



## Renewable energies and their correlation with civil engineering: a sustainable approach for the urban future

*Renewable energies and their correlation with civil engineering: a sustainable approach for the urban future*

Felipe Girardi

### SUMMARY

This article aims to present a comprehensive overview of renewable energy and its correlation with civil engineering, focusing on the contribution of this interaction to sustainable urban development. Based on a literature review and analysis of recent global data (up to early 2021), the article discusses how sources such as solar, wind, biomass and hydroelectric are being integrated into infrastructure projects. Furthermore, the role of the civil engineer in the implementation of efficient and sustainable energy solutions is highlighted. The article also points out the challenges faced by this sector, proposing ways to overcome them and increase the role of clean energy in the cities of the future.

**Keywords:** renewable energy; civil engineering; sustainability; infrastructure; urban planning.

### ABSTRACT

This article aims to present a comprehensive overview of renewable energies and their impact on civil engineering, focusing on the contribution of this interaction to sustainable urban development. Based on a literature review and analysis of recent global data (up to early 2021), it discusses how sources such as solar, wind, biomass and hydroelectric are being integrated into infrastructure projects. In addition, it highlights the role of the civil engineer in the implementation of efficient and sustainable energy solutions. The article also points out the challenges faced by this sector, proposing ways to overcome them and increase the role of clean energies in the cities of the future.

**Keywords:** renewable energies; civil engineering; sustainability; infrastructure; urban planning.

## 1 INTRODUCTION

With the increase in energy demand and the environmental impacts associated with burning fossil fuels, the transition to cleaner energy sources becomes urgent and sustainable. Global climate change, the harmful effects of air pollution and the depletion of non-renewable natural resources highlights the need for a energy matrix based on renewable sources.

According to the International Renewable Energy Agency (IRENA, 2021), renewable energy accounted for approximately 29% of global electricity generation in 2020, with a trend

growing. However, for this scenario to expand, a restructuring will be necessary significant in the way cities and their infrastructures are planned and built.

In this context, civil engineering plays a fundamental role in integrating energy solutions into urban infrastructure, building and mobility projects. The work of these professionals involves everything from the design of energy-efficient buildings to the adaptation of systems urban areas to incorporate clean energy sources. This article aims to discuss how advances in renewable energy technologies can be incorporated into civil engineering practices, promoting more resilient, efficient and less polluting cities.

## 2 RENEWABLE ENERGIES: A GLOBAL OVERVIEW

The main sources of renewable energy used in the world are: solar, wind, hydroelectric, biomass and geothermal. Photovoltaic solar energy directly converts sunlight into electricity, while wind energy harnesses the power of the wind through turbines. The Hydroelectric power uses the force of moving water to generate energy, being one of the most traditional renewable sources. Biomass is obtained from the decomposition of organic waste, and Geothermal energy comes from the Earth's internal heat.

According to IRENA's Renewable Capacity Statistics 2021 report, the installed capacity Global renewable energy consumption reached 2,799 GW in 2020. Solar photovoltaic energy accounted for 714 GW and wind, 733 GW, being the sources that grew the most that year. China, the United States The United States and the European Union led investments, with contributions exceeding US\$300 billion in the sector (BNEF, 2021).

In Brazil, according to data from the Energy Research Company (EPE, 2021), the electricity matrix was composed of 83% renewable sources in 2020, with emphasis on hydroelectric power (63%) and wind power (10%). This demonstrates the country's strategic position in the global clean energy scenario. The International Energy Agency (IEA, 2020) already pointed out that Brazil is among the five largest renewable energy markets in the world, alongside China, India, the United States and Germany.

### 3 THE INTERFACE BETWEEN CIVIL ENGINEERING AND RENEWABLE ENERGY

Civil engineering plays a vital role in the design, planning and execution of projects involving the implementation of renewable energy systems. From soil analysis to installation of solar panels, construction of bases for wind turbines, to the development of infrastructures adapted to decentralized energy systems, the participation of the engineer civil is indispensable.

Furthermore, civil engineering is directly involved in the creation of urban buildings sustainable. The use of solar roofs, hydraulic heating systems using energy solar energy, rainwater reuse and cross ventilation are increasingly popular strategies common. The incorporation of these technologies depends on structural, thermal and technical feasibility, all within the competence of civil engineering (PINHEIRO et al., 2021).

Another important aspect is the role of civil engineering in the implementation of infrastructure for smart grids, which allow the efficient integration of different energy sources renewable. These systems optimize urban energy consumption and increase autonomy communities' energy. According to Garcia (2018), civil infrastructure is essential for accommodate innovations in energy efficiency and sustainability, making the transition possible for smart cities.

### 4 CASES AND PRACTICAL APPLICATIONS

A notable example is the Matarazzo City project in São Paulo, where technologies sustainable such as solar panels, rainwater harvesting, ventilated façade and lighting natural were integrated into the architectural project. The civil engineer was responsible for enabling structures that allow such energy efficiency, in addition to ensuring safety and functionality of the building.

In Europe, the initiative of the Vauban neighborhood in Freiburg (Germany) stands out, considered



global reference in sustainable urbanism. In this neighborhood, all residences are equipped with solar panels, streets prioritize pedestrians and cyclists, and public transportation is powered by clean energy. Integrated urban planning with sustainable civil engineering solutions allows the neighborhood to generate more energy than it consumes, becoming a replicable example for other cities.

Other examples include the Masdar City district in the United Arab Emirates, planned for operate exclusively with renewable energy, and buildings certified by the LEED seal, which require the adoption of sustainable construction and operating practices.

## 5 CHALLENGES AND OPPORTUNITIES

Among the main challenges faced in expanding the use of renewable energy in civil engineering are the high initial installation costs, the need for technical training specialized, cultural resistance to the adoption of new technologies and the difficulty of accessing adequate financing.

However, these barriers are gradually being overcome. The cost of solar systems and wind power fell by more than 80% between 2010 and 2020 (IRENA, 2020), making them increasingly competitive compared to conventional sources. In addition, the growing demand for professionals specialized in the area of renewable energy opens up new opportunities for action for civil engineers.

Another significant opportunity is in updating the academic curricula of the courses engineering, which should include disciplines focused on sustainability, energy efficiency and green urban planning. Training professionals prepared to deal with the challenges environmental and energy issues of the 21st century are essential to ensure a more sustainable future (LIMA et al., 2019).

## 6 FINAL CONSIDERATIONS

The transition to a clean energy matrix is irreversible, and civil engineering is positioning itself as a protagonist in promoting sustainable solutions. By incorporating renewable technologies in their projects, civil engineers have the power to transform the urban landscape and mitigate the environmental impacts of constructions.

It is essential that professionals in the field are up to date with emerging technologies and committed to environmental, economic and social sustainability. The adoption of policies public policies that encourage the use of clean energy, combined with responsible technical action, will allow civil engineering to continue to play a central role in the construction of more resilient, efficient cities that are in harmony with the environment.

## REFERENCES

NATIONAL ELECTRICITY AGENCY (ANEEL). Electrical matrix data

Brazilian. Available at: <https://www.aneel.gov.br>. Accessed on: May 2, 2021.

BNEF DATABASE – Bloomberg New Energy Finance. Global trends in clean energy

investment 2020. Available at: <https://about.bnef.com>. Accessed on: May 2, 2021.

ENERGY RESEARCH COMPANY (EPE). National energy balance 2021. Brasília:

EPE, 2021. Available at: <https://www.epe.gov.br>. Accessed on: May 2, 2021.

GARCIA, AB Urban infrastructure and sustainability: challenges for civil engineering. Journal

Built Environment, v. 18, n. 1, p. 39-53, 2018.

INTERNATIONAL ENERGY AGENCY (IEA). Renewables 2020: Analysis and forecast to

2025. Paris: IEA, 2020. Available at: <https://www.iea.org>. Accessed on: May 2, 2021.

INTERNATIONAL RENEWABLE ENERGY AGENCY (IRENA). Renewable Capacity

Statistics 2021. Available at: <https://www.irena.org>. Accessed on: May 2, 2021.

INTERNATIONAL RENEWABLE ENERGY AGENCY (IRENA). Renewable Power Generation Costs in 2020. Abu Dhabi: IRENA, 2021. Available at: <https://www.irena.org>. Accessed on: May 2, 2021.

LIMA, DF; COSTA, MA; FREITAS, RC The training of sustainable civil engineers: a review of pedagogical practices. *Journal of Engineering Education*, v. 6, n. 2, p. 55-72, 2019.

PINHEIRO, MS; OLIVEIRA, TB; LIMA, RS Sustainability in civil construction: integration of green technologies. *Sustainable Engineering Journal*, v. 4, n. 1, p. 22-35, 2021.