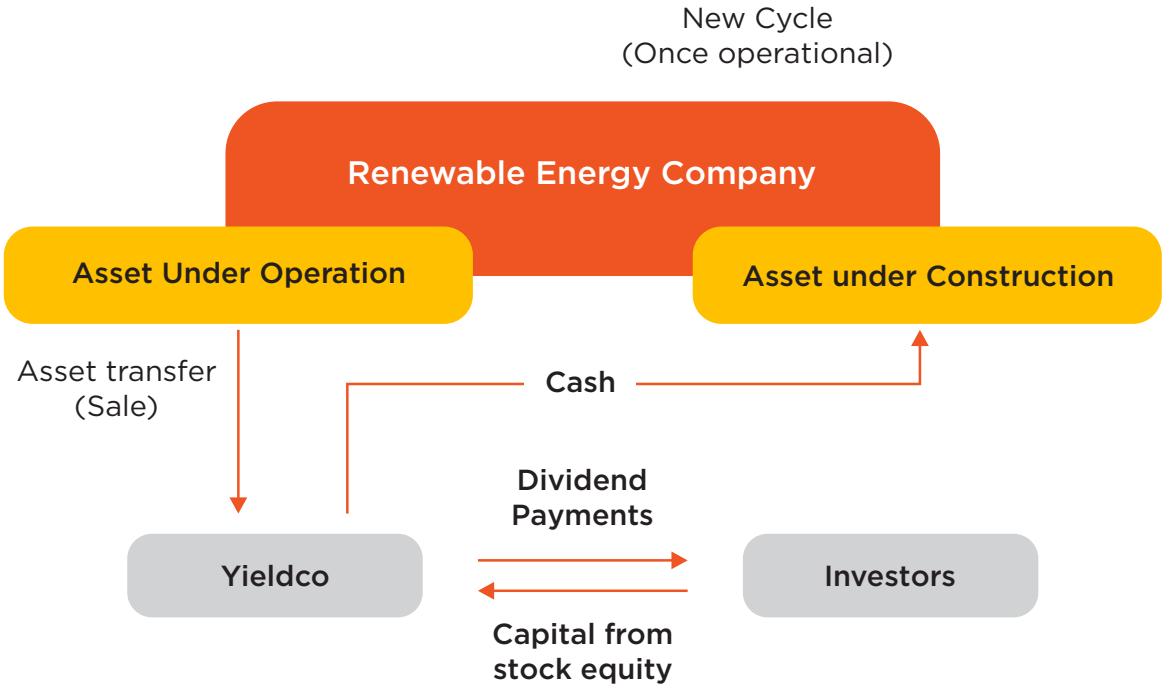


Figure 54 Simplified flowchart of yieldco cycle

65 Yieldco Asset Management (Global) - OECD

Yieldcos/InvITs share history: ups and downs

In 2013, developers like NextEra, SunEdison, and others established yieldcos for the first time in the United States driving the way. From July 2013 to June 2015, seven yieldcos in the USA were recorded and the design was generally welcomed by the financial backers as the organizations raised over $3.5 billion. After that, YieldCo "bubble" started to crash in mid-2015 and seven companies combined lost almost 55% of their market capitalization between July 2015 and February 2016, causing the market to plunge, primarily due to the failure of SunEdison[66].

In the fallout of the emergency that the YieldCo stocks went through in 2015 and 2016, where the YieldCo stocks performed inadequately compared with different record benchmarks, the sector was rebuilt in the following years. The organizations have given indications of recuperation and have, now and again, even beat the market and the utility benchmarks. The exhibition of each stock in 2020 onwards can be viewed as sure, since, by and large, the stocks had returns close to or over the S&P benchmarks. The key InvITs in the climate index as well as their price trends over the past five years are depicted in the figure below. In disparity to the S&P 500, the most broadly followed equity index that tracks the stock performance of 500 large companies listed on US stock exchanges, as depicted in the graph below[67].

Figure 55 Price trends of major yieldcos/InvITs vs S&P 500 (as of 9th September 2023)

Source: Google Finance

66 The Evolution of the YieldCo Structure in the United States
67 Google Finance

InvITs market structure emerging in India

The Securities and Exchange Board of India (SEBI) implemented InvIT in 2014. Since then, InvIT has been registered on infrastructure assets such as roads, power transmission facilities, etc. InvIT is a popular investment instrument, in which an individual and/or an organization buys shares. It is a means of pooling capital to invest in an asset. InvIT is designed to provide a more stable financial instrument for infrastructure investments. Considering India's rapidly increasing demand for renewable energy, Virescent was established in 2020 to acquire renewable energy assets. Virescent became India's first privately listed renewables-focused InvIT in September 2021. As of March 31, 2023, Virescent had grown to a portfolio of 16 operating solar projects with a total capacity of 538 MWp and an AUM (asset under management) of Rs 4,121 crore (~$502 millions). since its inception[68].

AnZen India Energy Yield Plus Trust is a diversified and growth-oriented energy InvIT focusing on high quality energy assets, with an initial AuM of over INR 2,300 cr(~$280 millions). The Initial Portfolio Assets comprise power transmission projects spread across the states of Bihar, Punjab, and Haryana with a total network of 427.4 kms, and right of first offer (ROFO) assets comprising 12 renewable energy projects together have an aggregate generation capacity of 813.2 MWp (Megawatt peak) spread across Rajasthan, Andhra Pradesh, Uttar Pradesh, Telangana, and Punjab[69].

68 Virescent
69 About Us – Anzen Energy

Advantages and disadvantages of yieldcos/InvITs

InvIT is open to anyone who invests in the capital markets. The benefits of InvIT are:

- By investing in InvIT, investors can diversify their portfolio with steady growth and distribution. They provide investors with high dividend yields and the potential for dividend growth by purchasing assets that generate new cash flows. The yieldco/InvIT structure is low-risk securities.
- InvIT owns long-term infrastructure assets with outstanding credit quality and low price and demand risk. These assets provide a clean visible return to its investors.

However, there are a few risks while investing in InvIT:

- There may be delays in collection, one-time costs, or even price changes. All of these affect the company's cash flow.
- Debt is the main source of financing for most infrastructure projects. Interest rate fluctuations can pose a refinancing risk.

4.5 Blockchain technology has the potential to open new resources for solar financing

As an emerging technology, blockchain is attracting attention from a wide range of companies around the world, including energy companies, startups, technology developers, financial institutions, governments, and academic institutions. Some industry executives believe blockchain technology has the potential to bring substantial advancement and benefits. For example, blockchain technology was inspired by decentralized digital currency[70].

Blockchain as a digital pioneer through the infrastructure value chain has the potential to open new resources of financing and gather existing industry efforts to reduce carbon by establishing new funding platforms. The goal is to reduce the capital cost of solar infrastructure projects while improving liquidity, transparency, and access to finance.

Why does blockchain matter for clean energy projects such as solar?

- Blockchain technology connects investors and consumers to renewable energy projects. Distributed ledger technology is a revolutionary new way to facilitate investment in green energy by providing a platform that links development projects with investors and energy consumers.
- Blockchain-Enabled microgrids allow communities to use local renewable energy sources.
- Blockchain can facilitate peer-to-peer solar energy trading, simplifying the process of connecting solar producers with consumers who want access to sustainable energy.

Australian startup Power Ledger has used the blockchain platform for this purpose. They note that their service allows solar producers to get paid instantly for the energy they produce, unlike the typical 60- to 80-day utility billing cycle. This approach could provide an alternative to net metering. It could also offer a solution to the same challenge that community solar and virtual net metering systems seek to solve – enabling households and businesses that may not be able to go solar on their own, to participate in using energy from outside solar projects[71].

Use case of Blockchain

Sun Exchange is a peer-to-peer solar equipment rental marketplace based in South Africa. The Sun Exchange's mission is to "enable everyone to use solar energy and transition the planet to an abundant, clean energy economy." It is the world's first peer-to-peer solar panel rental platform that enables individuals and businesses around the world to make money while making a positive impact.

Essentially, the company provides a solar-powered crowdfunding platform using blockchain. Investors around the world can purchase individual solar cells/panels in arrays for schools, hospitals, wildlife shelters, and other customers in developing countries. They operate in areas where there is no continuous electricity, but where solar energy is an abundant resource. The systems are leased to customers and investors earn revenue - receive monthly income into their SunExchange wallet or in Bitcoin or South African rand - through energy payments after the project is launched[72],[73].

70 Emerging Trends in Blockchain Technology and Applications: A Review and Outlook
71 5 Reasons Blockchain Is Game-Changing for Solar Energy | Aurora Solar
72 EARN WITH PURPOSE | The Sun Exchange
73 https://www.greentechmedia.com/articles/read/the-sun-exchange-uses-blockchain-for-solar-project-insurance

P2P solar energy trading in India, March 2021

In partnership with India Smart Grid Forum (ISGF), Tata Power DDL2 and Power Ledger launched the first P2P solar energy trading pilot project in Delhi. The uGrid platform from Power Ledger was used in the project, which included 150 solar PV sites with a combined capacity of less than 2MW. Prosumers will offer an overabundance of energy to other private and business buyers in a dynamic pricing environment, profiting from the P2P energy exchange. Power Ledger's blockchain-empowered records of energy exchanges will give close-time settlement and complete straightforwardness in the meantime[74].

4.6 Credit enhancement for green projects: Potential to ease risks and bring surplus capital

Bringing a project to financial closure requires that all the risks of a project to be mitigated or transferred. However, for projects in emerging countries, 'residual' risks that few investors willing to take are usually linked to the country itself. The buyer of energy may not be creditworthy, there is a risk at the legal and fiscal framework environment will change over time, or the new government may want to change price, among other things. Credit improved tools provided more security against default payment and other risks. Credit enhancements can take different forms: for example, stabilizing cash flows can prevent or delay potential difficulties and defaults; Improved collection can reduce losses in the event of default[75].

Credit enhancement schemes meet the need to reduce project risk and attract other sources of financing and investment for the project. This is an external mechanism to increase the credit rating/creditability of a project. The main aim of the credit enhancement mechanism is to improve the credit quality of projects that have reached a certain minimum threshold, to attract more private capital for the project[76].

The different mechanisms commonly used by multilateral banks and development financial institutions are detailed below.

Guarantees as Credit – enhancement mechanisms[77]

In project finance, guarantees are used to stabilize financing and reassure lenders and investors that they will be compensated. In the event of default, most guarantees have simple methods for triggering them. The various ways of available guarantees aim to cover a specific risk or portion of the debt as credit-enhancement mechanisms.

- **Partial Credit Guarantee (PCG)**

An infrastructure project's debt service default risk is covered by a partial credit guarantee, regardless of the reason for the default. This is especially helpful for improving a project's credit profile, allowing it to attract more investors and negotiate better debt terms. PCG can be used for any commercial debt instrument (loans, bonds) from a private lender.

- **Political Risk Guarantee (a.k.a. Partial Risk Guarantee) (PRG)**

PRGs insure private lenders and investors against certain risks associated with lending to government or sub-government borrowers. Thus, by definition, PRG necessarily includes private participation in the project. PRG is used quite often and favorably in green energy/energy efficiency projects. PRG are used quite often and favorably in green

74 Tata Power-DDL rolls out live peer-to-peer (P2P) solar energy trading, a first-of-its-kind pilot project in Delhi — Powerledger
75 PowerPoint Presentation (gfdrr.org)
76 Credit enhancement: a boost to private capital in infrastructure? (worldbank.org)
77 Credit Enhancement for Green Projects by IISD

energy/energy efficiency projects.

- **First loss provisions**

The first loss provision refers to any device designed to protect investors from the loss of capital that would occur first if there were a financial loss. They can also take the form of single-line insurance that guarantees debt securities providers are obligated to compensate investors, regardless of the cause of the loss.

- **Contingent loans**

In project finance, contingent loans are frequently used to support the main debt by offering a payment option in certain case scenarios. For instance, if the government is unable to obtain quality cash flows, the contingent loan is activated, and investors are compensated.

- **Viability gap funding (VGF)**

VGF is used specifically and extensively in infrastructure to cover the critical initial financing needed to launch projects. An analysis of the viability of a proposed project highlights the weaknesses that prevent large-scale funding. A VGF scheme can be implemented through capital grants, subordinated loans or even interest subsidies to target specific issues that are affecting the viability of the project.

Analysis of credit-enhanced infrastructure project by World Bank Group in Nigeria for power sector guarantees is provided below[78].

Although Nigeria's economic growth has accelerated, fundamental problems with local infrastructure remain. Despite its substantial oil resources, access to electricity remains limited. Given limited budgets, it is crucial to reinforce the promotion of private sector investment alongside public investment. The Power Sector Guarantees Project (PSGP), implemented by the World Bank in Nigeria, aims to address the comprehensive gaps in the power sector in Nigeria. PSGP is a loan and guarantee package that supports a wide range of energy projects. Guarantees from the International Bank for Reconstruction and Development (IBRD) include forward-looking risk-sharing and mitigation arrangements, designed to accelerate power sector reform.

Significance

PSGP is innovative because it is deployed on a very large scale and integrates many different tools, including guarantees. The package includes two new green energy projects that benefit from credit enhancement and commercial debt guarantees with the aim of integrating green energy projects into Nigeria's developing economy. The second major instrument is partial hedging, which covers only clearly identifiable risks related to subsidies and tariffs.

78 https://www.iisd.org/system/files/publications/credit-enhancement-green-projects.pdf

Case Study: 'Solar Facility' a partial guarantee mechanism introduced by ISA for accelerating investments into solar sector

To bolster investments in solar power projects, the International Solar Alliance (ISA) on Oct 2022 introduced the 'Solar Facility', a payment guarantee mechanism expected to stimulate investments into solar projects especially in Africa through three financial components - a Solar Payment Guarantee Fund, Solar Insurance Fund and Solar investment fund. The Solar Facility is expected to stimulate high potential solar technologies, by attracting private capital to flow into underserved markets in Africa, while ensuring a payment and insurance mechanism as a first loss guarantee. The Solar Facility ISA would aim to crowdsource investments from various donors across the globe and proposed projects in Africa would be able to purchase payment guarantees or partial insurance premiums from these funds. The Solar Facility is looking to support projects by reducing lenders' apprehensions and enabling finance to flow for projects that otherwise may not have received funding. The payment guarantee fund will only provide a partial guarantee. With minimal default, the guarantee fund would enable investments in geographies that do not receive investments. In addition, the Solar Insurance Fund will reduce the burden of insurance premiums for solar developers in the pre-revenue phase of the project. It will offset the cost of insurance for a specified period. The investment fund would provide the core investment up to 10% of project costs in projects that are participating in the Solar payment guarantee fund and/or solar insurance fund.

ISA flagship initiatives on Solar financing- 'Solar X' to facilitate investment

ISA launched the 'SolarX Grand Challenge' at CoP27 on November 10, 2022, with the aim of accelerating investment, fostering innovation and the startup ecosystem, and exploring local solutions in the African solar sector. It aims to crowdsource implementable, cost-effective, scalable, and innovative solutions to some of the persistent challenges faced by the solar energy sector of the member countries. The first edition will focus on the African region to attract investments in the solar energy sector, reduce the gap between energy demand and supply, and promote a robust start-up ecosystem in Africa. The SolarX will enable three-fold benefits in technology, finance, innovation, thereby building on the start-up ecosystem of the solar energy sector[79]. SolarX will play a leading role in driving the global transition to a renewable energy economy that fosters innovation in solar sector and accelerates a responsible energy transition. The challenge is expected to attract more than 100+ start-ups from all of the African solar sector in its first year. SolarX will select 20 startups and innovators from across Africa and a $ 300,000 cash grant will be awarded to the winners. Winning entrepreneurs will be enrolled in an acceleration program, mentored, networked with investors, and given access to the African market[80].

79 International Solar Alliance (isolaralliance.org)
80 ef6061a90f7fef0ea228704fa4a6d2.pdf (isolaralliance.org)

4.7 Other enablers to enhance renewable energy financing

There are a few other focused organizations that work to increase investments in renewable energy in a focused manner, in addition to the innovative tools mentioned above for financing projects for renewable energy projects around the world.

4.7.1 Joint SDG fund supports countries accelerate progress towards the Sustainable Development Goals (SDGs)

Joint SDG fund is an inter-agency mechanism that incentivizes transformative policy and financing to shift and stimulate strategic investments required to catalyze and accelerate progress against the Sustainable Development Goals (SDGs) at the country level. Below given is an illustrative example of how this program will improve Uruguay's environmental sustainability by helping to deploy low-carbon and decarbonized technologies in industry and transportation.

Innovative finance for clean tech solutions in Uruguay[81]

Uruguay still faces a reliance on fossil fuels for industry and transportation, despite commendable advances in renewable energy. To lead Uruguay's 2nd energy transition, innovative technologies in this area are essential. The program will establish a Renewable Energy Innovation Fund (REIF) with a technical assistance facility to support Uruguay´s 2nd energy transition, to decarbonize the economy and boost competitiveness. A technical support system will also be created to assist companies in validating 2nd energy transition technologies and innovative business models.

The REIF will combat climate change by helping transition Uruguay's transportation and industry sectors to green energy and by providing affordable access to innovative clean technologies. The Joint SDG fund will provide a grant of $ 10 million, leveraging around $70 million of co-financing from regional development banks and private commercial banks. Beyond Uruguay, this program will have a strong demonstrative impact on innovation finance for developing countries.

4.7.2 Dedicated Financial Institutions (FIs) provide a focused approach to the clean energy transition solutions

Some nations have established specialized organizations to oversee the financing and development of renewable energy projects because of the increased focus on the clean energy transition. In India, the public area endeavors that take care of the development of the RE area are SECI and IREDA.

The Ministry of New and Renewable Energy (MNRE) of the Indian government oversees their administration. Each is described in detail below:

Indian Renewable Energy Development Agency Limited (IREDA): Established in 1987, IREDA advances, creates, and expands monetary help for environmentally friendly power and energy proficiency/protection projects in India. It also serves as an implementing agency for the development of solar parks and is in charge of providing developers of solar parks with financial assistance.

Solar Energy Corporation of India (SECI): Established in 2011, SECI, the only government company dedicated to the field of solar energy, was established to facilitate the implementation of the National Solar Mission, which aims to position India as a world leader in solar energy by enabling the establishment

81 Renewable Energy Fund: Innovative Finance for Clean Tech Solutions in Uruguay | Joint SDG Fund

of a policy framework for the deployment of 100GW of solar power projects by 2022.

Clean Energy Finance Corporation (CEFC): Established in 2012, CEFC is a green bank owned by the Australian government that was established to make it easier to get more money into the clean energy industry. The CEFC makes investments in projects related to energy efficiency, low-emission technology, and renewable energy. Financing for the most part given through credits based on business or concessional conditions. The CEFC is responsible for investing $10 billion in clean energy projects for the Australian Government[82].

In addition to these dedicated organizations, several dedicated green banks are emerging in several nations to facilitate the movement of low-cost capital into the clean energy sector. The Clean Energy Finance Corporation of Australia, the New York and Connecticut Green Banks in the United States, Triodos Bank in the United Kingdom, and the Energy Research Office (EPE) in Brazil are just a few examples among others.

4.7.3 Dedicated climate fund offers substantial subsidies to accelerate clean energy transition

The number of climate funds established to assist nations in their climate change mitigation and adaptation efforts, as well as readiness activities, has increased. Banks, multilateral and bilateral financing institutions, and other public and private institutions have all contributed to the creation of these funds. In this section, we will discuss the two most widely popular climate funds.

Climate Investment Funds (CIF)

Under the guidance of the World Bank, the CIFs were established in 2008 to pool international resources and provide developing nations with urgently required assistance in moving toward low-carbon development. It is a leading multilateral climate finance partnership that provides concessional financing for both upstream advisory and downstream investment activities to support climate action through six multilateral development banks (MDBs).

CIF's investments are implemented by partners from the World Bank Group, which also includes the International Finance Corporation, the African Development Bank, the Asian Development Bank, the European Development Bank, and the Inter-American Development Bank. There are two main funds under the umbrella of the CIFs, the Clean Technology Fund (CTF), which grasps nearly 70% of total funding, and the Strategic Climate Fund (SCF)[83].

Green Climate Fund (GCF)

GCF accounts for two-thirds of all multilateral climate finance, making it the largest dedicated fund supporting developing nations. The governments of 194 nations created the Green Climate Fund (GCF), a one-of-a-kind global platform, to address climate change and assist vulnerable societies in adapting to its inevitable effects. Formulated in 2015 by the UN Framework Convention on Climate Change (UNFCCC). The fund's sole purpose is to dedicatedly assist developing nations in moving toward low-emission and climate-resilient development strategies. GCF has arrived at a significant achievement of supporting complete financing worth of $11.4 billion spread over for 209 projects in 128 countries. In 2022, the GCF portfolio reaches maturity, with more than $3 billion disbursed and more than 80% of projects completed[84].

The chart below shows the total investment made by GCF in energy access and power generation projects and the investment made in solar power projects only.

82 Clean Energy Finance Corporation (Australia) - OECD
83 CIF Funding | Climate Investment Funds
84 Green Climate Fund-1, Progress Report, 2023

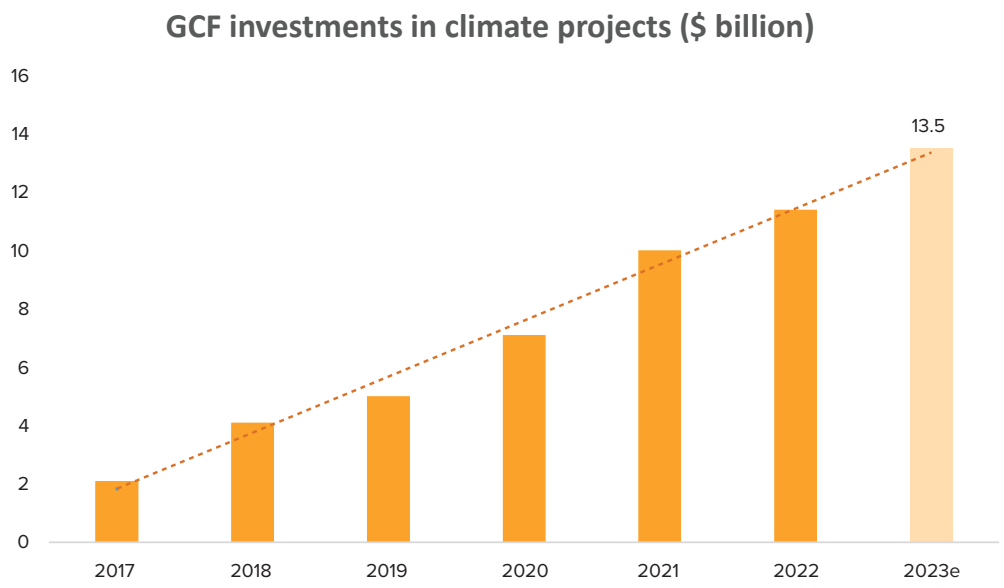


Figure 56 GCF investments in climate projects ($ billion)
Source: Green Climate Fund 2023

- In 2022, the board approved nearly $1.43 billion in GCF funding for new climate projects. By 2023, the portfolio is expected to reach $13.5 billion.
- As of the end of 2022, GCF has committed a total of $11.4 billion of its resources - $42.8 billion with co-

financing—to 209 projects in 128 countries.

4.7.4 Crowdfunding can help support small-scale renewable energy projects

A novel method of raising funds for renewable energy projects, particularly on a smaller scale, has emerged because of a lack of affordable financing options. Crowdfunding is a novel approach in which individuals can invest, frequently in smaller amounts than usual, in projects and concepts with institutional funders. Communities and organizations can now raise money for renewable energy projects through crowdfunding platforms.

So, crowdfunding is a great way to raise money for new, often smaller projects that need to get off the ground and running. Crowdfunding makes it possible to raise money while also enhancing the profile of a project. Additionally, it is often easier than obtaining a bank loan and gives investors the chance to support a local project that could yield substantial returns.

Renewable Energy Crowdfunding Platforms[85],[86]

There are different platforms through which crowdfunding can be done. This choice depends on the stage of the project and the type and size of any required investment. The following is a list of some popular crowdfunding platforms:

Details of some of the popular crowdfunding platforms

Crowdsourcing platform	Description
Kickstarter	Kickstarter gives new projects an often-welcome boost to get started. Creators on the platform offer rewards rather than equity, typically related to the product. They appeal to a whole range of sectors, including renewable energy. Projects on Kickstarter are generally early stages; hence it helps an idea come to life.
Citizenergy	Citizenergy helps the public get involved in sustainable energy projects. It allows investors to own equity, finance renewable energy projects with loans, or purchase bonds in European renewable energy projects and making it possible for projects to access essential financing.
Lumo	Lumo is a crowdfunding platform in France that is owned by Société Générale, a large French bank. Most sustainable energy projects can be funded with smaller sums on the platform. Investors receive a return in interest from the green energy that the projects produce and sell, rather than equity.
Crowdway	Crowdway is the largest equity-based crowd-investing platform in Poland that focuses on startups, SMEs, and green energy projects.
Bettervest	Bettervest is an equity crowd-investing platform based in Germany that focuses on energy-efficient projects that help save resources, cut CO_2 emissions, and reduce expenses. The platform contributes to the development of a society and economy that are more environmentally and climate-friendly by funding sustainable projects all over the world.

85 https://lenderkit.com/blog/crowdfunding-for-energy-projects-market-overview-and-business model/#Crowdfunding_platforms_for_energy_projects
86 Crowdfunding Renewable Energy. Alternative Financing for Clean Energy. (trvst.world)

How crowdfunding could raise $12 billion to boost renewable energy access in Indonesia

Indonesia needs at least Rp 1,600 trillion ($102.4 billion) to achieve its goal of making renewable energy account for 23% of its energy mix by 2025. This is not an easy task, especially for projects of a medium or small scale.

Small renewable energy projects are unattractive and therefore unbankable due to the high cost of large investments. They are forced to rely on grants and government budgets as a result. Indonesia looks for funding elsewhere to achieve its energy mix goal.

According to the research that was done by "the conversation," public crowdfunding may be an option for financing the development of clean energy. They discovered that individuals were indeed eager to invest or donate, which has the potential to finance medium- and small-scale environmental projects without relying on large donors or government funds.

According to their research, it is possible to raise Rp 192 trillion ($12.29 billion) annually for green financing by soliciting public donations. Mass funding has the potential to be one of the country's main drivers of sustainable development if it is optimized. This figure could fund around 5,949 off-grid solar power plants of 1 Megawatt (MW) out of Indonesia's complete 200,000 MW solar plant potential. In less than 24 months, these potential investors anticipate a return of 5-8%[87].

4.7.5 Blended Financing is key to mobilizing additional funds into the clean energy sector

The growing interest among institutional investors to align portfolios with the Paris Agreement has increased demand for investments in bankable clean energy projects. The use of blended finance mechanisms is seen as an effective option to improve project bankability.

The term "blended finance" refers to a strategy for increasing project funding by combining various forms of financing from various sources and/or for various purposes that contribute to development, social, environmental, or humanitarian objectives and generate financial returns. Fundamentally, blended finance is a system that permits associations with various targets to 'invest' alongside each other while accomplishing their own goals.

There are three key characteristics associated with blended finance:

- **Leverage:** Use of humanitarian and/or development finance and philanthropic funds to attract commercial finance into projects.
- **Impact:** Investments that drive development, social, environmental, and/or humanitarian progress.
- **Returns:** Financial returns for private investors in line with market expectations, based on real and perceived risks.

87 How crowdfunding could raise US$12 billion to boost renewable energy access in Indonesia (theconversation.com)

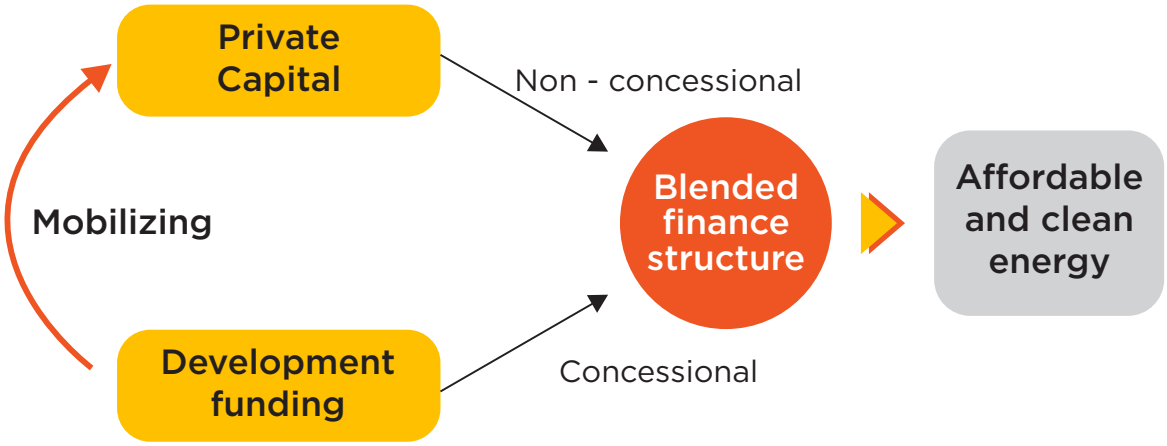


Figure 57 Overview of blended finance, adapted from OCED 2020

What role can blended finance play in bridging the clean energy funding gap?

The role of blended finance is to increase returns and/or lower risks for a commercial entity, which in turn allows it to mobilize private capital to develop markets it would not normally enter. As the private sector puts its own money into the solution, blended finance can help fill funding gaps by providing an improved risk-return proposition for the private sector. Blended finance is seen as a mechanism to mobilize private sector investment to support the delivery of the SDGs[88].

Blended finance to mobilize private capital for clean energy

In several emerging and developing economies, the use of blended finance schemes to facilitate investments in sustainable infrastructure, particularly clean energy, is on the rise. For instance, established government-owned financial institutions with development mandates have been actively supporting the development of clean energy projects in Indonesia and South Africa.

The SDG Indonesia one platform is a blended finance fund in Indonesia that is managed by PT Sarana Multi Infrastruktur (PT SMI). It gives private partners access to a variety of public support schemes, such as grants, concessional finance, and equity access, that can be used to de-risk projects and make them more appealing to commercial lenders. PT SMI has been actively supporting geothermal development in the clean energy sector by providing funding for the extremely risky exploration phase of project development. Additionally, support for the development of small hydro projects is being considered by PT SMI.

In South Africa, the Development Bank of South Africa (DBSA) with capital and specialized help from the Green Climate Fund (GCF) has set up the climate finance office, which mixes GCF assets to work with business finance among local banks. By providing tenor extensions in accordance with the green bank model, this facility makes it easier for renewable energy projects to obtain long-term financing. Another example of a blended finance mechanism that helps projects that

88 Blended Finance Solutions: Bridging the funding gap and driving self-sustaining solutions in displacement settings | Global Platform for Action (humanitarianenergy.org)

do not have a sovereign guarantee backing their power purchase agreement is the DBSA's embedded generation investment program, which is supported by the GCF. It aims to establish a market for embedded generation and supports power projects of up to 75 megawatts through credit enhancement. The objective of this scheme is to demonstrate the viability of renewable projects built without government support[89].

4.7.6 Microfinancing can accelerate the clean energy transition in low-income countries

Energy efficiency, combined with renewable energy, should be the ultimate goal of energy transformation for the world. The unique challenge of energy access is encouraging millions of energy-poor people to leapfrog from a scenario of no electricity and dirty fuel for cooking to a future with the most efficient appliances using electricity generated from renewable sources. Microfinance is the opportunity that helps in procuring cleaner, low-carbon options and it can bridge this gap[90].

Microfinancing of renewable energy technologies could provide a strong impetus for governments of developing countries to increasingly promote the successful and beneficial use of such technologies and therefore pave the way for a more sustainable future. Microfinance can make energy systems more affordable and can benefit both the user and the supplier. While the user can use electricity to increase productivity and improve quality of life, microfinance institutions find in renewable energy a new loan item that will strengthen their user's economic activity and diversify their lending portfolios. The financing option is particularly lucrative for clean energy technologies because the monthly savings on fuels exceed the monthly loan payments and provide several long-term economic benefits for the user in the long run[91].

How Microfinance can expand access to energy

Access to modern energy services can be greatly enhanced if people also have access to microfinance loans to pay for these services. Over the last 20 years, microfinance has played an important role in enhancing the economic opportunities available to poor people, but the experience to date with loans

89 Summary-Side-event-on-Blended-Finance-to-Mobilise-Private-Capital-for-Clean-Energy.pdf (oecd.org)
90 Microfinance and energy access (downtoearth.org.in)
91 3.186_Bunse.indd (eceee.org)

for energy services and products is limited. On the energy side, especially for people living in rural areas, energy services may not be available because energy companies do not typically view them as a strong, viable market for their products and rarely offer company-provided financing options. Microfinance institutions, however, can expand access to energy for poor clients by offering credit and/or loans for energy products and by partnering with local energy companies to help them branch out into new markets that include poor and rural people. As linkages are built between the microfinance and energy sectors, financial institutions may be more willing and able to channel capital into loans for energy services. Access to modern energy services provides a multitude of health, environmental, educational, and gender-equality benefits, but when utilized productively, energy services offer new options for diversifying and increasing incomes—an urgent need throughout developing countries. Investment in modern energy systems by clients of MFIs and by energy companies can become more attractive if these investments are coupled with increased economic productivity[92].

Microfinance Case Study: Grameen Shakti

Grameen Bank, a Bangladeshi bank specializing in lending to the poor, represents one of the most established and prosperous microfinance examples. Grameen Bank has created a family of micro-investment programs to finance the economic activities of the poor community in various fields. Grameen Bank launched Grameen Shakti, a Bangladeshi market-based company created to focus on microfinance for renewable energy. Grameen Shakti is a rural-based renewable energy company, founded as a biogas program in 2005 that rapidly grew to include an improved cooking stoves Program in 2006, and later a solar home systems (SHS) program. By december 2012, Grameen Shakti had installed more than 1 million SHSs in rural areas of Bangladesh. The company uses several options to finance solar projects. Under each option, the homeowner must make an upfront payment (15–25%) and then pay the balance in small monthly installments over a period of two to three years. Using financing micro, Grameen Bank has been able to effectively finance several types of developments, including robust biogas and solar home systems[93].

The Success of Microfinance in Kenya

Kenya represents the most developed financial services market in East Africa, with the highest rate of market penetration of financial products and services. The industry has grown significantly over the last 10 years, both in terms of the gross loan portfolio disbursed and the number of active borrowers served. Similarly, the diversity of financial products and services available to low-income people is notable. Mobile banking and digital financial services are most developed in Kenya and complimentary regulatory policies related to deposit collection, branchless banking, and agent banking have helped the industry grow rapidly in the last decade[94].

In one such case of access to clean energy in Kenya, off-grid solar solutions provider d.light in partnership with micro lender Musoni provided low-income consumers access to solar energy at affordable prices in 2017. Around 600,000 Kenyans got access to solar home systems through an arrangement whereby Musoni absorbs the upfront cost of solar systems and customer services the loan over a certain time in regular small installments. These people reduced kerosene consumption substantially while getting access to clean energy for lighting and running other household appliances such as radio and TV etc[95].

92 Pnadm641.pdf (usaid.gov)
93 Innovative Financing for Renewable Energy (pace.edu)
94 Microfinance to accelerate the adoption of efficient cookstoves and solar lanterns in Kenya - Shifting Paradigms
95 The impact of off-grid solar home systems in Kenya on energy consumption and expenditures

4.7.7 Public Private Partnership (PPP)

A public-private partnership involves a partnership between a government agency and a private sector company that can be used to finance, build, and operate projects. Financing a project through a public-private partnership can enable the project to be completed sooner. PPPs are created on the principle of more efficient and cost-effective provision of public assets than fully state-funded projects, while spreading counterparty risks among public and private. In other words, risks that are best borne by the public sector will persist, and vice versa[96].

The World Bank and the Global Center on Adaptation have noted that PPPs can be a key tool for integrating adaptation and resilience into infrastructure projects. They can also be a point of collaboration between the various parties that can contribute to the success of a project, including government officials, infrastructure operators, asset managers, investors and financiers, private sector and non-governmental organizations. The greater the proportion of public finance included in an investment, the greater the influence that this finance could have on ensuring that projects are implemented in a manner that accounts for projected physical climate hazards and risks.

Because the adaptation benefits of climate-resilient infrastructure may not result in direct revenue but have significant social and environmental value, PPPs are integral to attracting private sector interest to close crucial funding gaps. The participation of public actors will strengthen these projects by encouraging private actors and ensuring the creation of co-benefits.

4.7.8 Venture Capital investment in clean energy startups soars[97]

Venture Capital (VC)[98] refers to investments in early-stage companies, aiding them in commercializing their product and scaling it up until the technology matures for late-stage investors. In the later stages of a company's development, venture capital gives way to private equity, with investors providing a steady stream of capital that can help scale the technology further.

Global VC funding in clean energy startups has increased significantly over the past three years, rising more than six times from $1.9 billion in 2019 to $12.3 billion in 2022, boosted by investment in battery technology and new government subsidy programs in the United States and Europe[99]. There is no doubt that catalysts such as the Inflation Reduction Act (IRA) in the U.S.A. and the corresponding measures in the European Union (EU), such as the Net Zero Industry Act, have helped the clean energy sector grow. Both new laws aim to reduce red tape around regulation and increase subsidies for clean energy solutions, with a substantial potential to strengthen investor interest in the sector in these regions.

Venture capitalists in North America were the main driver in clean energy investment in 2022 funding $7 billion, or about 57%, of the annual total. That funding was up from $5.5 billion in 2021. Europe was the other active region for clean energy investment, with a 2022 total of $3.5 billion. The two regions together account for 85 % of total funding for clean energy startups last year.

96 Public-Private Partnerships (PPPs): Definition, How They Work, and Examples (investopedia.com)
97 Green venture capital firms generally invest in startups that are early-stage, environmentally friendly, and have enormous potential to grow.
98 Venture-capital-and-private-equity--Catalysing-the-solar-se_2022_Solar-Compa.pdf
99 Why Funding For Startups In Clean Energy Is Booming (oliverwyman.com)

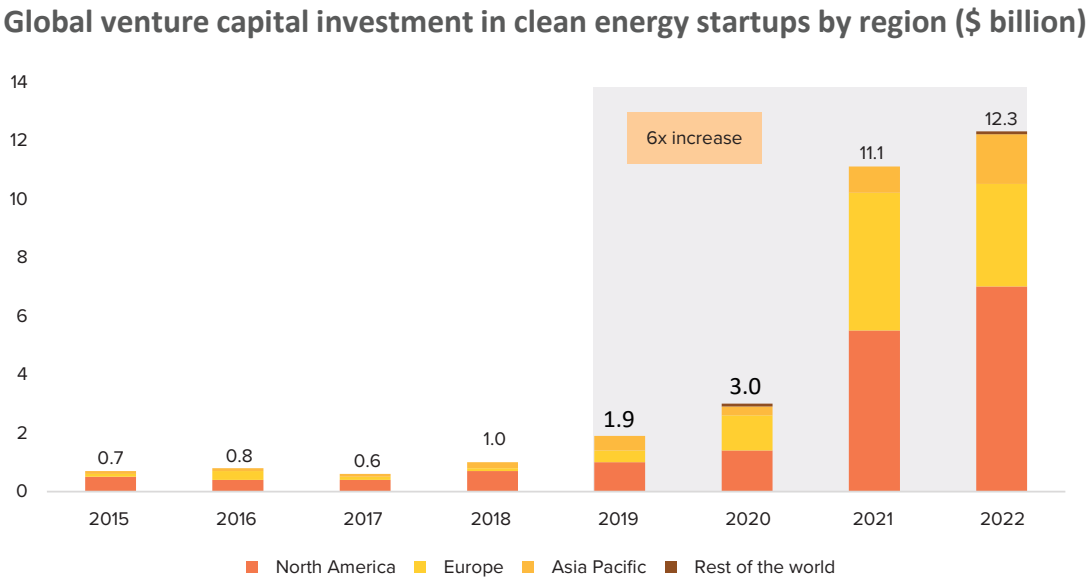


Figure 58 Global venture capital investment in clean energy startups by region ($ billion)

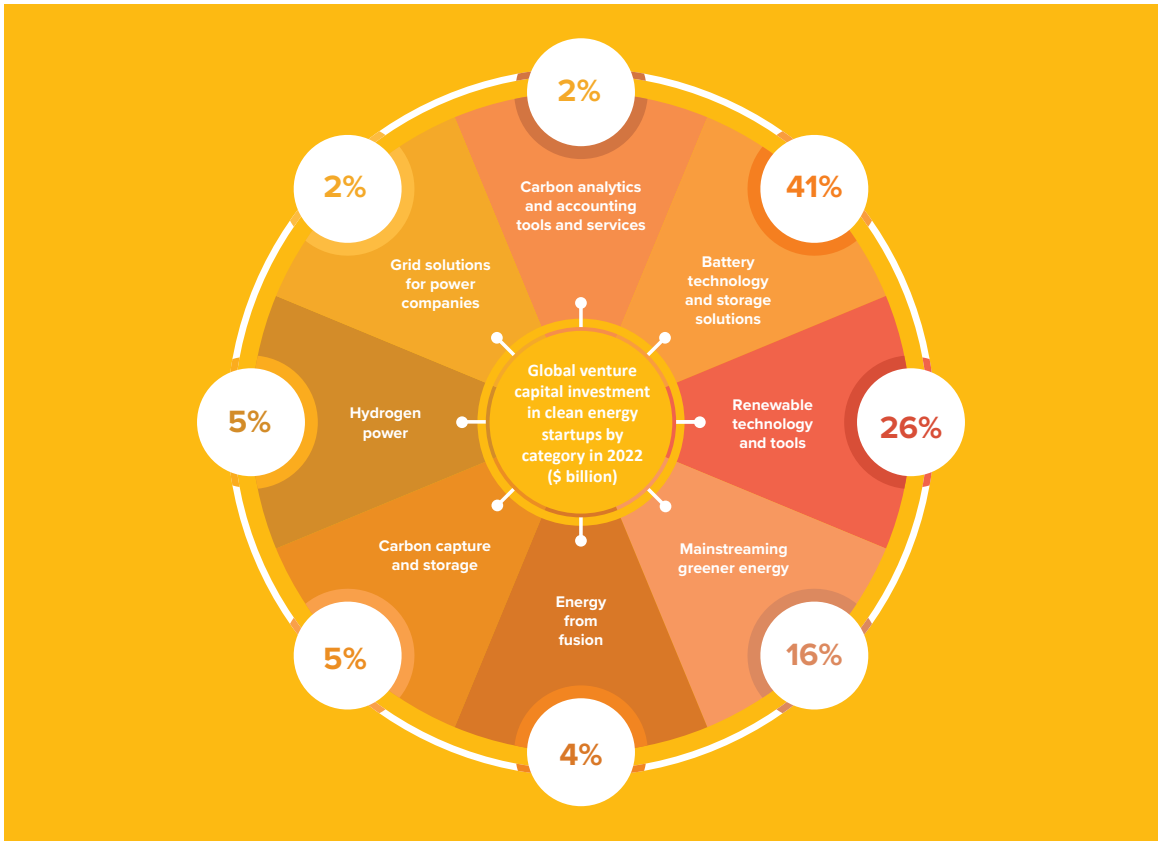


Figure 59 Global venture capital investment in clean energy startups by category in 2022 ($ billion)

Source: Crunchbase, Oliver Wyman analysis

Some examples of top venture capital firms across the globe that focus on clean energy are given below[100].

- **Energy Foundry(founded in 2012 and invested $22 million till now)**

Energy Foundry works with startups in the renewable industry to provide them with the tools and resources they need to grow further and ensure a green future.

- **Energy Impact Partners (founded in 2015 and invested $1.1 billion till now)**

Energy impact partners works with the most influential companies to shape a green and sustainable future. Through close collaboration with strategic investors, this clean energy venture capital firm seeks to bring the best buying power, companies, and vision in the industry to bear on the prominent energy landscape.

- **Clean Energy Venture Group(founded in 2005 and invested $500 million till now)**

Clean Energy Venture Group strives to invest in firms that specifically focus on climate change while ensuring attractive financial returns. They provide funding and bring years of energy expertise to assist businesses in their growth.

Key Takeaways:

- **Venture capital funding of cleantech startups has grown significantly over the past decade.**
- **Venture capital will continue to play a key role in the development of new technologies relevant to solar energy such as grid integration and grid management, as well as in the development of newer and more efficient technologies of solar generation itself.**

4.7.9 Clean Energy Finance and Investment Mobilization Program (CEFIM) can help attract investment in renewable energy efficiency and decarbonization of industry in emerging countries

The CEFI Roadmap was developed by the OECD Clean Energy Finance and Investment Mobilization (CEFIM) team in partnership with the Natural Resources Defense Council (NRDC). It is a strategic plan that builds on the best practices to identify innovative solutions to improve the overflow of capital to the renewable energy sector with a focus on Micro, Small, and Medium Enterprises (MSMEs). It was launched in June 2021 under the guidance of govt of India and chaired by the Ministry of New and Renewable Energy (MNRE).

This program can help India to achieve its clean energy ambitions, bringing together government and private sector stakeholders to agree upon a clear action plan that identifies and addresses bottlenecks complicating or constraining finance and investment in renewable energy and energy efficiency developments. CEFI roadmap will identify opportunities to channel capital into clean energy development at the appropriate scale. This includes identifying innovative financing solutions and effective investment instruments that help strengthen local capital markets, and attract new investors, and international capital for clean energy[101].

100 13 Best Clean Energy Venture Capital Firms (theimpactinvestor.com)
101 oecd.org/environment/cc/policy-highlights-clean-energy-finance-and-investment-roadmap-of-india.pdf

Enabling Environment for Scaling Solar Investments

A strong and predictable enabling environment is essential to help countries plan, implement and accelerate investments in a resilient and low-carbon economy to increase required investments capital. This chapter describes the key verticals needed to increase investments in renewable energy.

The 'enabling environment' requirements are key to directing investments in the solar energy sector that are emphasized particularly in emerging and developing countries. Increasing the required investments flow and adoption of solar energy as part of the net zero journeys requires multiple interventions across the entire value chain. Finally, the need for cooperation among key stakeholders was emphasized to increase the flow of capital to clean energy projects.

5.1 Enable a conductive environment to facilitate clean energy investments through upstream activities such as legal and regulatory framework development

The last decade has seen a great increase in investments in the solar sector, yet there's room for continued growth of investments to make sure that the world attains its net-zero goal and mitigates the adverse effects of climate change. Recently, renewable energy has demonstrated its resilience even during the COVID-19 pandemic and Russia-Ukraine war that has led to a global energy crisis and supply chain constraints, making it more attractive to investors. Transformative change towards sustainable pathways requires more than a simple scaling up. Multiple interventions are important for unlocking potential investments by helping to develop and execute an effective net zero investments strategy as highlighted in Chapter 4.

A comprehensive framework for accelerating investments in clean energy should include the following core areas as discussed below.

5.1.1 Legislative and Regulatory framework to support sustainable energy investments

Regulatory frameworks are legal mechanisms that exist on national and international levels. It ensures investment plans contribute to increasing renewable sources and promotes accessibility through government policy-compliant extensions. The development of a renewable energy framework or action plan can facilitate the development of renewable energy projects that meet basic commercial viability and bankability requirements of domestic and foreign private investors. The framework will support and encourage investments in energy-efficiency projects and projects that support the transition to clean energy[102].

5.1.2 Goals set for the future of renewable energy

With ambitious goals, visionary initiatives and strategies, the world has rapidly accelerated its renewable energy generation endeavors in the last few years. Renewable energy targets are defined by identifying relevant sectors, such as electricity, heating and cooling, and transportation. It will also help assess the current level of risk and a starting point for investors. Strengthening the alignment of investments and assets with net zero trajectories is key to achieving the goals.

5.1.3 Clean energy financial incentives

Financial incentives have been widely implemented by governments around the world to support scaled-up deployment of renewable energy and energy efficiency technologies. To address key market barriers, renewable energy, and energy efficiency financial incentives provide some form of monetary benefit to support the deployment of renewable energy and energy efficiency technologies. It includes tax measures, rebates, grants, and performance-based incentives and loan programs, guarantees, and credit enhancements are provided to support renewable energy deployment[103].

5.1.4 Credit risks specific to clean energy projects

The constraints to clean energy finance are aggravated for clean energy projects, as they have a problem of scaling up and higher

102 54049-001: Development of a Legal Framework and Documentation Conducive to Viable Private Sector Renewable Energy and Energy Efficiency Projects | Asian Development Bank (adb.org)
103 nrel.gov/docs/fy16osti/65541.pdf

off-taker credit risk. Investors perceive the credit risk in clean energy to be very high or unknown. Developers are on a small scale with little or no credit history, which has a negative impact on credit assessment, making financing riskier as well as expensive. Another risk associated with clean energy projects is maturity mismatch. It arises due to insufficient long-term capital compared to demand. Clean energy projects are more exposed to this risk because they have a more early-stage capital structure and require more initial capital to cover the longevity of the project. Clean energy projects are subject to high uncertainties due to technology risk, which may increase credit risk. The situation is more complicated for projects in developing countries, where there are also monetary and political risks. Together, these risks make it difficult for clean energy projects to qualify for investment ratings. The G20/OECD guidelines on pension funds for green infrastructure looked at the impact of credit ratings on financing green infrastructure projects[104].

5.1.5 Addressing off-taker risk in renewable projects

Investments in renewable energy are related to the default risk of the power off-taker, generally the power company. It is one of the most important risks associated with India's renewable energy sector. This risk mainly stems from systemic inefficiencies in India's public electricity sector. State-owned electricity distribution companies, or DISCOMs, form the largest group of electricity consumers for India's renewable energy sector, under pre-determined price and long-term power purchase agreements (PPAs) with independent renewable energy producers. Because of these inefficiencies, these companies are plagued by poor financial health. Mitigating this risk requires long-term structural solutions that address systemic utility failures through the concerted efforts of central and state governments and DISCOMs.

Therefore, it is important to regularly monitor the transparency of the operations of utility companies, which are often the main customers of renewable energy projects[105].

104 Managing Credit Risk and Improving Access to Finance in Green Energy Projects (adb.org)
105 A-Framework-for-Designing-a-Payment-Security-Mechanism-as-a-Credit-Enhancement-Device-4.pdf (climatepolicyinitiative.org)

5.2 Policies and regulations are critical to attract investments in sustainable energy

Investors look at whether a country has clear plans for expanding its renewable energy portfolio and access through grids and stand-alone systems. Financial incentives in building clean energy sector such as electricity, heating, and cooling as well as transport and access to electricity, especially in rural and remote regions, also influence investments decisions[106].

A focus on stimulating investments among key industry players and improving access to finance for projects at critical stages will help ensure project viability in the growing solar market. In the following section, we will focus on transferring subsidies from fossil fuels to solar energy. This section also describes new funding methods and drivers for securing investments in R&D. Recommendations are given to address the challenges of developing and underdeveloped regions. Finally, this section emphasizes the need to diversify and expand the solar manufacturing sector to meet growing demand.

5.2.1 Moving subsidies from the fossil fuel sector to the solar sector

Since most countries depend on fossil fuels, their markets are also affected by fluctuations in fossil fuel prices and subsidies for fossil fuel consumption. Fossil fuel prices have been unusually high and volatile in 2022 as energy markets grapple with tensions caused by Russia's invasion of Ukraine - in particular, a sharp cut in Russian natural gas shipments to Europe. In 2022, natural gas and electricity consumption subsidies more than doubled from 2021, while oil subsidies increased by about 85%. Subsidies are mainly concentrated in emerging and developing countries, and more than half are in fossil fuel-exporting countries. Global fossil fuel subsidies have increased by about 26%, from $5.9 trillion or 6.8% of global GDP in 2020 to $7.5 trillion or 7.84% of global GDP in 2022 as the share of fuel consumption in emerging and developing markets continues to climb[107],[108].

In the early stages of the energy transition, supply-side subsidies will be required, particularly for emerging and developing countries and for solar deployment, even though solar continues to be cost-competitive, as highlighted in Chapters 3 and 4. A planned transition of subsidies from fossil fuels to solar energy will help ensure the sustainability of the transition to clean energy. These subsidies may be reduced in the future as solar technology becomes fully matured and even more price-competitive compared to other fuel sources.

5.2.2 Various channels to mobilize investments in emerging and developing countries to overcome unequal investments distribution

Regardless of continued recognition of the various benefits of solar energy, the adoption of solar technology is not evenly distributed around the world. This contributes to the unequal distribution of investments, as explained in Chapter 3. Even though the potential of solar energy is enormous, most emerging and developing countries in Africa, the Middle East, Latin America, and the Caribbean have recorded only a small percentage of global solar energy investments. This limitation stems from political, social, economic, technological, and environmental reasons, these act as a factor hindering the widespread use of solar energy worldwide equally. There is a

106 Policy and Regulatory Frameworks | Sustainable Energy for All (seforall.org)
107 Still Not Getting Energy Prices Right: A Global and Country Update of Fossil Fuel Subsidies (imf.org)
108 Fossil Fuels Consumption Subsidies 2022, IEA

large gap between the investments required and the investments realized. The systemic challenges highlighted in Chapter 3 in these emerging and developing countries increase the project's risk profile and as a result impede investments flows. It is therefore imperative to identify the obstacles encountered in scaling up solar PV deployment in emerging and developing countries and address them through joint action of stakeholders while creating an atmosphere of satisfaction for all stakeholders to ensure equitable distribution and allocation of investments within the region[109].

5.2.2.1 Strengthening Financial and Capital Markets for sustainable investment inflows

A capital market is a network of specialized financial institutions, a series of mechanisms, processes, and infrastructure that in various ways facilitate the pooling of medium and long-term providers and users of capital. Most developing and least developed countries have weak financial and capital markets that are unable to mobilize capital and allocate finance for renewable energy projects.

Given its role in the economy, capital markets play an important role in economic development as they facilitate the development of the solar industry and infrastructure developers and access to long-term financing. Economic development driven by capital markets is not limited to economic growth but also includes macroeconomic stability, development of the legal environment, and free flow of financial

109 Breaking barriers in deployment of renewable energy - PMC (nih.gov)

information between investors and holding groups and companies. Therefore, developing robust banking and capital markets can ensure sustainable investment inflows. Emerging and developing countries need to strengthen banking regulations and build well-regulated securities markets. At the same time, demonstrating the financial viability of new innovative business models for various solar applications is equally important, which helps mitigate the risks associated with the models[110].

5.2.2.2 Role of private sector engagement in developing countries

Debt burdens are growing in many countries around the world and many governments in emerging and developing economies lack the financial space to mobilize resources for a sustainable recovery. The COVID-19 pandemic has posed unprecedented challenges for low- and middle-income countries. Even before the crisis began, rising levels of public debt and increased vulnerability to debt were a concern in many countries. These vulnerabilities have increased significantly in 2020. According to the World Bank, the external debt of 123 low and middle-income countries in 2020 rose, by an average of 5.6%, amounting to $ 8.7 trillion. However, for many countries, the increase was in double digits. The crisis has increased financial demand and therefore increased public borrowing while weakening each country's economic fundamentals. This has affected the ability of developing economies to spur investments in the solar sector[111].

Debt allows the developing private sector to mobilize the resources they need to invest and build a sustainable economic recovery. In this context, the role of the private sector in resource mobilization becomes even more important. Private sector capital includes

110 The Role of the Capital Markets in Economic Development, Cytonn
111 International Debt Report 2022, World Bank

the funding provided by private financial institutions, investors, and companies in climate-friendly projects and financial assets. To engage with the private sector, initiatives must be taken to achieve rapid success and adopt a results-oriented approach. As the private sector strives for uniform policies in the areas of project preparation, implementation, and follow-up, there is a need for a review of policies and regulations. These need to be linked to mitigate various risks associated with land access, taxation, power supply and grid integration.

ISA has recognized the crucial role of the private sector in driving solar growth. The private sector contributes nearly 90% of solar investments in ISA member countries. ISA has developed a targeted private sector engagement (PSE) Strategy to support the 'Towards 1000' vision of private stakeholders. The vision aims to mobilize $1 trillion in investments in solar energy solutions by 2030, while providing access to energy for 1 billion people using clean energy solutions, resulting in 1,000 gigawatts (GW) of installed solar capacity. This contributes to reducing global solar emissions equivalent to 1 billion tons of CO_2 each year. ISA aims to reduce barriers to industry growth by working on two thematic pillars, namely enabling policy frameworks and catalyzing investments, thereby, driving the convergence of new policy frameworks, investment strategies, and market intelligence within and across regions[112].

5.2.2.3 Attracting foreign direct investments (FDI)

Investments is critical for economic and social development in any country, but especially in emerging and developing countries. FDI plays an important investment tool for these emerging and developing countries. They have demonstrated resilience during financial crises; this is evident from the various financial crisis cases that have occurred around the world. For example, the entire African continent (except South Africa) received an estimated $8.2 billion in FDI inflows in 2000, and this amounted to only 0.6% of total global FDI inflows[113]. Moreover, FDI can contribute to job creation, technology diffusion, economic growth, and sustainable development of the host country. FDI can also increase competition in domestic input markets. However, potential risks should be minimized through good governance, effective institutions, and regulatory frameworks[114].

The 2021 FDI recovery brought growth in all regions. However, almost three-quarters of the global increase was due to the upswing in developed countries, where FDI reached $746 billion – more than double the 2020 level. FDI flows to developing economies grew more slowly than those to developed regions but still increased by 30%, to $837 billion. The increase was mainly the result of strong growth performance in Asia, a partial recovery in Latin America and the Caribbean, and an upswing in Africa. FDI flows to Africa reached $83 billion, from $39 billion in 2020. Most recipients saw a moderate rise in FDI[115]. Hence, boosting FDI would provide transparent and consistent regulations for all types of businesses, whether foreign or domestic, which will contribute to the growth of solar energy. Key supporting factors such as a favorable business environment, easy access to imported goods, a flexible labor market, and protection of intellectual property rights will help ensure increased FDI inflows.

5.2.2.4 Improving blended finance for a sustainable future

Blended finance is the strategic use of development finance for the mobilization of additional finance toward sustainable development in developing countries. It includes a combination of instruments such as grants, guarantees, debt, and equity through appropriate structuring that can reduce the

112 pib.gov.in/PressReleaseIframePage.aspx?PRID=1930426
113 Finance & Development, June 2001 - How Beneficial Is Foreign Direct Investments for Developing Countries? (imf.org)
114 Foreign Direct Investments for Development (oecd.org)
115 United Nations Conference on Trade & Development (UNCTAD)'s World Investments Report 2022

perceived risk of third-party investors in these projects and, consequently, the cost of capital. Blended Finance mechanisms have great potential to accelerate high-impact private sector investments in emerging and developing markets and can help bridge the estimated $2.5 trillion per year investment gap for delivering sustainable development goals (SDGs) in these emerging and developing countries[116,117].

Blended finance is therefore an important leveraging tool that Development Finance Institutions (DFI) can use to amplify the effects of finance and tap private sources of finance. The increased use of blended financing to finance green technology will encourage the industry to move away from self-funding on its balance sheet and towards more funding from global financial institutions.

ISA is designing a blended finance risk mitigation facility (BFRM) with a fund size of over $700 million and a pan-Africa mandate in its initial phase. BFRM will provide a contemporary partnership model, that will be replicable, sustainable, and scalable. Overall, the facility will enable demand creation and an environment for solar deployment in Africa by providing different risk mitigation instruments, concessional finance, and technical assistance. The facility is aimed at stimulating high-potential solar technologies by attracting private capital to flow into underserved markets in Africa by providing interventions at two main levels - stimulating demand through technical assistance and attracting commercial capital providers. The facility is expected to spur follow-on investments to the tune of $5-10 billion over the next 10 years, bringing energy access to 35-40 million households and mitigating 0.5-1 million tons of carbon emissions[118].

5.2.2.5 Institutional capability development can foster new investments channels

Emerging and developing countries have limited institutional capacity to mobilize investments in the solar PV sector. Harnessing the institution's capability of financial institutions represents another key aspect of the transitional infrastructure that is essential to realizing a solar energy future. The availability of cost-effective capital is essential for the implementation of clean energy transition projects. Addressing this issue requires strengthening the capacity of institutions while creating a favorable environment to attract investors. New institutional structures are therefore needed to streamline risk assessments, provide more certainty to investors, and more effectively manage the actual or perceived risks associated with investors associated with energy transition projects[119].

5.2.2.6 Multilateral and national development banks (MDBs and NDBs) can play a vital role in directing capital to support climate issues in emerging market and developing economies (EMDE)

These banks can countercyclically intervene in the credit market through direct lending, providing credit guarantees, or purchasing loans and securitized products. They can provide long-term resources or incentives and promote private sector participation (e.g., a re-lending scheme). Because of their financial model, MDB's ability to mobilize capital through bond issuance depends in part on its capital adequacy framework.

To protect their ratings, MDBs have traditionally been cautious in managing their finances. Equity investments allow the public sector to participate in price appreciation, but they also help to maximize private capital mobilization, which is particularly beneficial as most EMDEs are already insolvent. Thus, MDBs can play an additional role in helping countries

116 Making-Blended-Finance-Work-Executive-Summary.pdf (oecd.org)
117 IRENA_Risk_Mitigation_and_Structured_Finance_2016.pdf
118 ISA Newsletter June 2022.pdf (isolaralliance.org)
119 Low-cost finance for the energy transition, IRENA

structure financial products to secure equity and thereby attracting private sector capital. Public equity investments are critical to help achieve the developed countries' $100 billion annual commitment to climate action in the EMDEs[120].

5.2.2.7 A wide range of bankable projects will speed up investments

Financiers and investors often complain that the main obstacle to infrastructure development in EMDE is not funding, but the lack of "ready to go" fundable projects and programs. It is estimated that 80% of infrastructure projects are not feasible. Effective early-stage selection and identification of priority projects through master plans/policy documents can improve the chances of financial closing and successful implementation. The pre-development stage is important and includes the preparation of pre-feasibility and feasibility studies, including technical, financial, economic, political, legal, and environmental assessments. Government guarantees and support letters would also help in enhancing the bankability of a project and, to some extent, reduce some of the political risks[121].

120 Mobilizing Private Climate Financing in Emerging Market and Developing Economies, IMF
121 Draft_develop_bankable_transport_infrastructure_project_24sep1_0.pdf (un.org)

Key Takeaways:

- **Transferring fossil fuel subsidies to renewables is crucial in the path of the transition to clean energy.**
- **Multiple channels are required to mobilize investments in emerging and developing economies to overcome skewed investments distribution.**
- **Improving banking regulations and developing robust securities markets will enable investments in the solar sector.**
- **The private sector plays a key role in investing in developing countries and mobilizing resources to build a sustainable future.**
- **Encouraging FDI would increase the volume of capital as well as decrease the cost for developing economies.**
- **Blended finance has the potential to fill additional investments gaps in developing countries.**
- **Financial institutions represent a key aspect of transition infrastructure critical to the transition to clean energy.**
- **MDBs provide long-term resources and play an important role in channeling capital to support a sustainable future in developing economies.**
- **While developing a solar project, it is important to structure the investments proposal to meet the needs of the respective investor.**

5.2.3 Innovative financing mechanism and new sources of capital to mobilize investments

Ramping up investments requires new and innovative financing options. Innovation finance is an expression of two main trends in international development: increased focus on programs that deliver results and a desire to support cross-sectoral collaboration. This requires mutually reinforcing efforts by governments, financial institutions, and public and private investors. This section focuses on innovative tools that can be explored to reduce the risks of raising capital, especially for emerging and developing countries. The section below explores new investments options that can also help attract new investors that have not been tapped to date.

5.2.3.1 Innovation in financing and risk mitigation tools

Risk mitigation is especially important for renewable energy projects due to the large upfront capital requirements. A combination of financial risk mitigation tools and sound policies can reduce the cost of financing renewable energy investments and help attract large-scale capital. Project risks can be multiple and often parallel. These include political and regulatory risks, counterparty, grid, and transmission link risks, currency, liquidity and refinancing risks, and resource risks. By providing access to effective risk mitigation tools, public financial institutions make an essential contribution to raising private capital for investments in renewable energy. This is a particularly important strategy due to the limited public resources to invest in renewable energy projects. These tools will therefore become increasingly important as the proportion of private investments in renewable energy projects increases along with the growing demand for new energy solutions worldwide[122].

122 Unlocking Renewable Energy Investments, IRENA

The table below sums up the types of risks encountered in many clean energy projects and the risk mitigation tools available to the public capital providers to meet them.

TYPES OF INVESTMENTS RISKS	FINANCIAL RISK MITIGATION TOOLS
Political risk	• Government guarantee • Political risk insurance • Partial risk/credit guarantee
Policy or Regulatory risk	• Government guarantee • Political risk insurance • Export credit guarantee
Counterparty (power off-taker) risk	• Government guarantee • Political risk insurance • Partial risk/credit guarantee • Export credit guarantee
Currency risk	• Currency risk hedging • Local currency lending • Currency risk guarantee fund
Technology risk	• Specialized insurance products • Partial risk/credit guarantee
Liquidity and Refinancing risk	• Internal/external liquidity facility • Liquidity guarantee
Resource risk	• Grant and convertible grant • Resource guarantee fund • Portfolio guarantee

5.2.3.2 Unlocking institutional capital for ramping up solar investments in developing countries

Institutional investors, such as pension funds, insurance companies and sovereign wealth funds, are key players in the global economy and their share of the international market has steadily increased, but their potential role in financing the energy transition has so far been largely untapped. With over $100 trillion in assets in 2019 in OECD countries alone, institutional investors potentially represent a key source of long-term financing to support sustainable growth in developing countries. Just shifting 3.7% of the $100 trillion in assets held by institutional investors globally to sustainable practices in developing countries would be enough to close the $3.7 trillion gap. Hence, they are expected to play an important role in increasing investments. Nonetheless, this will require increased cooperation between public and private parties, including development finance providers, to ensure that the right tools (e.g., risk mitigation tools) and standards are in place to raise private capital for developing countries in line with the SDGs. Developing countries need long-term investors to help fund activities that support sustainable growth through clean energy transition[123].

Key Takeaways:

- **Risk management tools and policies have the potential to reduce the long-term cost of financial clean energy investments.**
- **Institutional investors represent one of the largest capital pools in the world, but their potential role in financing the energy transition has so far been largely untapped.**

5.2.4 Strengthening, expanding, and diversifying the supply chain for solar PV manufacturing is essential to meet the growing demand

Achieving international climate and energy goals requires deploying solar PV to grow on an unprecedented scale. This in turn requires further expansion of production capacity, while ensuring the world's ability to rapidly develop flexible supply chains. This is a key aspect of achieving net-zero targets, as outlined in Chapters 3 and 4. Solar demand for key minerals will increase promptly on the path to net-zero emissions. The production of many of the key minerals used in solar PV is highly concentrated with China playing a dominant role. Despite improvements in the more efficient use of materials, the demand for minerals from the photovoltaic industry is expected to increase significantly[124].

The long-term financial sustainability of solar PV manufacturing is essential for a rapid and cost-effective clean energy transition. The net profit of the solar sector for all segments of the supply chain has been volatile, leading to several bankruptcies despite political support. Bankruptcy risk and low profitability can slow the clean energy transition if companies are unwilling to invest due to low returns or are unable to withstand sudden changes in market conditions.

Another key risk that has affected the growth of solar PV manufacturing is increasing trade restrictions, which threatens to slow solar deployment. Because trade plays an important role in supplying the various materials needed to manufacture solar panels and get them to final markets.

Recent trade restrictions in supply chains, disruptions caused by the COVID-19 pandemic and the Russian invasion of Ukraine, and current supply chain vulnerabilities. This

123 Mobilizing Institutional Investors for Financing Sustainable Development in Developing Countries, OECD
124 Special Report on Global PV Supply Chains, IEA

emphasizes the need to diversify existing offers centralized supply chain. Domestic manufacturing can also help reduce production emissions thanks to more efficient logistics.

5.2.5 Encouraging investments in R&D and ensuring sector coupling can accelerate the adoption of solar energy

Viewing the ongoing global energy transition as a technological revolution can provide a good indication of how capital is likely to flow into new technologies over time and help policymakers select the policies and support frameworks needed to meet the needs of investors at each stage of technology development, thereby accelerating the energy transition. While at an early growth stage, investments are often led by inventors/startups as well as public capital, at later stages, as the market share of emerging technologies increases, private sector involvement plays a more important role. In addition, while solar PV for power generation is the primary use, new technologies and applications such as electric vehicle charging, green hydrogen heating and cooling, and solar PV recycling will require investments to ensure continued R&D. This potential to combine solar energy with other sectors is intended to provide an increase in global demand for solar energy.

5.3 Cooperation between public financial institutions, private investors, governments, and developers is the key to mobilizing investments

Barriers to scaling solar investments vary by technology type as well as by market. These include perceived and actual financial and political risks, regulatory uncertainty, as well as the lack of viable investments projects. Proven solutions to each of these barriers exist, however, implementing them on a large scale will require a determined effort among different stakeholders. Hence, accelerating solar investments and financing at the pace needed will require investments and action from governments, financial institutions, and private investors – and these actions will support each other.

With limited public financing, private funding is needed to provide a significant portion of the overall investments needs. According to the UNFCCC, the private sector is expected to provide 70% of capital investments worldwide, almost half of which is financed directly from a company's balance sheet. Financial actors, from commercial financial institutions to infrastructure funds, institutional investors, private equity, and venture capital, will play an important role in direct investments and especially in facilitating and supporting business and household investments[125].

To increase the flow of capital in developing countries to meet climate ambitions collaboration between developers, investors, public financial institutions, and governments can help ensure the efficient mobilization of the investments. This highlights the need for a platform that brings together all the key stakeholders who will play a key role in mobilizing investments in the solar sector. The platform can be leveraged to learn from the practices and approaches adopted by other countries that have had successful solar journeys in recent times which would also help countries.

125 What's the cost of net zero? - Climate Champions (unfccc.int)

Climate Investments Platform: Cooperating for an increase flow of capital to clean energy projects

The Green Climate Fund (GCF), IRENA, SEforAll, and United Nations Development Programme (UNDP) have launched a joint partnership 'Climate Investments Platform (CIP)' to accelerate the low-carbon energy transition and advance climate ambition. The Climate Investments Platform (CIP) is a comprehensive partnership that welcomes all stakeholders from governments and international organizations to the private sector to scale climate action and transform ambitious national climate goals into concrete investments. It is designed to provide tailored technical assistance to projects in member countries. With energy accounting for two-thirds of all greenhouse gas emissions, the first service line of the platform is dedicated to the global transition to clean energy. The forum aims to strengthen the capacity of decision-makers to create an enabling environment for investments and help developers prepare financially viable projects and access capital[126].

Key Takeaways:

- **Bringing together all stakeholders including developers, financial institutions, the private sector, and governments will simplify access to climate finance. It will catalyze investments for mitigation and adaptation in developing countries, supporting those most in need of climate action.**

126 New Climate Investments Platform Targets Increase in Flow of Capital to Clean Energy Projects | United Nations Development Programme (undp.org)

Way Forward

The global energy investment landscape has matured during the past decade. The need for countries to become self-reliant in terms of energy needs has been bolstered by some of the recent events such as the COVID-19 pandemic and the Russia-Ukraine war which have resulted in supply chain disruptions and global energy crisis.

Since solar energy is widely available and cheaper than any alternative form of renewable energy, solar technology has matured over time and is expected to attract the majority of investments going forward as well. Solar and wind technologies together are expected[127] to meet 70% of the electricity generation needs of the world by 2050.

After the detailed analysis of the global investment landscape, the following conclusions have been drawn for the concerned stakeholders for increasing investment in the solar sector and accelerating global solar deployment.

- Investments in renewable energy hit an all-time high in 2022 having crossed $590 billion, with solar energy attracting the majority investments at 52% of renewables. Having said that the investments are insufficient to meet the set climate goals and need to be increased significantly to tackle global climate change and accelerate clean energy transition.
- With the growing interest in solar-enabling technologies, increased investment in the grid infrastructure and energy storage is required to promote solar technology while increasing its reliability.
- Although spending on solar energy has increased significantly in recent years, it is overwhelmingly concentrated in a small number of developed countries where the solar PV market has achieved maturity.
- The solar manufacturing supply chain is geographically concentrated in Asia Pacific region and particularly in China, making the manufacturing sector vulnerable to supply chain instability. To minimize risks to the supply chain due to global tensions and trade disputes, domestic manufacturing must be encouraged.

127 IEA Net Zero by 2050 - A Roadmap for the Global Energy Sector

- To keep up with the growing RE demand, it is not only necessary to ramp up solar manufacturing capacity around the globe but also build diverse, resilient, affordable, and sustainable supply chains.
- Emerging and developing countries around the world, whose potential has not yet been realized, should be given priority to increase global investment in solar PV for making the energy transition more inclusive.
- Around 733 million people around the world[128] lack access to electricity even today. Investment in the solar off-grid segment is gaining momentum but access to affordable financing remains a key challenge in making the segment accessible to masses. The challenge needs to be addressed through low-cost financing products or other innovative financial instruments to maximize business potential and advance climate and energy access goals.
- To mobilize more funding and to engage a wide range of players such as banks, oil and gas companies, institutional investors, etc. in the global investment landscape, policy and regulatory assistance from governments are needed to mitigate

128 Off-Grid Solar Market Trends Report 2022: State of the Sector

investment risks and provide some level of comfort to such investors for investing in the solar sector. Also, policy and regulatory support is required for a planned transition of providing subsidies fossil fuels to solar energy that will ensure the sustainability of the transition to clean energy.

- To ensure an efficient mobilization of investment, cooperation between all stakeholders will play a significant role that will simplify access to climate finance. It will catalyze investment for mitigation and adaptation in developing countries, supporting those most in need of climate action. Public financing has a critical role to play for a just energy transition.
- Implementation of financial innovation is essential for the rapid expansion of solar energy sources around the world. Sustainable financing instruments such as green bonds, dedicated climate funds, blended finance, and credit enhancement instruments, etc. hold great potential for channeling substantial capital into energy transition-related technologies such as solar.

Note

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