How to realize

Zero Energy Building

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01

Introduction

In a historic global effort to combat climate change, 195 parties have signed the Paris Agreement, underscoring a unified commitment to limit global warming and achieve a carbon-neutral society. This ambitious goal necessitates a comprehensive transformation across various sectors, guided by strategic frameworks and innovative technologies.

Transitioning to a carbon-neutral society requires a fundamental shift in our energy mix. This involves significantly increasing the share of renewable energy sources such as wind, solar, hydro, and geothermal, while simultaneously enhancing energy efficiency across all sectors. Electrification plays a crucial role in this transition, enabling the use of clean, renewable electricity in place of fossil fuels.

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IEA's roadmap to net zero

The International Energy Agency (IEA) has outlined a detailed roadmap to achieve net-zero emissions by 2050. This scenario emphasizes several key strategies:

Deployment of CCUS systems:

Implementing Carbon Capture, Utilization, and Storage (CCUS) technologies to capture carbon dioxide emissions from industrial processes and power generation is vital. Captured CO_2 can be utilized in other processes or stored underground, preventing it from entering the atmosphere.

Shift towards hydrogen and hydrogen-derived synthetic fuels:

Developing hydrogen, produced using renewable energy, is essential for decarbonizing sectors that are difficult to electrify, such as heavy industry and long-haul transport. As a clean energy carrier, hydrogen can replace fossil fuels in these challenging areas, significantly reducing emissions and supporting the transition to a carbon-neutral society.

In addition, producing synthetic fuels from hydrogen and captured carbon dioxide offers a sustainable alternative for existing infrastructure and vehicles. These synthetic fuels can be seamlessly integrated into current systems, providing a practical solution for reducing emissions without the need for extensive modifications to existing technologies.

By advancing the use of hydrogen and synthetic fuels, we can address some of the most challenging aspects of the energy transition, ensuring a more sustainable and resilient future.

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Use of more sustainable alternative fuels and feedstock such as bioenergy:

Utilizing biomass and biofuels as renewable energy sources can significantly reduce reliance on fossil fuels. Ensuring sustainable production practices is crucial to maximizing the environmental benefits of bioenergy, making it a viable component of a low-carbon energy mix.

Furthermore, employing waste materials and other sustainable feedstocks for energy production and industrial processes can further reduce emissions. This approach not only lowers the carbon footprint but also promotes circular economy principles by turning waste into valuable resources.

Electrification of transport, industry and buildings

1. **Transportation**

   The widespread adoption of electric vehicles (EVs) and the development of robust charging infrastructure are essential for reducing emissions in the transportation sector. This shift not only cuts greenhouse gas emissions but also significantly improves air quality, benefiting public health and the environment.

2. **Industry**

   Electrifying industrial processes and machinery where feasible can lead to substantial emission reductions. This includes the use of electric furnaces, motors, and other equipment, which can replace traditional fossil fuel-based systems. By transitioning to electric alternatives, industries can achieve greater efficiency and lower their carbon footprint.

3. **Buildings**

   Enhancing energy efficiency in buildings is critical for reducing emissions and energy consumption. This can be achieved through better insulation, advanced energy management systems, and the use of electric heating and cooling systems. These measures not only lower emissions but also reduce energy costs and improve indoor comfort.

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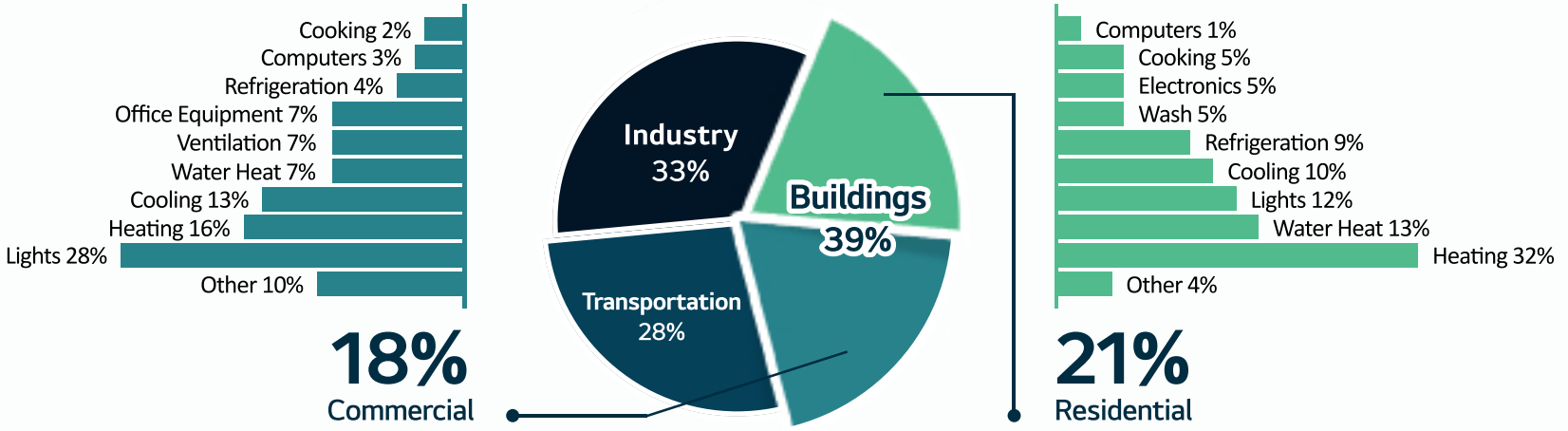
Energy consumption by sectors



*Source: Buildings Energy Databook with SEDS distributed to all end-uses

Why are buildings important?

The buildings sector, which encompasses the energy used for constructing, heating, cooling, and lighting homes and businesses, as well as the appliances and equipment installed within them, accounts for over one-third of global energy consumption and emissions. Specifically, building operations contribute to 30% of global final energy consumption and 26% of global energy-related emissions. This includes 8% from direct emissions within buildings and 18% from indirect emissions resulting from the production of electricity and heat used in buildings.

In 2022, direct emissions from the buildings sector decreased compared to the previous year, despite extreme temperatures in certain regions driving up heating-related emissions. However, overall energy use in the buildings sector increased by around 1% in the same year.

Addressing the energy consumption and emissions of the buildings sector is crucial for achieving global climate goals. Enhanced energy efficiency, better insulation, and the adoption of electric heating and cooling systems are key strategies to reduce the sector's environmental impact.

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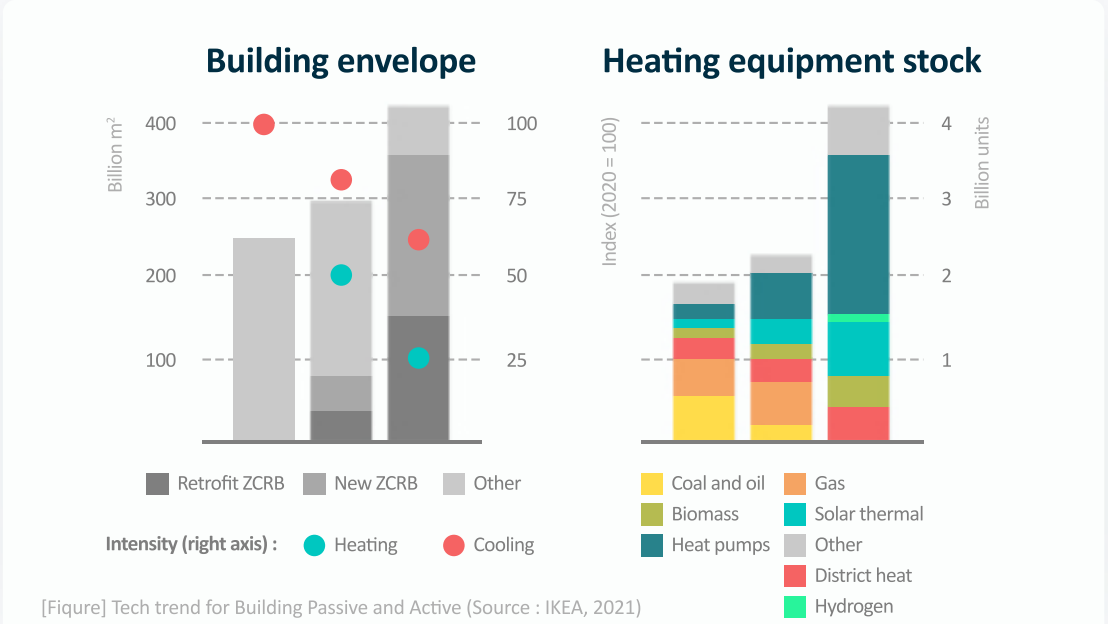
As the world intensifies its efforts to combat climate change, the push for building energy independence has never been more critical. Recent advancements in various technologies are paving the way for more sustainable and energy-efficient buildings. Here, we explore some of the groundbreaking innovations that are driving this transformation.

Innovations in building energy Independence:

Technologies for a sustainable future



[Fiqure] Tech trend for Building Passive and Active (Source : IKEA, 2021)

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PVT (Building-Integrated Photovoltaic Thermal) systems

One of the most promising developments is the PVT-GSHP hybrid system, which aims to achieve building energy independence by combining the advantages of solar and geothermal heat. This innovative system integrates photovoltaic panels with thermal collectors, harnessing both solar and geothermal energy to meet a building's heating, cooling, and electricity needs.

Heat pumps

Heat pumps are a highly efficient technology that transfers heat from one place to another, providing both heating and cooling for buildings. They work by extracting heat from a source (such as the air, ground, or water) and transferring it to another location. In the winter, heat pumps can draw heat from the outside air or ground and move it indoors to warm a building. In the summer, the process is reversed to provide cooling. Heat pumps are another critical component in the quest for energy-efficient buildings and LG Electronics also offers various types of heat pumps so that people can choose the right solution.

These innovations enhance the efficiency and performance of heat pumps, making them a more viable option for both residential and commercial applications. By leveraging these advanced technologies, heat pumps can significantly reduce energy consumption and greenhouse gas emissions, contributing to a more sustainable built environment.

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IoT-Based ZEB BEMS

The Internet of Things (IoT) is revolutionizing building energy management. IoT-based Zero Energy Building (ZEB) Building Energy Management Systems (BEMS) provide real-time monitoring and control of energy use, enabling buildings to operate more efficiently. These systems integrate various energy sources and technologies, optimizing their performance to achieve zero energy consumption.

LG Electronics also provides LG BECON, a cloud-based digital monitoring platform that allows service providers to monitor, interact, and change the parameters of their clients' heat pumps remotely. With all the data collected, BECON cloud is able to use big data analysis to assess the performance of each system and pinpoint any abnormalities or issues that have occurred while providing customized energy modeling capabilities. This analysis also allows BECON cloud to predict issues that may occur with each system in the future. Once issues have been identified, customers can be alerted and LG engineers can begin to take action as quickly as possible and limit downtime while maintaining optimal system efficiency. The overall impact of AI-based BECON cloud data analysis optimizes comfort and energy consumption while simultaneously reducing maintenance times and minimizing CO2 emissions.

Thermal storage

Thermal storage systems are essential for optimizing energy use in buildings. By storing excess thermal energy generated during off-peak hours, these systems can provide heating and cooling when demand is high, thereby reducing energy consumption and costs.

Automatic hybrid ventilation systems

Ventilation is crucial for maintaining indoor air quality and comfort. The development of automatic hybrid ventilation systems, which combine natural and mechanical ventilation, offers a smart solution. These systems automatically adjust ventilation modes based on real-time conditions, ensuring optimal air quality and energy efficiency.

03

Infrastructure analysis

Achieving Zero Energy Buildings (ZEB) requires collaboration and expertise across multiple fields. Comprehensive infrastructure analysis provides valuable information about key organizations and experts involved in ZEB initiatives. This knowledge is crucial for stakeholders to make informed decisions and drive the successful implementation of ZEB projects.

Classification	Elementary or system technologles	Non-residential	residential	Advanced required
Cooling and heating	Energy-efficient heat distribution systems	●	▲	Neutral
	Radiant heating and cooling	▲	●	High
	District heating and cooling systems	●	●	High
	Advanced heat pumps technologies	●	●	High
	Thermal energy storage (TES)	▲	●	Neutral
	Low global warming potential (GWP) refrigerants	●	●	Neutral
renewable energy	Geothermal systems	●	●	Neutral
	Solar thermal systems	▲	●	Neutral
	Integration of renewable energy sources	●	▲	High
Ventilation	Natural ventilation and passive cooling	–	●	Neutral
	Demand-controlled ventilation	▲	●	Neutral
	Heat/energy revcovery ventilation	▲	●	High
	Advanced heat exchangers	●	▲	Neutral
	Innovative heat recovery technologies	●	●	Neutral
Hot water	Hybrid systems and multi-energy systems	●	●	High
	Water-efficient DHW systems	–	●	Neutral
Control	Building Energy Management Systems (BEMS)	●	–	Neutral
	Advanced energy monitoring and visualization	●	▲	High
	Advanced building automation and control strategies	●	–	Neutral
Evaluation	Occupant behavior and comport	●	●	High
	Life cycle assessment (LCA) and energy modeling	●	▲	Neutral

[Table] ZEB active system technology development status and need for (future) advancement

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Heat pumps:
A key player in the clean energy transition

What are heat pumps?

Heat pumps are an innovative technology that operates similarly to refrigerators or air conditioners, but in reverse, they extract heat from a source—such as the air, ground, or water—amplify it, and then transfer it to where it is needed. This process makes them highly efficient for both heating and cooling purposes. Current models are 3-5 times more energy-efficient than traditional gas boilers. Reflecting their growing popularity, global sales of heat pumps have been increasing at double-digit rates over the past few years.

The role of heat pumps in clean energy transitions

Heat pumps have been increasingly recognized as a critical technology for the de-carbonization of heat. They have received substantial policy support in several countries in recent years. According to the International Energy Agency (IEA), heat pumps have the potential to reduce global carbon dioxide (CO_2) emissions by at least 500 million tons by 2030. This reduction is equivalent to the annual CO_2 emissions of all cars in Europe today, highlighting the significant impact heat pumps can have on mitigating climate change.

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	2010	Today 2017*/2018/ 2019e**	Transforming Energy Scenario 2030	2040	2050	On/Off track	Implications
Electrification with renewables							
Share of electricity in final energy consumption (TFEC)	18%	20%	29%	38%	49%	Off track	Focus on electric mobility and electrifying heat in buildings and industry, and on synthetic fuels and feedstocks - see further recommendations below.
▶ **Renewable energy share in power generation**	20%	26%	57%	75%	86%	Progress	Emphasise solar and wind deployment, but also maximise soild biomass and biogas in the niche applications where they make sense.
Annual solar PV additions	17 GW/yr	93** GW/yr	300 GW/yr	355 GW/yr	360 GW/yr	Progress	Accelerate solar deployment by reinforcing existing policy and market support.
Annual wind additions	31 GW/yr	60** GW/yr	200 GW/yr	210 GW/yr	240 GW/yr	Off track	Plan fot wind industry and required logistics to enable accelerated deployment. Consider the large potential of offshore deployment.
Passenger electric cars on the road	<0.5 min	7.9 min**	379 min	744 min	1109 min	Progress	Enact measures to support getting electric cars purchasing price down and invest heavily in charging infrastructure.
▶ **Heat pumps**		38 min	155 min	259 min	334 min	Off track	Promote pubilc awareness about the advantages of heat pumps and create special lines of finance to project developers that can disseminage the technology.

*Source : IRENA 2020 report

Heating and Cooling 5.5 hr/day

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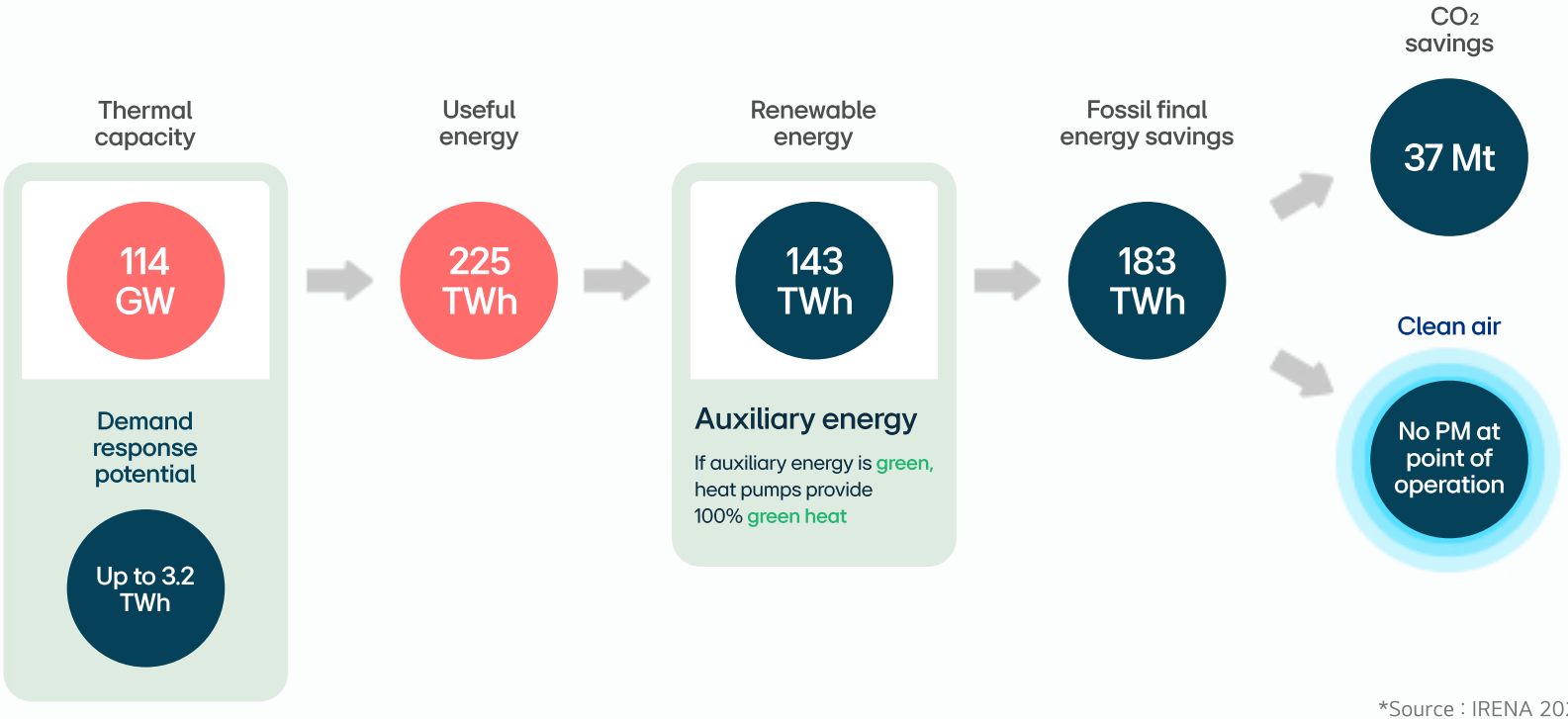
Where do we need to go?

Despite their benefits, heat pumps currently meet only around 10% of the global heating demand in buildings. This is far below the deployment level required to align with the Net Zero Emissions by 2050 Scenario. To achieve this ambitious target, the adoption of heat pumps needs to accelerate significantly. Increased investment, supportive policies, and public awareness are essential to drive the widespread adoption of this technology.

Heat pump benefits 2019

Based on 13.2 million heat pumps installed



*Source : IRENA 2020 report

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Recommendations and conclusions

As the world grapples with the urgent need to combat climate change, the construction and renovation of buildings present a significant opportunity for reducing carbon emissions. Here are key strategies to advance zero-carbon buildings and promote energy-efficient solutions.

Implement zero-carbon-ready building standards

To ensure that both new and existing buildings meet stringent energy efficiency criteria, it is essential to implement zero-carbon-ready building standards. Establishing enforcement and compliance procedures will ensure that these standards are adhered to, driving significant reductions in carbon emissions from the building sector.

Stimulate financing and market

Increasing the affordability of best-in-class products is vital for widespread adoption. Stimulating financing and market mechanisms can make energy-efficient solutions more accessible to consumers and developers. Financial instruments, such as grants, loans, and tax incentives, can motivate increased investment in these technologies.

Set clear and measurable targets

Clear and measurable targets are necessary to drive market transformation towards high-performing buildings. Setting specific goals can provide a roadmap for the industry, ensuring that progress is tracked and adjustments are made as needed.

Introduce supporting information instruments and incentives

To facilitate the implementation of these regulations, it is crucial to introduce supporting information instruments and incentives. These tools can help stakeholders understand the benefits of zero-carbon buildings and encourage compliance with new standards.

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Set long-term de-carbonization plans and net zero pledges

Long-term de-carbonization plans and net zero pledges provide a clear vision for the future. These commitments signal to the market that there is a sustained effort to reduce carbon emissions, encouraging innovation and investment in zero-carbon technologies.

Design and use heat pumps in buildings

Heat pumps are a key technology for achieving zero-carbon buildings. To accelerate their adoption, it is important to:

1. **Reduce cost barriers**

   Particularly for the renovation market, reducing the cost of heat pumps can make them a more viable option for a wider range of projects.

2. **Develop new business models and preferential tariffs**

   Innovative business models and preferential tariffs can make heat pumps more attractive to consumers and developers.

3. **Support workforce training, education, and reskilling**

   Ensuring that the workforce is equipped with the necessary skills to install and maintain heat pumps is crucial for their wide-spread adoption.

05

References and sources

1. The society of air-conditioning and refrigerating engineers of Korea

2. Buildings energy databook with SEDS distributed to all end-uses

3. Tech trend for building passive and active (*Source: IEA, 2021)

4. ZEB active system technology development status and need for (future) advancement

5. IRENA 2020 Report

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