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King Abdullah Petroleum Studies and Research Center

Energy-Efficient Policy in the Built Environment: From Formulation to Implementation

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About KAPSARC

KAPSARC is an advisory think tank within global energy economics and sustainability providing advisory services to entities and authorities in the Saudi energy sector to advance Saudi Arabia's energy sector and inform global policies through evidence-based advice and applied research.

This publication is also available in Arabic.

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Building energy efficiency is a critical component of efforts to address climate change and achieve sustainable development and can potentially reduce greenhouse gas emissions, save money, lower energy bills, create new jobs, and improve occupants' indoor comfort and quality of life. By stimulating and implementing energy-efficient building strategies, countries may make significant progress toward achieving their climate targets. This brief summarizes the discussions carried out during a workshop jointly hosted by King Abdullah Petroleum Studies and Research Center (KAPSARC) and Gulf University for Science and Technology (GUST).

The workshop sought to raise awareness about the importance of energy-efficient policy in the built environment, providing a platform on which participants can share their experiences and ideas on this critical topic. The workshop offered a comprehensive overview of the drivers and promises of energy efficiency in buildings, as well as the policy mix needed to improve energy efficiency.

The sessions emphasized the importance of designing energy-efficient buildings and implementing policies that promote energy conservation. Participants discussed opportunities and challenges in terms of achieving energy efficiency and explored policy options for improving energy efficiency in the built environment.

Key Points

In March 2023, the King Abdullah Petroleum Studies and Research Center (KAPSARC) and Gulf University for Science and Technology (GUST) cohosted a workshop titled "Energy-Efficient Policy in the Built Environment: From Formulation to Implementation." The workshop was part of the KAPSARC's Building Energy Efficiency project. The workshop focused on the theme of formulating and implementing energy-efficient policies in the built environment. The workshop explored the latest developments in energy-efficient policies and strategies and their performance in Saudi Arabia as well as worldwide.

The main objectives of this workshop were the following:

- Raise awareness about the importance of energy-efficient policy in the built environment.
- Share best practices and innovative solutions in the field of energy-efficient policy.
- Explore the formulation and implementation of energy-efficient policies in Saudi Arabia and GCC countries.
- Discuss the challenges and opportunities in terms of the implementation of energy-efficient policies.

The workshop consisted of two main sessions.

The workshop's first session was titled "Energy Demand in the Built Environment: Drivers and Conservation Opportunities" and focused on the drivers of energy demand in the built environment and the conservation opportunities available. The session covered topics such as the factors contributing to high energy demand in buildings, the impact of energy use on the environment, the potential for improved energy conservation through building design and technology, and the importance of a systematic approach that operates from the building level to the district level.

More specifically, the first session focused on addressing the importance of designing buildings with energy-efficient features, such as insulation, ventilation, and shading, and of integrating renewable energy; the drivers, benefits, and energy conservation opportunities in GCC countries and globally; strategies for encouraging energy-efficient behavior among occupants, such as education and incentive strategies; and the challenges and opportunities in terms of achieving energy efficiency at the city level using smart technologies. The following takeaways emerged from the presentations and the follow-up discussions in this session.

- Building energy demand is influenced by many drivers, including socioeconomic characteristics, design, construction, operation, technology, and behaviors.
- To understand the impact of such drivers, accurate energy, socioeconomic, and building data are needed.
- Energy efficiency has many benefits for both individuals and society.
- Energy conservation opportunities include passive design strategies, energy-efficient appliances and systems, and improved occupant behavior.
- A systematic energy-efficient approach at the city level using smart technologies has unique energy conservation challenges and opportunities.

The second session was titled "Policy Options to Improve Energy Efficiency in the Built Environment"

and explored policy options for improving energy efficiency in the built environment. The session covered topics such as the role of policies in promoting energy efficiency, the importance of stakeholder engagement, and case studies of successful policy implementation.

More specifically, the second session focused on addressing the successful and current energy-efficient initiatives in Saudi Arabia and globally, the importance of setting energy-efficient targets and establishing policies through which to achieve them; the role of financing mechanisms such as tax incentives, and the use of regulations such as building codes in promoting a sustainable built environment; strategies for engaging stakeholders, such as education and outreach, to promote energy-efficient policy implementation; and the importance of considering a lifecycle or broader system perspective in energy-efficient policy design in the built environment. The following takeaways emerged from the presentations and follow-up discussions in this session.

- Energy-efficient policies can reduce the levels of energy consumption and GHG emissions while also providing economic and social benefits.
- Options for improving building energy efficiency include market understanding, research and development, financing mechanisms, regulations, and stakeholder engagement.
- Effective policy implementation requires coordinated approaches on the demand side and collaboration among stakeholders, including the government, industry, and civil society.

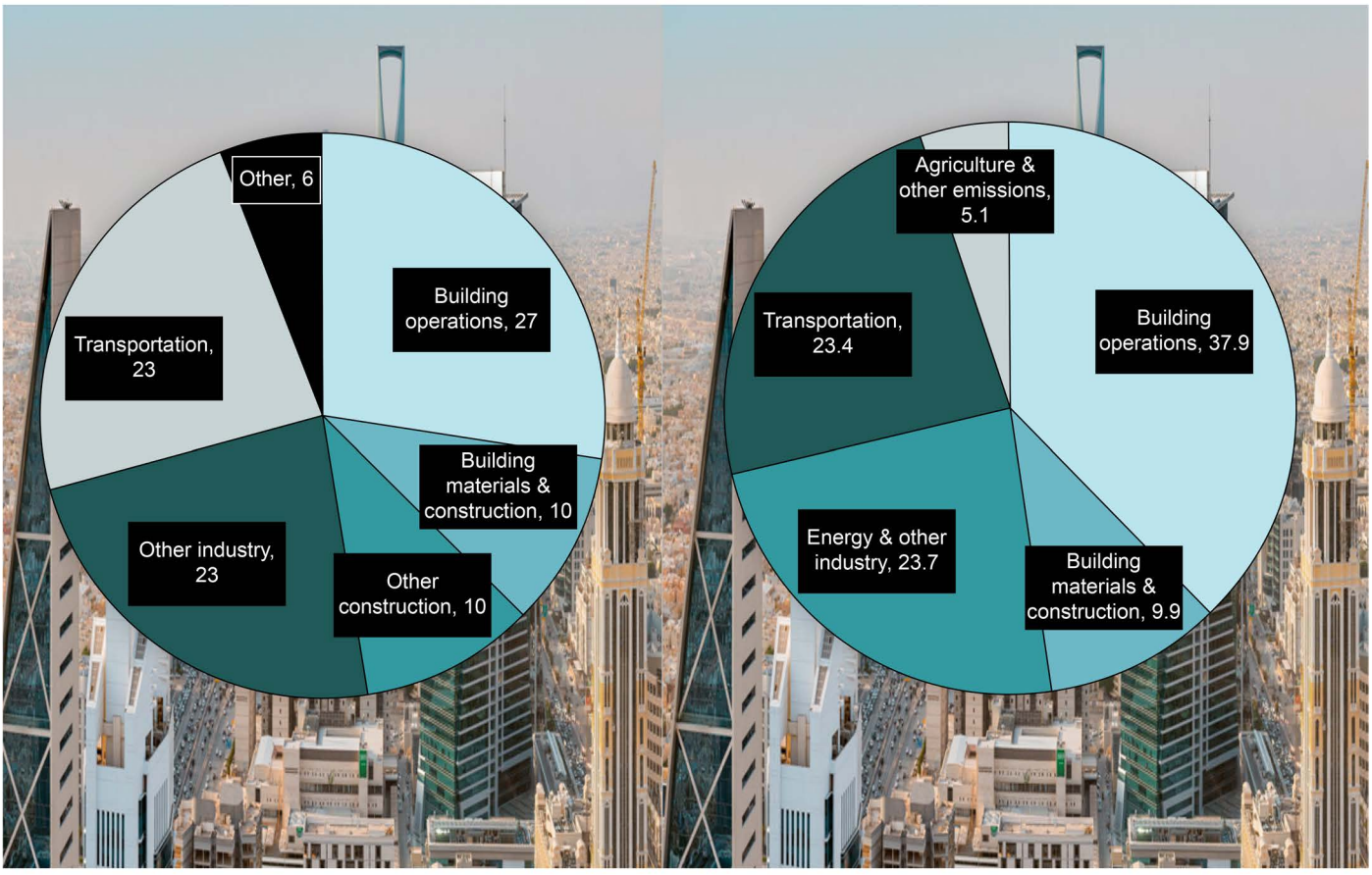
Background: Energy Efficiency in Buildings and Its Contributions to Climate Objectives

As the world grapples with the urgent challenge of climate change, many policymakers are looking for practical solutions to reduce GHG emissions. Energy efficiency is cost effective and constitutes a genuine asset for accelerating the energy transition pace and achieving a low-carbon future.

Buildings are among the largest contributors to worldwide energy consumption and greenhouse gas emissions. The built environment accounts for approximately 47% of global CO_2 emissions and nearly half of Middle Eastern CO_2 emissions (Figure 1). This finding is due mainly to the need for energy to heat, cool, and power buildings, as well as the materials used in their construction.

Understanding energy demand dynamics and improving energy efficiency in buildings has, therefore, become an increasingly important priority for policymakers worldwide in an effort to mitigate climate change (Belaïd et al. 2022). Investing in building energy efficiency offers many benefits for both individuals and society.

Figure 1. Built environment CO_2 emissions globally and in the Middle East.



Source: Authors' design using IEA and Architecture 2030 data.

One of the key benefits of building energy efficiency is its potential to reduce GHG emissions significantly. As mentioned earlier, buildings are responsible for a large portion of global energy consumption and CO_2 emissions. By making buildings more energy efficient, energy consumption and emissions can be reduced, which can contribute to mitigating the negative impacts of climate change (Belaïd 2022b; Belaïd and Massié 2022, 2023).

Improving energy efficiency in buildings also has the potential to save money, lower energy bills, and increase affordability (Belaïd 2022a), which can be particularly important for those low-income households or businesses that may struggle to afford high energy bills. Moreover, building energy efficiency has the potential to create new jobs in the green economy. Improving energy efficiency in buildings requires the installation of energy-efficient systems and materials, which can create jobs in terms of the manufacturing, installation, and maintenance of these systems. Additionally, improving energy efficiency in existing buildings requires upgrading and renovation, which can offer employment opportunities for local contractors and skilled tradespeople. In addition to the abovementioned potential benefits, building energy efficiency can also improve comfort and quality of life for the people living and working in these buildings. Energy-efficient buildings can provide more comfortable and healthy indoor environments with improved ventilation, lighting, and temperature control, which can lead to better health outcomes, increased productivity, and a better quality of life.

Despite the numerous benefits of energy efficiency in buildings, economic agents may not be investing as much as they could in energy-efficient upgrades. This situation can be due to a range of reasons—commonly known as the energy efficiency paradox—including a lack of awareness and information about the benefits of energy efficiency, concerns about the upfront costs of such investment, limited access to financing, a lack of trust in energy-efficient industry, the uncertainty and irreversibility of investments, principal-agent issues, and competing priorities (Belaïd, Youssef, and Lazaric 2020; Economidou et al. 2020; Gillingham et al., 2009; Labanca and Bertoldi 2018; Linares and Labandeira 2010).

Many individuals may not realize that investing in energy efficiency can pay off in the long run through reduced energy bills, improved comfort of indoor spaces, and the mitigation of the negative impacts of climate change. However, a lack of awareness and information about the benefits of energy efficiency can prevent individuals from making such investments.

The upfront cost of energy-efficient upgrades can also be a significant barrier for some individuals. Purchasing and installing solar panels or upgrading to a high-efficiency HVAC system can be expensive, and not every individual may have the financial resources to make these investments. Additionally, limited access to financing can make it difficult for individuals to pay for energy-efficient upgrades over time.

Concerns about the quality and reliability of energy-efficient products and services may also prevent individuals from investing in energy efficiency (Bakaloglou and Belaïd 2022). Some individuals may hesitate to invest in energy-efficient upgrades without first seeing evidence that they will deliver the promised energy savings.

Finally, competing priorities and financial constraints can also prevent individuals from investing in energy efficiency. For example, an individual may be more focused on paying off debt or saving for retirement than on investing in energy-efficient upgrades.

In sum, addressing these barriers to energy-efficient investments requires a combination of education, financial incentives, and policy interventions. Raising awareness and providing access to financing and other resources can empower people to invest in energy-efficient improvements, resulting in cost savings, an improved indoor environment, and reduced greenhouse gas emissions.

Session 1: Energy Demand in the Built Environment: Drivers and Conservation Opportunities

Buildings consume a significant portion of world energy and are responsible for a substantial proportion of GHGs. As many countries strive toward achieving global climate goals, addressing the energy demand level in buildings and finding ways to decarbonize the sector are essential. Moreover, improving knowledge about the context of building energy efficiency is crucial to provide a baseline for tracking the progress and evaluating the effectiveness of energy-saving measures.

This session explored the various factors that contribute to the high energy demand level in the built environment, such as building design, lighting, heating, cooling, and ventilation systems, as well as the behavior of building occupants. The speakers discussed the challenges of reducing energy demand while maintaining occupant comfort and productivity; also highlighted the environmental impacts of energy use, including greenhouse gas emissions; and discussed the potential for energy conservation through building design and technology. The speakers shared case studies of successful energy conservation efforts in the built environment and discussed the role of smart technologies and multiscale renovation approaches at the city level.

Speakers and participants also highlighted the following:

Achieving climate objectives in the Middle East requires the decarbonization of the built environment. By 2040, the population in the Middle East is projected to increase by 180,000,000 people[1] (PopulationPyramid.net). To accommodate this level of population growth, 60 million new housing units, 540 thousand new hospital beds, 73 thousand new schools, as well as new public and commercial buildings and associated infrastructures, will be required. With approximately half of the direct Middle East CO_2 emissions attributed to the built environment, how fast the sector is decarbonized may very well determine whether the country can meet the Paris Agreement's planetary warming targets. Hence, how the built environment is planned, designed, and constructed may dictate decarbonization outcomes.

Achieving net-zero carbon in the built environment requires a two-step process: (1) planning, design, and construction and (2) renewable integration (Figure 2). It is also essential to focus on and prioritize the decarbonization of large buildings, which represent 50% of total emissions (Figure 3).

Finally, the integration of renewable energy constitutes a genuine solution to power the built environment. We can easily power any building in the world with a free energy source if we capture it and store some of it to use in the off hours or evening (Figure 4).

Kuwait needs to develop a comprehensive energy policy to achieve this goal. In Kuwait, energy efficiency has been pursued by the Kuwait Institute for Scientific Research (KISR) since the

[1] https://www.populationpyramid.net/world/2022/.

Figure 2. Ways to achieve carbon neutrality in the built environment.

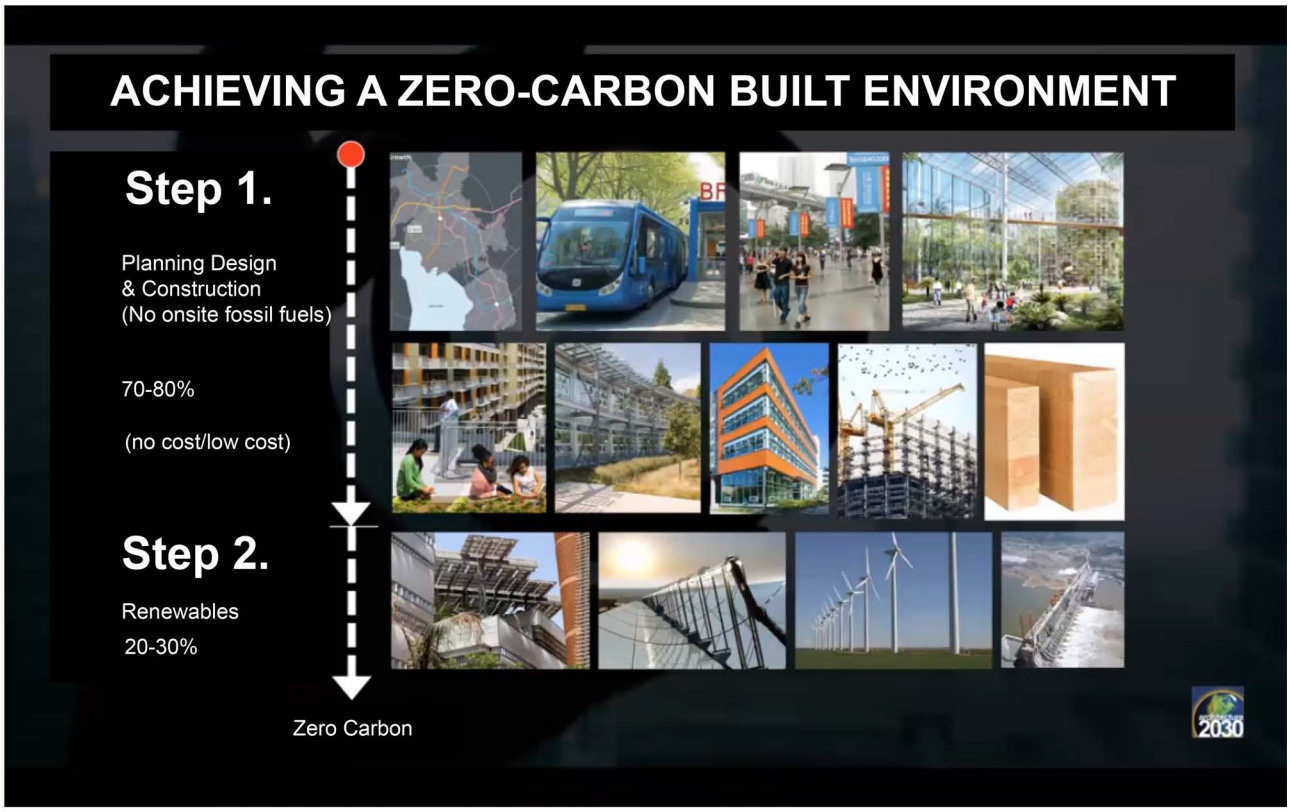


Figure 3. Total emissions by building size.

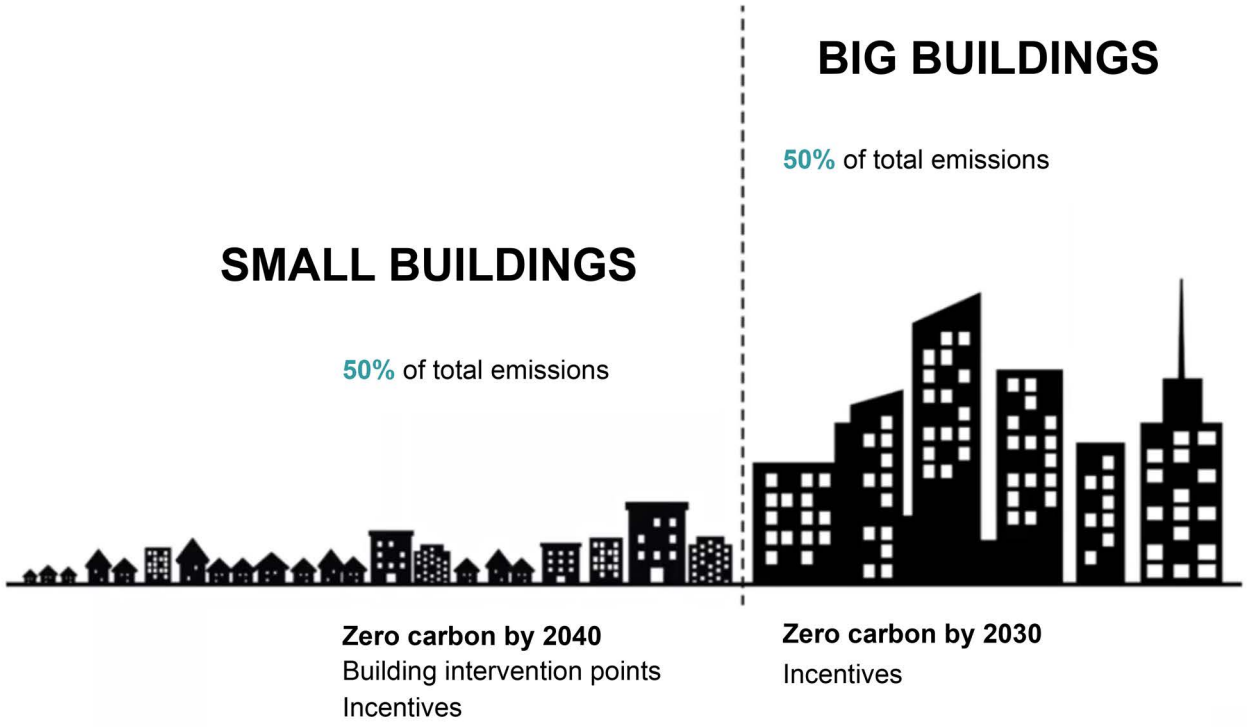
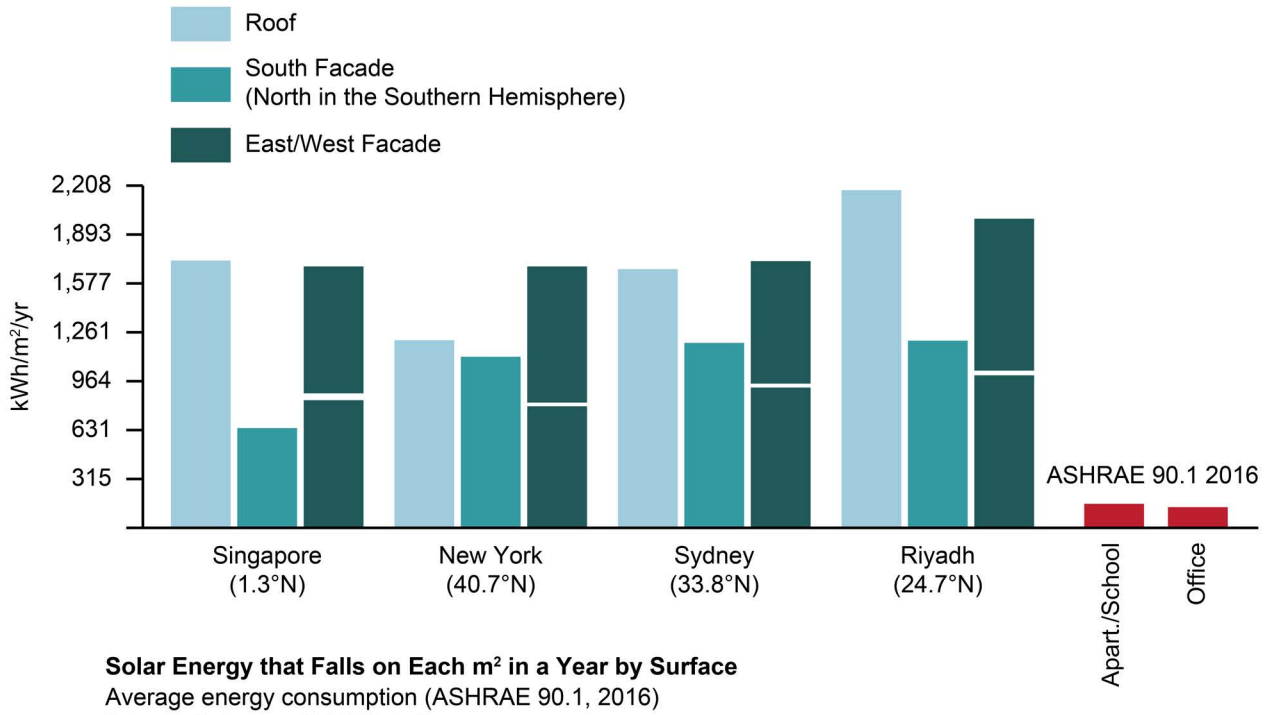


Figure 4. Total emissions by building size.



Solar Energy that Falls on Each m² in a Year by Surface
Average energy consumption (ASHRAE 90.1, 2016)
Primary School = 138 kWh/m²/yr
Office Building = 100 kWh/m²/yr
Apartment Building = 133 kWh/m²/yr

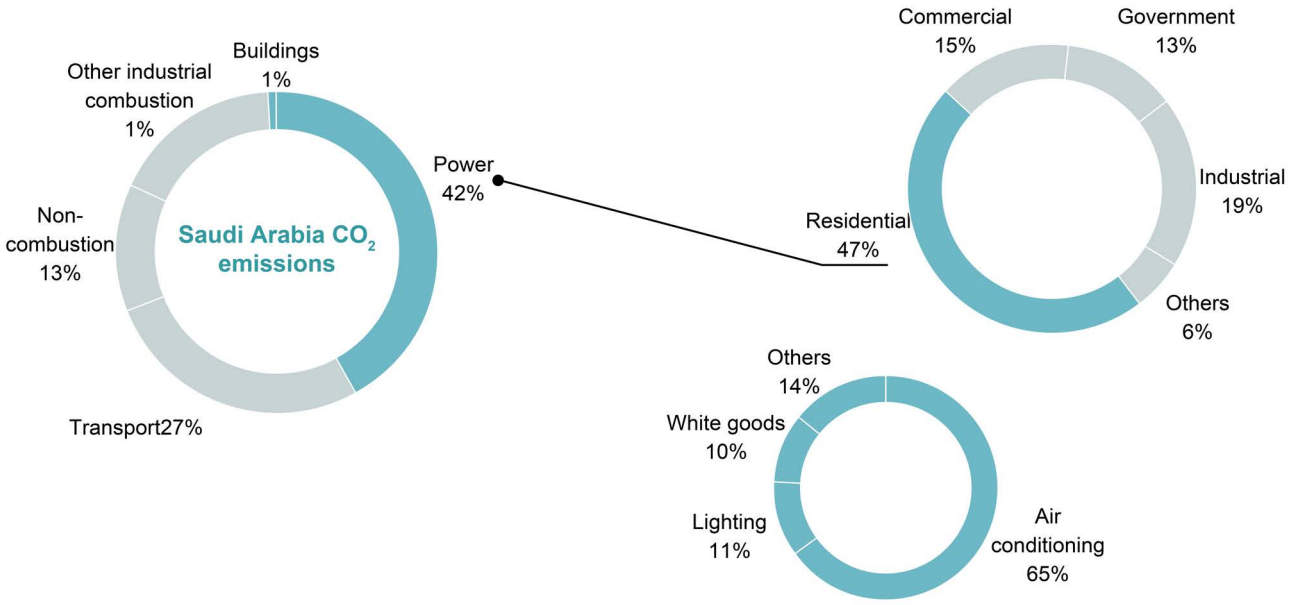
Solar Data Source: PV Watts

early 1980s, as the first energy conservation code went into force in 1983. Kuwait has also pursued solar energy since the early 1970s, but this pursuit was put on hold due to the high system prices and low oil prices. Accordingly, the KISR focused on pursuing energy efficiency by conducting several applied research projects, including updating the national energy conservation code, energy auditing, demand side management, home automation, and the assessment of the efficiency of air-conditioning systems, among others. Later, the KISR, in the early 2000s, continued its applied research on solar energy and invested in conducting demonstration projects targeting renewable energy. Despite the measures taken thus far, Kuwait still has room to enhance its energy efficiency, reform its energy needs, and decrease its carbon footprint.

Buildings are a significant energy consumer in Saudi Arabia, with approximately 47% of electricity consumption in the country being attributed to the residential sector (Figure 5). In addition, the energy demand for buildings is expected to increase significantly in the coming years due to population growth and urbanization. An improvement in the energy efficiency of the building sector may contribute up to a 30% electricity reduction by 2060.

Energy consumption is a crucial aspect of every sector, and understanding its drivers is essential for effective policymaking. Accurate data on energy, socioeconomic factors, and buildings are necessary to comprehend the impact of these drivers (Belaid, Youssef, and Omrani 2020; Lévy and Belaïd 2018; Tsemekidi et al. 2019). However, the effect of

Figure 5. Electricity consumption in Saudi residential buildings.



these drivers can be mitigated through efficiency improvements to limit or reduce total energy consumption. Decomposition and econometric modeling are valuable tools for identifying the impact of drivers and causality, enabling policymakers to implement the appropriate strategies. By analyzing and assessing these drivers, policymakers can develop effective strategies through which to address the issue of energy consumption in buildings.

Scaling up smart building solutions for districts is crucial, and comprehensive solutions play a vital role in achieving this goal. The integrated application of smart building methods has become increasingly significant in the contemporary context. This approach encompasses not only the building itself but also extends to the district level. Smart technology plays a crucial role in enabling this transition. By virtue of the Internet of Things (IoT) and crowdsourcing, the data collection and service layers can bridge the gap between physical and digital realms, which are the essential pillars of smart city ventures. For example, brownfields can be converted into eco-friendly neighborhoods using smart technologies. Such transformation encompasses the deployment of sustainable energy systems, effective waste management regimes, and other environmentally friendly initiatives.

Session 2: Policy Options to Improve Energy Efficiency in the Built Environment

This session focused on policy options for improving energy efficiency in the built environment. The speakers discussed the importance of stakeholder engagement in the policy development process, including the involvement of building owners, developers, designers, and occupants. They also discussed the role of policies in promoting energy efficiency and highlighted examples of successful policy implementation from Saudi Arabia and worldwide. The speakers shared insights into how to design effective policies, including the use of incentives, regulations, and market-based approaches. Furthermore, the speakers discussed the challenges of policy implementation and

identified strategies through which to overcome them.

Many strategies and technologies are available to improve building energy efficiency, including envelope insulation, high-efficiency HVAC systems, building automation, and renewable energy integration. Some of these strategies can be relatively low cost and easy to implement, such as weather sealing and lighting upgrades, while others may require more significant upfront investments, such as deep renovation and solar panel or geothermal system installations.

Governments and international organizations have recognized the importance of building energy efficiency and have developed policies and programs to support its implementation. For example, many countries have established building codes and standards that require new buildings to meet specific energy-efficient requirements. Some countries also offer financial incentives or support programs to encourage building owners to invest in energy-efficient improvements.

Speakers and participants also highlighted the following:

Saudi Arabia has been very active during recent decades and has implemented a range of initiatives and programs through which to promote energy efficiency in the building sector as part of its broader National Energy Efficiency Program (NEEP) (Figure 6). The NEEP program aims to reduce the country's level of energy consumption, with a particular focus on improving energy efficiency in buildings (Ministry of Energy 2023).

To oversee the implementation of energy-efficient initiatives, the Saudi Energy Efficiency Center (SEEC) was established in 2010. One of the SEEC's main objectives is to rationalize energy consumption in the Kingdom and promote energy efficiency in buildings by improving building design and construction practices. The SEEC has also developed many regulations and introduced building codes that require new buildings to meet specific energy-efficient standards, including requirements for insulation, lighting, and HVAC systems.

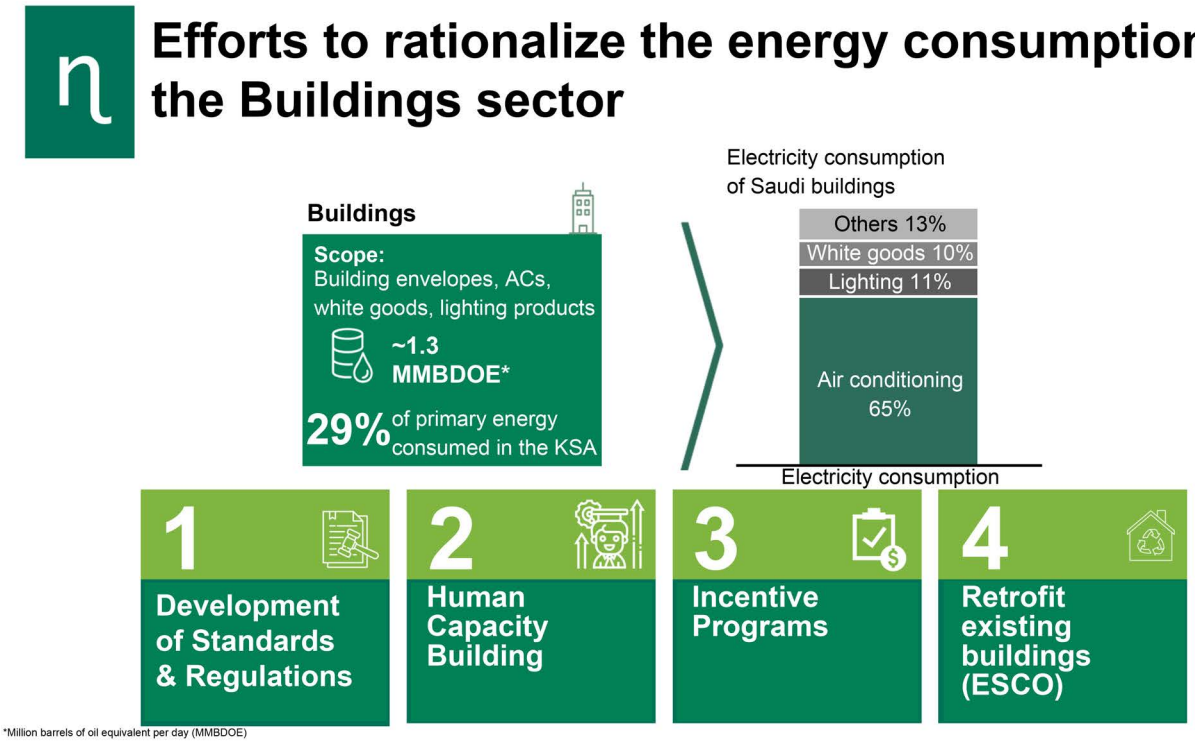
The SEEC has also been making efforts toward improving energy efficiency in existing buildings through renovation and retrofitting programs, such as the High-Efficient Air Conditioning Initiative. These programs aim to upgrade the buildings' envelopes, HVAC systems, lighting systems, and other equipment to reduce energy consumption.

There has been a focus on human capacity building and awareness campaigns to support these efforts. The SEEC has launched various training programs and established centers of excellence in energy efficiency at universities to develop the skills and knowledge necessary to design and construct energy-efficient buildings. There has also been a focus on raising awareness among building owners and occupants about the benefits of energy efficiency through public awareness campaigns and outreach activities. Since 2004, more than 25 energy-efficient campaigns have been developed, leveraging both traditional and digital means of communication.

Energy audits are also becoming more commonplace in Saudi Arabia. Both government and private-sector organizations are conducting audits to identify areas where energy efficiency can be improved in buildings. By identifying areas for improvement, building owners can take steps to reduce their energy consumption levels and lower their energy bills.

Implementing a sustainable national energy policy is crucial for enhancing building energy

Figure 6. Efforts toward rationalizing energy consumption in the Saudi building sector.

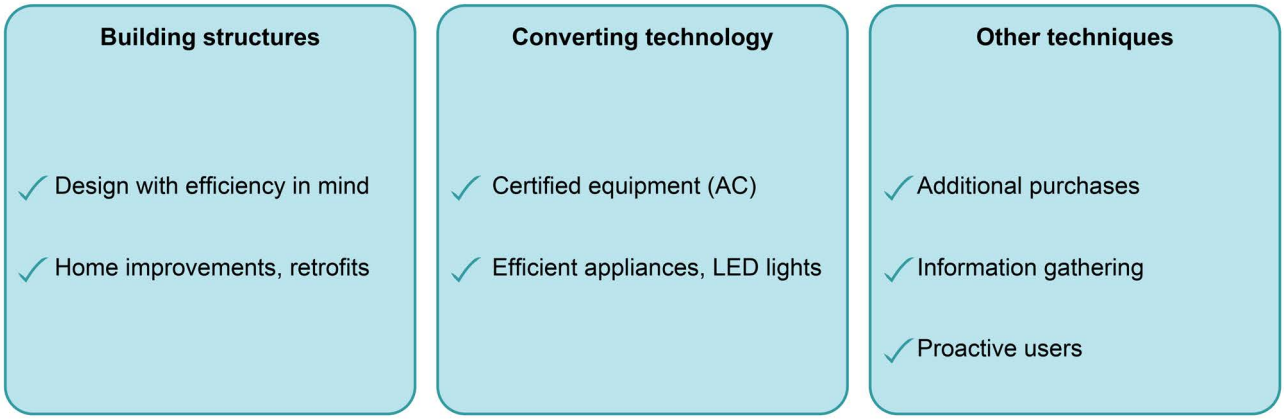


efficiency in Kuwait and the GCC region. This policy should involve stakeholders from the beginning and focus on both the demand and supply sides. Subsidy reform should be implemented, including targeted subsidies and public awareness campaigns. Subsidies must be reformed in a targeted manner, providing help to those who need it most and encouraging a shift toward energy-efficient practices. Public awareness campaigns can boost consumers' consciousness of the importance of saving energy and encourage them to conserve energy.

Moreover, investment in energy-efficient technologies, such as LED lighting and smart meters, is essential. Efficacy standards and regulations should be established, along with sustainable energy technologies like solar panels. Research and development funding should support innovation in energy efficiency. The prioritization of energy efficiency in air conditioning and appliances is also vital. By implementing these measures, Kuwait and GCC countries can achieve significant energy savings and promote sustainability in their buildings.

Building energy efficiency can be achieved through three broad types of incremental improvements (see Figure 7). First, new buildings can be designed with efficiency considerations, which means that builders should consider natural lighting and orientation, among other factors. Renovations and retrofits can improve the energy efficiency of existing building stocks by adding insulation and sealing doors and windows to reduce heat loss in the winter and heat gain in the summer. Second, energy-converting technologies, including energy-intensive equipment like ACs or smaller appliances and lighting, can be made more efficient. LED lighting is more energy efficient than is traditional incandescent lighting, and

Figure 7. Incremental steps to achieve building energy efficiency.



Energy-Star-certified appliances use less energy than do their noncertified counterparts. Third, some additional purchases improve the comfort level of building spaces, such as buying a ventilation system for better air circulation or blackout curtains for additional protection. Smart energy management instruments such as smart thermostats and smart lighting systems can enable energy consumers to gather information for better decision-making. Other techniques include performing regular maintenance and obtaining an energy audit. Finally, the promotion of behavioral changes among building occupants can reduce energy use. Simple actions such as turning off lights and appliances when not in use, using natural light instead of artificial light, and proactively adjusting the thermostat can all contribute to significant energy savings.

There are two broad types of policy approaches adopted around the globe. These approaches are *carrot approaches,* which provide financial and/or nonfinancial incentives for the adoption of energy-efficient measures, and *stick approaches,* which are prescriptive mandates regulating behavior or lack of action. **Figure 8** provides some examples of each approach. Most countries use a combination of both approaches. For instance, according to the American Council for an Energy-Efficient Economy (ACEEE) [7], the Netherlands ranks first in building efficiency efforts, which is attributed to the country's varying levels of the carrot-and-stick approach. For example, the country has a building upgrade policy that sets standards for home insulations and other norms/regulations at the local level, where noncompliance is fined. The government

Figure 8. Examples of carrot and stick approaches for incentivizing energy efficiency.

also provides several financial incentives, such as subsidies, loans, and information provisions, which are designed differently for different sectors (e.g., property owners, associations, and corporations). In the Netherlands, policy incentives are also available for the supply side, particularly encouraging innovations (e.g., digitalization and circular systems) in the construction sector.

A cohesive and interconnected approach is essential for achieving building energy efficiency targets. Such an approach can be considered through the "7 Ds" framework, which includes decoupling, decarbonization, decentralization, digitization, disruption, desilos, and desirability. First, decoupling energy consumption from economic growth entails breaking the traditional association between economic development and increased energy usage. By implementing energy-efficient technologies, practices, and behavior changes, we can achieve economic progress without a corresponding surge in energy consumption. Second, decarbonizing energy sources is vital for reducing GHG emissions. Integrating renewable energy sources, such as solar and wind power, reduces the reliance on fossil fuels and promotes a cleaner and more sustainable energy mix. Third, decentralizing energy production involves transitioning from centralized energy systems to localized generation. By embracing onsite renewable energy generation and implementing microgrids, energy loss during transmission can be minimized, resulting in improved energy efficiency. Fourth, digitizing energy management through advanced technologies enables real-time monitoring, data analytics, and automation. Smart building management systems, IoT devices, and energy-efficient appliances empower energy conservation, optimize energy use, help identify areas for improvement, and enhance overall energy performance.

Fifth, embracing disruption and innovation allows for the exploration of emerging technologies and novel solutions. Energy storage and advanced energy management systems represent disruptive innovations that can unlock new possibilities and drive greater energy efficiency. Sixth, breaking down silos and promoting cross-functional collaboration are essential for achieving collective energy goals. Fostering cooperation between stakeholders provides a real opportunity for them to share knowledge, leverage diverse expertise, and develop integrated energy solutions for maximum efficiency. Seventh, creating a desirable built environment that reconciles energy efficiency and occupant comfort can foster a healthier and carbon-neutral building sector. This concept ensures that buildings not only are energy efficient but also provide comfortable, healthy, and sustainable spaces for occupants. Incorporating these "7 Ds" into building energy policy practices has the potential to unlock significant energy savings.

Attaining building energy efficiency is the first, but not the only, step in achieving building decarbonization. Although energy efficiency has economic and environmental benefits, behavioral studies suggest that building occupants often tend to use energy-converting technologies more intensively after efficiency upgrades, thereby eroding the benefits of energy savings, compared to before such upgrades. The resulting phenomenon, referred to as the *energy rebound effect,* has been a popular topic of research in energy economics. If the rebound effect is present and strong enough, then policymakers should adopt behavioral strategies through which to affect actions instead of just relying on financial signals.

In conclusion, while nations are trying to achieve the best rate of energy efficiency, they should also strategically consider electrification (e.g., switching from natural gas to electricity) and cleaner energy sources (e.g., large-scale wind farms or solar panels) to support their net-zero emission goals.

Overall, the promotion of energy efficiency requires the following steps: (1) analyze and understand the market, (2) improve information and benchmarking, (3) stimulate research and development, (4) set performance standards, and (5) mobilize resources and scale up.

The consideration of a lifecycle or broader system perspective in policy design for energy efficiency in the built environment is important. Tackling embedded carbon in construction materials becomes equally important, at least in the context of pursuing the dual objectives of decarbonization and energy conservation. The presenter highlighted that public policy in the built environment could influence the upstream decarbonization efforts of construction materials such as steel, aluminum, cement, and concrete. An example of such a disruption would be the green public procurement pledge under the industry deep decarbonization initiative of the clean energy ministerial (IDDI), whereby governments have pledged to reduce the embodied carbon emissions of all major public construction projects by 2050, in line with a 1.5C global warming trajectory. Such measures could be introduced in a stepwise manner to create lead markets for low-emission construction materials.

Future Work and the Way Forward

As energy efficiency becomes an increasingly important consideration in the built environment, many research areas could help improve our understanding of how to rationalize energy consumption and promote conservation in the built environment.

A major area of research that has attracted considerable attention in recent years is the promise of smart building technologies in driving energy efficiency. Investigations could focus on the effectiveness of various smart building technologies, such as occupancy sensors, lighting controls, and smart thermostats, to identify the most effective solutions for reducing energy consumption in buildings.

Behavioral interventions are another potential avenue through which to promote energy efficiency in the built environment. Policymakers could consider the development of various behavioral interventions, such as feedback systems, social norms, boosts, and information campaigns, to promote energy-efficient behavior among building occupants.

Effective energy-efficient policy design is another area of focus that could help promote sustainability in the built environment. Policymakers should investigate the role of incentives, regulation, and market-based approaches in promoting energy efficiency and identify the most effective innovative business models and policy solutions in terms of their ability to rationalize energy consumption in buildings.

Another area of investigation that could improve our understanding of energy use in the built environment is energy modeling. Policymakers should conduct research to develop robust energy-modeling tools that accurately predict energy use in buildings, which could be achieved by using machine learning algorithms and other advanced modeling techniques to improve energy model accuracy.

Ultimately, energy storage systems are a promising type of technology for promoting energy efficiency in the building sector. Efforts should focus on developing various energy storage technologies, particularly batteries, flywheels, and thermal energy storage, to identify the most effective solutions for storing energy, enabling load shifting, providing flexibility, and optimizing costs.

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About the Workshop

The KAPSARC held this workshop in collaboration with the Gulf University of Science and Technology (GUST) as part of the KAPSARC's Building Energy Efficiency project. The event was held on Wednesday, March 15, 2023, at GUST University in Kuwait. The workshop featured a panel of experts in the field of energy-efficient policy, who shared their knowledge and experiences with participants.

The meeting included more than 35 participants.

The speakers at the workshop were as follows:

Mohamad Hejazi – Climate and Sustainability Program Director, KAPSARC

Kamaludin A Dingle – Director of Graduate Studies & Research

Fateh Belaid – Fellow, KAPSARC

Edward Mazria – Fellow of the American Institute of Architects, CEO, Architecture 2030

Foutouh Al-Ragom – President of the Association of Energy Engineers, Kuwait Institute for Scientific Research

Mohammad Al-Dubyan – Research Lead, KAPSARC

Paolo Bertoldi – Senior Expert, EU Commission

Adel Ben Youssef – Professor, Nice Sophia Antipolis University

Hakam Zummo – Building Department Manager, SEEC

Abdulaziz Alsubaihi – Building Department Manager, SEEC

Salem Alhajraf – Founder and CEO of Edama Consult

Benoit Lebot – French Ministry of Energy Transition

Mahelet Fikru – Missouri University of Science and Technology

Tareq Emtairah – Director of the Energy Department at UNIDO

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About the Authors

Fateh Belaïd

Fateh Belaïd was a full professor of economics at Lille Catholic University and director of the Smart & Sustainable Cities research unit. Fateh has also held various positions at the French Scientific and Technical Center for Building and led multiple collaborative projects for the French Ministry of Ecological Transition and the European Commission. He is an energy and environmental economist drawing from the fields of applied microeconomics, energy modeling, and econometrics.

He has published widely on household energy consumption, energy-saving behaviors, individual preference and investment in energy efficiency, energy poverty, renewables, and energy policy. He received a habilitation for supervising doctoral research from Orléans University, a Ph.D. in Economics, an M.S. in Applied Economics & Decision Theory from Littoral University, and an engineering degree in statistics.

His work has been published in journals including Ecological Economics, The Energy Journal, Energy Economics, Economic Surveys, Energy Policy, and Environmental Management

Mohammad Aldubyan

Mohammad is a research lead in KAPSARC's Climate & Sustainability program. His research focuses on energy efficiency and energy demand in buildings. He is currently leading the Residential Energy Model (REEM), which simulates residential energy demand and estimates the impact of energy efficiency programs on Saudi Arabia's housing sector. He also leads the long-term KAPSARC Oil Market Outlook (KOMO) in buildings and agriculture sectors.

Mohammad holds an M.Sc. in Renewable and Clean Energy from the University of Dayton, Ohio and an M.Sc. in Economics from Purdue University, West Lafayette.

Mohamad Hejazi

Mohamad Hejazi is the Program Director for the Climate and Sustainability Program at KAPSARC. He also leads the Climate Change Adaptation and Mitigation Partnership (CAMP) project, and his work focuses on climate change research, climate impacts and adaptation, climate mitigation, integrated assessment modeling, and energy-water-land nexus. Prior to joining KAPSARC, Mohamad worked as a senior research scientist at the U.S. Department of Energy's Pacific Northwest National Laboratory, where he served as the principal investigator for the Global Change Intersectoral Modeling System project, a multi-million-dollar project that includes over 40 interdisciplinary researchers across many institutions. He has also led and contributed to projects with the World Bank, Inter-American Development Bank, US-AID, US-EPA, USGS, NASA, and NSF-INFEWS. Mohamad has authored over 100 journal publications, and he has also served as a contributing author to the Fourth U.S. National Climate Assessment, and the AR6 IPCC WG III report on the mitigation of climate change. Mohamad holds a B.S. and M.S. from the University of Maryland, College Park, and a Ph.D. from the University of Illinois, Urbana-Champaign.

About the Project

The workshop is part of the ongoing KAPSARC Building Energy Efficiency project, the primary purpose of which is to implement a holistic approach over the whole value chain to identify low-energy-demand pathways in the building sector needed to meet the challenges associated with reducing energy emissions in Saudi Arabia. The project expects to cover a broad range of topics using innovative approaches and empirical studies to answer the following questions. (i) What are the challenges, barriers, and drivers of improving building energy efficiency in Saudi Arabia? (ii) What are the key enablers (investment, finance, behavioral interventions, etc.) for building energy efficiency in the Kingdom? How can we effectively federate and engage with the whole community of stakeholders and accelerate the adoption of new business models for energy-efficient buildings in the Kingdom? (iii) What are the critical social and economic benefits of energy-efficiency investments in buildings, and who will benefit from these investments?

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