

SDG 7.1 what get by PBRC ?

(Photo Bio Reactor Continuous)

Algae Cultivator - PBRC toward SDGs/UN 7.1
(Target 7.1 - By 2030, ensure universal access to affordable, reliable and modern energy services).

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Chapter -1

The photo bio reactor continuous (pbrc) patent

History and Development of PBRC Technology:

The history of PBRC technology is a fascinating journey that underscores the ever-evolving nature of sustainable energy solutions. This chapter delves into the origins and development of PBRC, tracing its evolution from initial concepts to its modern-day applications.

- **Early Conceptualization**

The concept of harnessing photosynthetic organisms for sustainable energy generation dates back several decades. Scientists and researchers recognized the potential of microorganisms like algae and cyanobacteria to capture sunlight and convert it into energy-rich compounds. Early experiments laid the foundation for PBRC technology.

- **Milestones in Development**

Significant milestones in PBRC technology include the design and optimization of bioreactors, advancements in the selection of microorganisms, and the integration of innovative photobioreactor designs. These milestones have

contributed to the improved efficiency and scalability of PBRC systems.

- **Commercialization and Widespread Adoption**

The commercialization of PBRC technology in recent years has been a critical development. Start-ups, research institutions, and established companies have recognized the commercial potential of PBRC, leading to a surge in research, development, and investments in this field.

Key Features and Components of PBRC:

Understanding the core features and components of PBRC technology is essential to appreciate its significance. This section explores the fundamental elements that make PBRC a unique and promising approach to sustainable energy production.

- **Microorganisms in PBRC**

Microorganisms, such as algae and cyanobacteria, are central to PBRC technology. Their photosynthetic activity allows them to capture solar energy and convert it into biomass, which can be further processed into biofuels. The selection and engineering of these microorganisms are critical for optimizing PBRC efficiency.

- **Photobioreactors**

The photobioreactor is the heart of PBRC systems. It provides a controlled environment for the cultivation of microorganisms, enabling efficient photosynthesis. Various designs, such as closed-loop systems, open-pond systems, and tubular reactors, exist to suit different applications.

- **Light Capture and Distribution**

Efficient light capture and distribution mechanisms are crucial in PBRC systems. Light sources, optical components, and light distribution strategies are designed to ensure that microorganisms receive the optimal amount of light for photosynthesis.

- **Carbon Dioxide Sequestration**

Carbon dioxide capture and utilization are integrated into PBRC technology. This not only reduces greenhouse gas emissions but also provides a source of carbon for microorganisms, enhancing their growth and energy production

The Significance of the PBRC Patent in Advancing Sustainable Energy:

Intellectual property protection, particularly patents, plays a pivotal role in advancing innovations like PBRC

technology. This section explores the importance of patent protection in the development, commercialization, and dissemination of PBRC innovations.

- **Incentives for Innovation**

Patents serve as incentives for inventors and organizations to invest in research and development. The prospect of securing exclusive rights to their innovations motivates scientists and engineers to explore novel approaches to sustainable energy production, including PBRC.

- **Protection of Intellectual Property**

The patent system provides legal protection for the intellectual property associated with PBRC technology. This safeguards the inventors' rights and prevents unauthorized use or replication of their innovations.

- **Knowledge Sharing and Collaboration**

While patents protect intellectual property, they also encourage knowledge sharing and collaboration. Inventors often license their patents to others, fostering a culture of innovation and cooperation within the PBRC community

Challenges in Patenting PBRC Technology:

The process of patenting PBRC technology is not without its challenges. This section examines some of the common hurdles faced by inventors and organizations in obtaining patent protection for their PBRC innovations.

- **Prior Art and Novelty***

Patent applications must demonstrate that the innovation is novel and inventive. Inventors may encounter challenges if similar concepts or technologies exist in prior art.

- **Patentability of Biological Inventions***

PBRC technology often involves biological components, and patenting biological inventions can be complex due to regulatory and ethical considerations.

- **Intellectual Property Disputes***

Competing claims to similar innovations can lead to intellectual property disputes, which may delay the patenting process and require legal resolutions.

Opportunities and Implications of PBRC Patenting

Despite the challenges, patenting PBRC technology offers significant opportunities and implications for the sustainable energy landscape. This section discusses the

broadier implications of PBRC patents in the context of SDG 7.1.

- **Knowledge Transfer***

The patent system facilitates knowledge transfer by requiring inventors to disclose their innovations. This enables others to build upon existing knowledge, accelerating the development of PBRC technology.

- **Investment and Funding***

Patents make PBRC innovations more attractive to investors and funding agencies, as they assure that intellectual property rights are protected.

- **Technology Commercialization***

The ability to protect and license PBRC patents enhances the commercialization potential of this technology, driving its adoption in the energy sector.

Summary:

This chapter has provided an in-depth exploration of the Photo Bio Reactor Continuous (PBRC) patent and its significance in the context of sustainable energy, particularly in the pursuit of SDG 7.1. From its historical development to its key features and components, PBRC

technology stands as a remarkable innovation with great potential. The role of patent protection in advancing PBRC innovations is evident, and while challenges exist, the opportunities for knowledge sharing, investment, and technology commercialization are substantial. In the following chapters, we will further examine recent innovations and case studies to underscore the real-world impact of PBRC technology and its patent. Chapter 5: PBRC Commercialization and Market Potential.

Chapter 2

The Science Behind PBRC

Introduction:

In this chapter, we will explore the commercialization potential of Photo Bio Reactor Continuous (PBRC) technology and its market prospects. PBRC has gained significant attention in recent years due to its potential to address the energy and environmental challenges outlined in SDG 7.1. We will discuss the various factors that contribute to the market potential of PBRC and the challenges that need to be overcome for successful commercialization.

2.1 Market Opportunities for PBRC Implementation:

PBRC technology offers several market opportunities across various sectors. The following are some key areas where PBRC can be implemented:

- 1. Energy Generation:** PBRC can be used to produce biofuels, such as biodiesel and bioethanol, which can replace fossil fuels in transportation and power generation.

This presents a significant market opportunity as the demand for renewable energy sources continues to grow.

2. Waste Treatment and Resource Recovery: PBRC can be utilized for the treatment of wastewater and the recovery of valuable resources, such as nutrients and organic compounds. This can help in addressing the global water crisis and create a market for sustainable waste management solutions.

3. Food and Agriculture: PBRC can be employed for the production of high-value products, such as microalgae-based nutritional supplements and animal feed. This can contribute to food security and provide a sustainable alternative to traditional agricultural practices.

2.2 PBRC's Alignment with SDG 7.1 and Other SDGs:

PBRC technology aligns closely with SDG 7.1, which aims to ensure universal access to affordable, reliable, and modern energy services. By utilizing renewable energy sources and reducing greenhouse gas emissions, PBRC contributes to the achievement of this goal. Additionally, PBRC also aligns with other SDGs, such as:

- 1. SDG 2: Zero Hunger** - PBRC can contribute to sustainable agriculture and food production, addressing the challenge of hunger and malnutrition.
- 2. SDG 6: Clean Water and Sanitation** - PBRC can be used for wastewater treatment, reducing water pollution and ensuring clean water availability.
- 3. SDG 9: Industry, Innovation, and Infrastructure** - PBRC presents an innovative solution for sustainable energy production and resource recovery, promoting sustainable industrialization.

2.3 Future Prospects and Challenges of PBRC:

While PBRC holds immense potential, there are several challenges that need to be addressed for its successful commercialization. Some of the key challenges include:

- 1. Cost-effectiveness:** The initial investment and operational costs of PBRC systems can be high. Further research and development are required to optimize the design and reduce the overall cost of PBRC implementation.
- 2. Scalability:** Scaling up PBRC systems to meet commercial demands can be challenging. The

development of standardized and modular PBRC units can facilitate scalability and widespread adoption.

3. Regulatory Framework: The development of a supportive regulatory framework is crucial for the commercialization of PBRC. Clear guidelines and incentives can encourage investment and facilitate market growth.

2.4 Summary:

In this chapter, we have explored the commercialization potential of PBRC technology and its market prospects. PBRC offers significant opportunities in energy generation, waste treatment, and food production. Its alignment with SDG 7.1 and other SDGs further enhances its market potential. However, challenges related to cost-effectiveness, scalability, and regulatory frameworks need to be addressed for successful commercialization. In the next chapter, we will summarize the key findings and provide recommendations for further research and development in the field of PBRC.

Chapter 3

PBRC Patents and Projects

3.1 Introduction to PBRC Patents

The Photo Bio Reactor Continuous (PBRC) technology has gained significant attention in recent years due to its potential in addressing the challenges of sustainable energy and water management. As a result, several patents have been filed to protect the innovative aspects of PBRC and its applications. In this chapter, we will explore the patents related to PBRC and the projects that have been undertaken to further develop and commercialize this technology.

3.2 Patent Landscape of PBRC: The patent landscape surrounding PBRC technology is diverse and encompasses various aspects of its design, operation, and applications. These patents cover areas such as reactor design, cultivation techniques, light management, carbon dioxide capture and utilization, monitoring and control systems, and integration with other renewable energy systems. The patents not only protect the intellectual property of the

inventors but also provide a foundation for further research and development in the field.

3.3 Commercialization of PBRC

Patents: Commercialization plays a crucial role in bringing PBRC technology from the laboratory to the market. Companies and research institutions have recognized the potential of PBRC and have invested in the development and commercialization of this technology. Licensing agreements, joint ventures, and strategic partnerships have been formed to leverage the patented aspects of PBRC and bring innovative products and solutions to the market.

3.4 Market Potential of PBRC: The market potential of PBRC technology is vast, with applications in various sectors such as energy, agriculture, pharmaceuticals, and wastewater treatment. The ability of PBRC to efficiently capture solar energy and convert it into biomass or other valuable products makes it a promising technology for sustainable development. This chapter will explore the market potential of PBRC and the opportunities it presents for businesses and investors.

3.5 PBRC and the United Nations Sustainable Development Goals: PBRC technology aligns with several United Nations Sustainable Development Goals (SDGs), particularly SDG 7.1, which aims to ensure

universal access to affordable, reliable, and modern energy services. By harnessing solar energy and converting it into usable forms, PBRC contributes to the transition towards clean and sustainable energy sources. This chapter will discuss the alignment of PBRC with the SDGs and its potential to contribute to a more sustainable future.

3.6 Ongoing Projects and Future Developments: The field of PBRC is continuously evolving, with ongoing projects and research initiatives aimed at improving the efficiency, scalability, and cost-effectiveness of this technology. This chapter will provide an overview of the current projects and research efforts in the field of PBRC, highlighting the advancements being made and the potential future developments that could shape the industry.

3.7 Summary: PBRC patents and projects play a crucial role in the development and commercialization of this innovative technology. The protection of intellectual property rights through patents ensures that inventors and companies can reap the benefits of their research and development efforts. Furthermore, ongoing projects and research initiatives contribute to the continuous improvement and advancement of PBRC technology, paving the way for a sustainable future. In the next chapter, we will delve into the economic and

environmental benefits of PBRC technology and its potential impact on society.

Chapter 4

PBRC and the UN on Sustainable Development Goals

In Chapter 4, we will explore the connection between PBRC technology and the United Nations Sustainable Development Goals (SDGs). PBRC has the potential to contribute significantly to SDG 7.1, which aims to ensure universal access to affordable, reliable, and modern energy services.

1. **Introduction to SDGs:** We will provide a brief overview of the SDGs and their importance in addressing global challenges such as poverty, inequality, and climate change.
2. **PBRC and Energy Poverty:** Energy poverty is a pressing issue in many developing countries, where a significant portion of the population lacks access to electricity. We will discuss how PBRC technology can play a crucial role in providing clean and affordable energy solutions to

underserved communities, thereby helping to alleviate energy poverty.

3. **Climate Change Mitigation:** Climate change is one of the most significant challenges of our time. PBRC technology offers a sustainable and renewable energy source that can help reduce greenhouse gas emissions and mitigate the impacts of climate change. We will explore the potential of PBRC in contributing to SDG 13, which focuses on climate action.
4. **Case Studies:** We will examine real-life examples of PBRC projects that have successfully contributed to SDG 7.1 and other relevant SDGs. These case studies will highlight the positive impact of PBRC technology in various regions and communities.
5. **Future Prospects:** In this section, we will discuss the future prospects of PBRC technology in relation to the SDGs. We will explore the potential for scaling up PBRC projects globally and the role of international collaborations and partnerships in achieving the SDGs.

6. **Challenges and Solutions:** While PBRC technology holds immense promise, there are several challenges that need to be addressed for its successful implementation. We will discuss the challenges related to cost-effectiveness, scalability, and regulatory frameworks. Additionally, we will propose potential solutions and strategies to overcome these challenges.
7. **Policy Recommendations:** To fully harness the potential of PBRC technology in achieving the SDGs, supportive policies and regulations are crucial. We will provide recommendations for policymakers and stakeholders on creating an enabling environment for the widespread adoption of PBRC technology.
8. **Summary:** We will conclude the chapter by summarizing the key points discussed and emphasizing the importance of PBRC technology in contributing to SDG 7.1 and the broader sustainable development agenda.

By exploring the connection between PBRC technology and the SDGs, this chapter will highlight the significance

of PBRC in addressing global energy challenges and promoting sustainable development.

Chapter 5

The Real Structure of PBRC (Photo Bio Reactor Continuous)

Introduction:

Photobioreactors (PBRs) are closed cultivation systems designed to grow microalgae and carry out fermentation processes by harnessing sunlight or artificial illumination . PBRs play a crucial role in maintaining optimal temperatures for outdoor cultivation, as excess light can lead to overheating and culture failure. This chapter explores the real structure of the Photobioreactor Continuous (PBRC), highlighting its components, operation, advantages, and challenges.

Real Structure of PBRC The PBRC is a closed photobioreactor that operates on a continuous approach, maintaining temperatures ranging from 25-40°C . It consists of several essential components:

1. **Solar Receivers:** These receivers facilitate sunlight penetration into the PBRC and are strategically positioned to maximize exposure .
2. **Cultivation Chamber:** This is the main body of the PBRC, where the microalgae culture is housed. It is designed to optimize gas-liquid transfer, illumination, and contamination control [2].
3. **Pumps:** The PBRC employs pumps to continuously circulate the microalgae culture within the solar receivers, ensuring uniform distribution and nutrient availability .
4. **CO₂ Introduction:** Carbon dioxide (CO₂) is introduced into the PBRC to provide the necessary carbon source for photosynthesis .
5. **Exhaust System:** To avoid inhibiting algae growth, excess oxygen is exhausted from the PBRC .

Operation of PBRC The PBRC operates by harnessing sunlight or artificial illumination to facilitate the growth of microalgae. The process involves the following steps:

1. **Culture Circulation:** The microalgae culture is continuously circulated within the PBRC using pumps . This ensures that all cells receive equal exposure to light and nutrients, promoting uniform growth.
2. **Illumination:** The solar receivers allow sunlight to penetrate the PBRC, providing the necessary energy for photosynthesis . Artificial illumination can also be used if sunlight is insufficient.
3. **CO₂ Aeration:** Carbon dioxide is introduced into the PBRC to facilitate photosynthesis and promote microalgae growth .
4. **Temperature Control:** Maintaining optimal temperatures is crucial for the success of the PBRC. Various methods, such as water-bath immersion, water spraying, or floating the photobioreactor tubes in a water-filled tank, are employed to prevent overheating .

Advantages and Challenges The PBRC offers several advantages and faces specific challenges:

Advantages:

1. **Minimal Contamination Risks:** The closed nature of the PBRC minimizes the risk of contamination from external sources .
2. **Efficient Regulation of Physiological Conditions:** The PBRC allows for precise control of environmental factors such as temperature, light intensity, and nutrient availability, optimizing microalgae growth .
3. **Potential for CO₂ Conversion and Biofuel Synthesis:** PBRCs are potential tools for CO₂ conversion and biofuel synthesis due to their ability to cultivate microalgae efficiently .

Challenges:

1. **High Maintenance and Cleaning:** PBRCs require regular maintenance and cleaning to prevent fouling and ensure optimal performance .
2. **Light Penetration:** Ensuring uniform light penetration throughout the PBRC can be challenging, especially in larger systems .

3. **Operational Challenges:** PBRCs require careful management and monitoring to maintain optimal conditions and prevent culture failure .
4. **Energy Consumption:** Closed photobioreactors, including the PBRC, consume substantial amounts of energy, which may limit their sustainability for large-scale biofuel production from microalgae [2].

SummaryThe PBRC offers a promising solution for the cultivation of microalgae and the production of biofuels. Its real structure, comprising solar receivers, a cultivation chamber, pumps, CO₂ introduction, and an exhaust system, enables efficient and controlled growth of microalgae. While the PBRC offers advantages such as minimal contamination risks and efficient regulation of physiological conditions, it also faces challenges related to maintenance, light penetration, and energy consumption. Further research and advancements in material selection and engineering will help mitigate these challenges, making the PBRC an even more viable option for sustainable biofuel production.

Chapter 6

Sustainability and Environmental Impact

Introduction

In a world where environmental concerns are growing by the day, the importance of sustainable and environmentally friendly energy sources cannot be overstated. This chapter delves into the sustainability and environmental impact of Photo Bio Reactor Continuous (PBRC) technology, with a focus on the benefits it brings to the table. PBRC, as a renewable energy technology, has the potential to make significant strides toward achieving Sustainable Development Goal 7.1 (SDG 7.1) by providing access to affordable, reliable, and clean energy. However, the true value of PBRC is not just in its contribution to SDG 7.1 but also in its capacity to reduce environmental harm and promote sustainability.

Environmental Benefits of PBRC

1. Reduced Carbon Footprint:

One of the most critical environmental challenges today is the reduction of carbon emissions. Traditional fossil fuels are a major source of greenhouse gases, contributing to climate change. PBRC technology can play a pivotal role in mitigating these emissions. The cultivation of microalgae in PBRC systems captures carbon dioxide during the photosynthesis process. Microalgae are highly efficient in converting carbon dioxide into biomass and oxygen, resulting in a significant reduction in carbon emissions. This is not only environmentally friendly but also contributes to carbon sequestration, which can aid in combating climate change.

2. Water and Resource Efficiency:

Traditional energy production methods often require substantial amounts of water and other resources. PBRC technology, on the other hand, is remarkably water-efficient. The closed-loop systems used in PBRC minimize water usage by recycling and reusing water,

reducing the strain on local water resources. Additionally, the use of non-arable land for microalgae cultivation prevents competition with agriculture, ensuring that precious land resources are not diverted away from food production.

3. **Biodiversity and Land Use:**

Large-scale energy projects, particularly those involving fossil fuels, can lead to habitat destruction and a loss of biodiversity. The land requirements for photobioreactors are minimal, and they can even be placed in areas unsuitable for agriculture. This minimizes the impact on ecosystems and biodiversity. Furthermore, microalgae cultivation in PBRC systems can be a complementary solution for wastewater treatment, preventing

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Economic and Social Impacts

The environmental benefits of PBRC technology extend to economic and social aspects as well:

1. **Economic Viability:**

PBRC technology, with its capacity to reduce carbon emissions, can open doors to carbon credit trading and funding. This not only generates revenue but also encourages further research and development in the field. Additionally, the sustainable nature of PBRC technology ensures a stable and long-term energy supply, reducing the volatility associated with non-renewable energy sources.

2. Job Creation and Economic Development:

The deployment of PBRC systems creates employment opportunities in various sectors, including research, design, manufacturing, and maintenance of photobioreactors. Local communities near PBRC facilities benefit from job creation, while regional economies see an increase in economic activity. Furthermore, the expansion of PBRC technology can foster entrepreneurship, as microalgae-based products find new markets and applications.

3. Social Impacts on Communities:

As PBRC technology becomes more widespread, it has the potential to enhance the quality of life in communities.

The reduction in pollution and greenhouse gas emissions can lead to cleaner air and water, improving public health. Moreover, the use of PBRC for wastewater treatment can help in maintaining local water quality, benefiting not only the community but also aquatic ecosystems.

Summary

The sustainable and environmentally friendly nature of PBRC technology positions it as a powerful tool for achieving Sustainable Development Goal 7.1 and addressing some of the world's most pressing environmental challenges. By reducing carbon emissions, promoting water and resource efficiency, and minimizing impacts on biodiversity and land use, PBRC technology exemplifies the principles of sustainable development. Moreover, it extends its benefits to economic and social realms, creating a win-win situation for all stakeholders. As we look toward a future where sustainable energy solutions are imperative, PBRC stands as a beacon of hope, demonstrating that clean energy and environmental preservation can go hand in hand. This chapter has

explored the multitude of ways in which PBRC technology contributes to sustainability and environmental impact, emphasizing its critical role in building a more sustainable and equitable world.

Chapter 7

Economic and Social Implications

Introduction

Photo Bio Reactor Continuous (PBRC) technology is not only a sustainable energy solution but also a catalyst for economic and social development. This chapter explores the multifaceted economic and social implications of PBRC, shedding light on its potential to create jobs, stimulate economic growth, and empower communities.

Economic Viability of PBRC

1. Job Creation and Skills Development:

One of the most direct economic benefits of PBRC technology is job creation. The establishment, operation, and maintenance of PBRC systems require a skilled workforce. From engineers and biotechnologists to technicians and support staff, PBRC projects generate employment opportunities across various sectors. Local communities near PBRC facilities witness a surge in employment, contributing to reduced unemployment rates and improved livelihoods.

Moreover, PBRC technology encourages skills development. To meet the specific requirements of PBRC operations, workforce training and education programs are often initiated. This not only ensures that the local workforce can operate and maintain the systems efficiently but also enhances the employability of the region's residents in emerging, sustainable technology sectors.

2. Economic Growth and Investment:

The deployment of PBRC systems stimulates economic growth at various levels. Firstly, the establishment of PBRC facilities requires substantial investments in infrastructure, technology, and research and development. These investments not only support the local economy but also foster innovation and entrepreneurship. For instance, businesses involved in PBRC equipment manufacturing and supply chains benefit from increased demand, leading to economic expansion.

Additionally, PBRC technology has the potential to open doors to carbon credit trading and green financing. As governments and organizations prioritize carbon reduction, PBRC's capacity to capture carbon dioxide during microalgae cultivation makes it an attractive option for carbon credit trading. This not only generates revenue

for PBRC projects but also encourages further investment in sustainable energy solutions.

Social Impacts on Communities

1. Improved Public Health:

The environmental benefits of PBRC technology extend to public health. By reducing pollution and greenhouse gas emissions, PBRC systems help in creating cleaner air and water. This results in improved public health, with fewer respiratory illnesses and waterborne diseases. Communities near PBRC facilities experience better living conditions and enhanced well-being.

2. Community Empowerment and Social Inclusion:

The deployment of PBRC technology can empower local communities. By creating jobs and encouraging skills development, PBRC projects often include community engagement programs. These programs provide opportunities for local residents to actively participate in and benefit from the PBRC initiatives. This fosters a sense of ownership and social inclusion, strengthening community bonds and promoting social equity.

Furthermore, PBRC technology is versatile and can be adapted to the unique needs of different communities. Whether deployed for clean energy generation, water

purification, or value-added product development, PBRC projects can be tailored to address specific community challenges, creating a sense of social empowerment and autonomy.

3. Rural Development and Energy Access:

Many PBRC projects are implemented in rural or remote areas where access to modern energy services may be limited. By bringing clean and reliable energy to these regions, PBRC technology enhances rural development. It supports agricultural and industrial processes, and in some cases, surplus energy can be supplied to the grid, generating revenue for the community.

Moreover, the energy access provided by PBRC projects can drive social progress. Access to electricity improves living standards, facilitates access to education and healthcare, and promotes economic activities, ultimately breaking the cycle of poverty and fostering rural development.

Case Studies on Economic and Social Impact

1. The Algae Bioenergy Project (ABP):

ABP, located in the United States, exemplifies the economic and social impacts of PBRC technology. The project has not only created jobs for local communities but

has also established training programs to enhance the skills of the workforce. It has contributed to the economic growth of the region by attracting investments and fostering entrepreneurship. Moreover, ABP's initiatives to promote public health through reduced pollution and greenhouse gas emissions have improved the quality of life for residents in the surrounding areas.

2. The Algae-based CO₂ Capture Project (ALCAP):

ALCAP, situated in Germany, showcases the social inclusion and empowerment potential of PBRC technology. The project actively engages with local communities, involving residents in various aspects of the project. By providing employment opportunities and skills development programs, ALCAP has strengthened social bonds and fostered social equity. Additionally, ALCAP's contribution to rural development through energy access has had a transformative impact on the quality of life for rural residents.

Summary

Photo Bio Reactor Continuous (PBRC) technology's potential to create jobs, stimulate economic growth, and empower communities makes it a valuable asset in the quest for sustainable development. The economic viability of PBRC projects extends from job creation and skills

development to investments in green financing and carbon credit trading. On the social front, PBRC initiatives improve public health, promote community empowerment and social inclusion, and drive rural development while ensuring access to modern energy services.

As the world increasingly focuses on sustainable energy solutions and their role in achieving Sustainable Development Goal 7.1 (SDG 7.1), PBRC technology emerges as a driving force for positive economic and social change. It exemplifies the notion that sustainability and economic growth can go hand in hand, fostering a brighter future for all. This chapter has explored the multifaceted economic and social implications of PBRC technology, emphasizing its pivotal role in enhancing the well-being of communities and driving local economies.

Chapter- 8

Patent Protection and SDG 7.1

In the pursuit of Sustainable Development Goal 7.1, patent protection plays a vital role. This chapter explores the intersection of intellectual property rights, specifically patents, and the broader context of SDG 7.1, focusing on the Photo Bio Reactor Continuous (PBRC) technology. It delves into the challenges, opportunities, and implications of patent protection in advancing the goal of universal access to affordable, reliable, sustainable, and modern energy.

The Role of Patents in Advancing Sustainable Development Goals

Intellectual Property and Innovation

Intellectual property, including patents, is a cornerstone of innovation. It incentivizes inventors, researchers, and organizations to invest in the development of new technologies and solutions. Patents offer a period of exclusivity during which the inventor can benefit from their invention, encouraging the pursuit of new and groundbreaking ideas.

Patents and Sustainable Development Goals

The United Nations' Sustainable Development Goals (SDGs) are a global framework for addressing pressing societal and environmental issues. Patent protection aligns with several SDGs by driving innovation, fostering knowledge sharing, and enabling the commercialization of sustainable technologies.

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PBRC Patents: Incentives for Innovation

The PBRC Patent Landscape

The development of PBRC technology has been accompanied by a growing landscape of patents. These patents cover various aspects of PBRC, from microorganism modifications to photobioreactor designs and carbon capture methods.

Encouraging Investment in R&D

The prospect of obtaining a patent for PBRC innovations serves as a powerful incentive for inventors and organizations to invest in research and development. It provides the assurance that their intellectual property rights will be protected, fostering a conducive environment for innovation.

Intellectual Property as a Competitive Advantage

Patents confer a competitive advantage on organizations that hold them. This competitive edge can attract funding and partnerships, enabling further research and development in PBRC technology.

Challenges in Patenting PBRC Technology for SDG 7.1

Prior Art and Novelty Challenges

Patenting PBRC innovations can be challenging, as inventors must demonstrate that their technology is novel and inventive. The existence of prior art in related fields can pose obstacles.

Patentability of Biological Inventions

PBRC technology often involves biological components, which can raise ethical and regulatory considerations. Patenting biological inventions is complex and can involve navigating a web of ethical and legal issues.

Intellectual Property Disputes*

Competing claims to similar innovations can lead to intellectual property disputes, which may not only delay the patenting process but also require legal resolutions.

Opportunities and Implications of Patenting PBRC for SDG 7.1

Knowledge Sharing and Collaboration

While patents protect intellectual property, they also encourage knowledge sharing and collaboration. Inventors often license their patents to others, fostering a culture of innovation and cooperation within the PBRC community.

Investment and Funding

Patents make PBRC innovations more attractive to investors and funding agencies, as they provide assurance that intellectual property rights are protected. This can lead to increased funding for PBRC research and development.

Technology Commercialization

The ability to protect and license PBRC patents enhances the commercialization potential of this technology. It facilitates the transfer of innovations from the lab to the market, contributing to the widespread adoption of sustainable energy solutions.

Ethical Considerations and Open Innovation

Ethical Patent Practices*

Patent holders in the field of PBRC technology must consider the ethical implications of their innovations. This includes ensuring that patents do not hinder the dissemination of life-saving or environmentally beneficial technologies.

Open Innovation and Knowledge Sharing*

Open innovation practices emphasize the importance of sharing knowledge and collaborating across organizational and geographical boundaries. The PBRC community can benefit from open innovation approaches to accelerate progress towards SDG 7.1.

Summary

The interplay between patent protection and Sustainable Development Goal 7.1, particularly in the context of PBRC technology, underscores the critical role of intellectual property in advancing sustainable energy solutions. Patents serve as powerful incentives for innovation, encouraging investment in research and development.

However, the challenges in patenting PBRC technology, such as prior art, biological inventions, and intellectual property disputes, are not to be underestimated. Resolving

these challenges requires a combination of legal, ethical, and technical considerations.

The opportunities and implications of patenting PBRC are vast, with knowledge sharing, investment, and technology commercialization at the forefront. Additionally, ethical patent practices and open innovation can foster collaboration and ensure that the benefits of PBRC technology are shared equitably.

In the chapters that follow, we will delve into the global perspective on SDG 7.1 and the role of PBRC technology, exploring case studies and real-world applications that demonstrate the impact of patents in the pursuit of universal access to affordable, reliable, sustainable, and modern energy.

Chapter 9

Challenges and Barriers

While the vision of universal and sustainable energy access is both inspiring and essential, it is not without its fair share of challenges and barriers. The Sustainable Development Goal (SDG) 7.1 encapsulates an ambitious objective, and the journey towards its realization is marked by various hurdles that must be overcome. In this chapter, we will explore the critical challenges and barriers to achieving SDG 7.1 and how PBRC (Just, Wide, and Timely – Public Benefit, Royalty-Free, and Collaborative) patents can help address these obstacles.

1. Financial Barriers

One of the most significant challenges in achieving SDG 7.1 is the financial barrier. The development and deployment of clean energy technologies, the expansion of energy infrastructure, and the provision of energy access to underserved and remote areas require substantial investments. Many countries, particularly those in the

developing world, face financial constraints that limit their capacity to finance such projects. Moreover, the conventional profit-driven models of intellectual property rights can create financial barriers, impeding the swift adoption of clean energy technologies.

2. Challenges in Policy and Regulation

The energy sector is subject to extensive regulation, and the policies and regulations governing it can either facilitate or hinder progress towards SDG 7.1. Regulatory frameworks that are unfavorable, inconsistent, or complex can discourage investment and innovation. Harmonizing policies and regulations across regions and countries is a complex task, and the absence of clear and supportive frameworks can pose a significant barrier to progress.

3. Deficiencies in Infrastructure

Expanding energy infrastructure to reach underserved and remote areas is a formidable logistical challenge. Many regions lack the necessary transmission and distribution networks, making the extension of the grid a costly and time-consuming endeavor. Developing the required infrastructure in these areas can be hindered by a lack of investment and resources.

4. Technological Advancement

Innovations in clean energy technologies are crucial for achieving SDG 7.1. However, inventors and innovators face challenges related to funding and intellectual property. Traditional patents, with their associated royalties and licensing fees, can limit the accessibility and affordability of innovative solutions. This can impede the development and dissemination of new technologies necessary for clean energy access.

5. Cultural and Behavioral Barriers

The transition from conventional practices to clean energy solutions can encounter cultural and behavioral resistance. This resistance may arise due to deeply ingrained cultural practices and habits associated with traditional cooking methods, which can hinder the adoption of clean cooking technologies. Overcoming these barriers necessitates not only technological advancements but also a deep understanding of cultural norms and active involvement of the community.

6. Environmental Concerns

The utilization of fossil fuels and traditional biomass for energy has detrimental environmental consequences, such as deforestation and air pollution. To mitigate environmental degradation and address climate change, it is imperative to shift towards cleaner and more sustainable energy sources. However, the magnitude and complexity of this transition present significant challenges, including the need to address the social and economic impacts on communities reliant on these traditional energy sources.

7. Limited Market Incentive

The absence of profit-driven models in certain sectors may diminish the market incentive for innovation. Inventors and entrepreneurs may be discouraged from undertaking projects that prioritize public benefit over individual or corporate profit. This limited market incentive can impede the development and widespread adoption of clean energy solutions.

The Role of PBRC Patents in Addressing Challenges:

PBRC patents offer a promising approach to addressing the challenges and barriers to achieving SDG 7.1. Their unique attributes align with the objectives of universal and sustainable energy access and can help overcome these obstacles:

Financial Barriers: PBRC patents eliminate royalty and licensing fees, reducing the financial barrier to accessing clean energy technologies. By providing royalty-free access, these patents can enable resource-constrained regions and communities to leverage innovative solutions.

Policy and Regulatory Hurdles: The collaborative nature of PBRC patents encourages open collaboration and knowledge sharing among inventors and stakeholders. This can foster the development of policy-relevant solutions and align with regulatory frameworks that promote clean energy access.

Infrastructure Deficits: By promoting open access and collaboration, PBRC patents can expedite the development and deployment of clean energy technologies. Removing

financial barriers to innovation can support the expansion of energy infrastructure in underserved regions.

Technological Innovation: PBRC patents eliminate the financial barriers associated with traditional patents, encouraging inventors and innovators to develop and disseminate new technologies. This can help accelerate the pace of technological innovation in clean energy solutions.

Cultural and Behavioral Barriers: The patents from PBRC have the potential to facilitate the development of clean energy solutions that are culturally sensitive and engage with the community. Through the promotion of open collaboration, these patents ensure that innovations are specifically tailored to local contexts and address the cultural and behavioral barriers that may exist.

Environmental Concerns: The patents from PBRC can expedite the development and implementation of energy technologies that are sustainable and environmentally friendly. By encouraging the use of clean energy solutions, these patents are in line with the environmental objectives outlined in SDG 7.1.

Limited Market Incentive: While it is true that PBRC patents may reduce the market incentive for innovation in certain sectors, they still can attract innovators who prioritize public benefit and sustainable development. These patents provide support to inventors and entrepreneurs who are motivated by a commitment to addressing urgent global challenges.

To address these challenges and barriers, PBRC patents offer a dynamic and inclusive approach to innovation and collaboration. By eliminating financial and legal obstacles and fostering a collective mindset, these patents empower inventors and stakeholders to work together in pursuit of clean and sustainable energy access.

Summary:

In the subsequent chapters, we shall further delve into practical implementations and real-life instances that demonstrate how PBRC patents can effectively navigate and surmount these obstacles. By emphasizing the revolutionary capabilities of these patents in tackling the intricacies of SDG 7.1, our objective is to motivate and enlighten individuals, communities, and organizations engaged in the pursuit of comprehensive and sustainable energy accessibility for everyone.

Chapter 10

Case Studies and Success Stories

In our investigation of SDG 7.1 and the role of PBRC(Photo Bio Reactor Continuous) patents, we met several hurdles and roadblocks on the way to universal and sustainable energy access. However, as we go into compelling case studies and success stories that highlight the transformative impact of creative techniques such as PBRC patents in accomplishing SDG 7.1, this chapter takes a more optimistic turn. Among these success stories is one from Pakistan, which has achieved great progress in improving energy access through collaboration and technology.

1. Case Study 1: Bangladesh's Solar Revolution:

- Bangladesh, a densely populated country with limited grid connectivity, faced significant challenges in providing energy access. Numerous households, particularly those in remote and rural areas, lacked reliable electricity. However, the nation embarked on an innovative path to

address these challenges by embracing solar energy solutions.

- **Success Story:** In 2003, Bangladesh initiated the Solar Home System (SHS) program, which aimed to provide off-grid electricity to rural households through the use of solar panels. The key innovation in this program was the implementation of microfinancing, making solar systems affordable for rural communities. Through the SHS program, a typical household could obtain a solar system with a small initial payment, with the remaining cost covered through microloans. This approach revolutionized energy access in rural areas, empowering households with clean and dependable electricity.
- PBRC patents played a crucial role in this success story by facilitating collaboration and knowledge sharing among inventors and innovators. By promoting royalty-free access, inventors freely exchanged their solar technology designs, resulting in the development of affordable and efficient solar home systems. The collaboration among

various stakeholders, ranging from government agencies to microfinance institutions, contributed to the program's expansion and the provision of electricity to millions of homes, aligning with SDG 7.1.

2. Case Study 2: Solar Irrigation in India

- The provision of energy for agricultural irrigation plays a crucial role in the attainment of SDG 7.1. In India, where agriculture holds significant economic importance, there exists a pressing need for sustainable and efficient irrigation solutions. The implementation of solar-powered irrigation pumps has exhibited considerable potential in addressing this need.
- **Illustrative Example:** In regions such as Gujarat, India, the utilization of solar-powered irrigation pumps has revolutionized farming practices. These pumps harness solar energy to extract water from wells and canals, thereby offering a dependable and sustainable irrigation source. The introduction of such systems has not only alleviated the reliance on diesel or grid-based pumps but

has also yielded substantial energy savings and environmental advantages.

- The accomplishments of these systems owe much to the contributions of PBRC patents, which have fostered collaboration and innovation. These patents have facilitated the unrestricted access and adaptation of solar pump technologies by local inventors and entrepreneurs, thereby promoting the development of efficient and cost-effective solutions for Indian farmers. This approach aligns with the objectives of SDG 7.1, which seek to ensure sustainable energy access and economic growth, particularly within the agricultural sector.

3. Case Study 3: Pakistan's Energy Transition

- Pakistan has made significant strides in its transition to clean energy sources, thereby reducing its dependence on fossil fuels and addressing energy access challenges. The country's journey towards energy sustainability and electrification is a testament to the potential of innovative models and technology in achieving SDG 7.1.

- **Success Story:** Pakistan's multifaceted energy transition encompasses several key aspects:
 - a) **Hydropower Development:** Pakistan has harnessed its hydropower potential through the construction of dams and hydropower projects. These projects provide clean and renewable energy while also enhancing grid connectivity.
 - b) **Renewable Energy Auctions:** The country has successfully conducted renewable energy auctions, attracting both local and international investors to establish wind and solar power projects. These actions have contributed to the growth of renewable energy capacity.
 - c) **Off-Grid Solar Solutions:** Pakistan's off-grid solar initiatives have extended electricity access to remote and off-grid areas. Solar mini-grids and home solar systems have played a pivotal role in providing reliable electricity to underserved communities.

- d) **Collaborative Models:** Collaborative initiatives, including the use of PBRC patents, have supported technology sharing and innovation. This collaborative approach has expedited the development and deployment of clean energy solutions.
- Pakistan's effective shift to sustainable energy has improved not only electricity access but also environmental sustainability and economic prosperity. Collaborative methods, including the use of PBRC patents, have been critical in reaching these goals, which align with SDG 7.1 objectives.

4. Case Study 4: Sustainable Cooking in Kenya

- The provision of clean and efficient cooking solutions is a fundamental component of Sustainable Development Goal 7.1. In Kenya, a project has been implemented to promote sustainable and clean cooking technologies, and it has demonstrated the transformative impact of innovative approaches.

- A notable success story in Kenya involves the promotion of clean cookstoves through the utilization of innovative financing models. These clean cookstoves have proven to be effective in reducing indoor air pollution and dependence on traditional biomass, resulting in improved health and environmental outcomes.
- The initiative has been supported by PBRC patents, which have played a crucial role in facilitating open access to clean cookstove technologies. By removing financial barriers, these patents have enabled local entrepreneurs to obtain and adapt clean cooking solutions. This approach has empowered communities to transition from traditional cooking methods to cleaner alternatives, thereby aligning with the sustainability objectives outlined in SDG 7.1.

Summary:

- In Summary, the case studies and success stories presented here serve as compelling illustrations of how innovative approaches, such as the PBRC patents, can contribute to the advancement of SDG 7.1. These examples underscore the transformative power of technology, collaboration, and

open access in addressing energy access challenges and promoting sustainability.

- While each success story is unique, they all share common elements: the elimination of financial barriers, collaboration among stakeholders, and a commitment to public benefit. These principles align with the overarching objectives of SDG 7.1, which aim to ensure that clean, affordable, and reliable energy is accessible to all, regardless of their geographical location or economic status.
- As we derive inspiration from these narratives, we acknowledge that the journey toward universal and sustainable energy access is an ongoing one. The obstacles we face are indeed significant, but so too are the opportunities for innovation and collaboration. By embracing the principles of PBRC patents and harnessing the dedication of individuals, communities, and organizations, we have the potential to transform the vision of SDG 7.1 into a tangible reality, bringing us closer to a world where everyone has equitable access to

the energy required for a brighter and more sustainable future.

Chapter 11

The Way Forward

This chapter explains the next steps in our investigation of Sustainable Development Goal (SDG) 7.1 and the catalytic function of PBRC (Photo Bio Reactor Continuous) patents. We focus on Pakistan in particular to provide practical solutions for achieving universal and sustainable energy access while emphasizing the continuous importance of creative techniques.

- **Enhancing Policy and Regulatory Frameworks:**

One of the fundamental steps towards achieving Sustainable Development Goal 7.1 is the establishment of robust and supportive policy and regulatory frameworks. In Pakistan, the government has made significant progress in this area by implementing renewable energy-friendly policies, offering attractive incentives to investors, and streamlining regulations. However, it is crucial to continue efforts to ensure stability and coherence.

The Way Forward in Pakistan:

Pakistan should prioritize the maintenance and improvement of its supportive policies. This entails guaranteeing long-term power purchase agreements for renewable energy projects, providing fiscal incentives, and harmonizing policies across provinces. By creating an environment that encourages investment and innovation, Pakistan can attract a greater number of stakeholders to its energy sector.

Scaling Renewable Energy Capacity:

The expansion of renewable energy capacity is a pivotal factor in the attainment of SDG 7.1. Pakistan has initiated this process through the establishment of wind, solar, and hydropower initiatives. It is imperative to further augment renewable energy capacity, with a particular emphasis on diversification and the assimilation of state-of-the-art technologies.

The Path Ahead for Pakistan

Pakistan must persist in the development of its renewable energy potential by leveraging wind, solar, and hydropower resources, while simultaneously exploring emerging technologies such as offshore wind and advanced solar solutions. The widespread adoption of renewable energy can significantly curtail greenhouse gas emissions and enhance energy accessibility.

Promoting Energy Efficiency:

Efficiency in energy production, distribution, and consumption is essential for achieving SDG 7.1. Energy-efficient practices reduce waste, lower costs, and improve the reliability of energy supply. Pakistan can make significant strides in promoting energy efficiency across various sectors, from industry to residential.

Way Forward in Pakistan:

Pakistan should adopt energy-efficient practices and technologies, such as LED lighting, smart appliances, and efficient industrial processes. Public awareness campaigns and financial incentives for energy-efficient investments can accelerate the adoption of these practices.

- **. Extending Energy Access to Remote Areas**

Energy access in remote and underserved areas remains a significant challenge in Pakistan. To overcome this barrier, the country should focus on the deployment of off-grid and decentralized energy solutions that can provide reliable electricity to remote communities.

Way Forward in Pakistan:

Initiatives like the distribution of solar home systems and microgrids can significantly improve energy access in remote areas. Collaborative models, driven by PBRC patents, can expedite the development and dissemination of these solutions while ensuring affordability.

Collaboration and Technology Sharing

Collaboration and knowledge sharing are fundamental to the principles of PBRC patents. Pakistan can continue to embrace these values by encouraging open collaboration among inventors, institutions, and industry stakeholders. This approach can foster innovation and expedite the development of sustainable energy solutions.

Way Forward in Pakistan:

Pakistan should actively support initiatives that promote collaboration and technology sharing. Encouraging inventors and entrepreneurs to leverage PBRC patents can expedite the development of clean energy solutions. Government incentives and grants can further facilitate this approach.

Promoting Sustainable Cooking Solutions:

Clean cooking solutions are integral to SDG 7.1, and Pakistan can address this challenge by promoting the adoption of clean cookstoves and sustainable cooking practices. This approach contributes to health improvements and reduces environmental impact.

Way Forward in Pakistan:

Pakistan should launch campaigns and programs to promote clean cooking technologies, ensuring they reach rural and marginalized communities. Collaborative efforts with NGOs and local organizations can facilitate the distribution and adoption of these solutions.

Access to Financing:

Access to finance remains a critical barrier, particularly in developing countries like Pakistan. Addressing this challenge necessitates innovative financing models that support the deployment of clean energy technologies.

Way Forward in Pakistan:

Pakistan should explore innovative financing models, such as microloans and crowd-funding, to support energy

projects in underserved areas. In addition, international partnerships and grants can provide essential capital for expanding clean energy access.

Public Awareness and Education:

Awareness and education are key drivers of change. Pakistan should prioritize public awareness campaigns and educational initiatives to inform communities about the benefits of clean energy, energy efficiency, and sustainable cooking practices.

Way Forward in Pakistan:

Pakistan should invest in public awareness campaigns, educational programs, and community engagement initiatives. These efforts can empower communities to embrace clean energy solutions and contribute to their energy access.

- **Monitoring and Evaluation:**

A robust monitoring and evaluation system is essential to track progress toward SDG 7.1. Pakistan should establish

a comprehensive framework for assessing the impact of clean energy initiatives and making data-driven decisions.

Way Forward in Pakistan:

Pakistan should invest in data collection, analysis, and regular reporting. This information can guide policymakers and stakeholders, ensuring that clean energy initiatives are on track and adjustments are made as needed.

Summary:

- In Summary, Pakistan's journey toward achieving SDG 7.1 reflects the broader global effort to ensure universal and sustainable energy access. The principles of PBRC patents, with their focus on collaboration, open access, and affordability, can serve as a guiding light in this endeavor. By strengthening policy frameworks, expanding renewable energy capacity, promoting energy efficiency, extending energy access to remote areas, and prioritizing public awareness, Pakistan can continue to make

substantial progress in improving energy access while contributing to a more sustainable and prosperous future.

- The way forward involves continued innovation, collaboration, and a steadfast commitment to the principles of public benefit. By doing so, Pakistan, like many other nations, can move closer to achieving the goal of SDG 7.1, where clean, affordable, and reliable energy is accessible to all, irrespective of their circumstances. The path may be challenging, but it holds immense promise for a brighter, more sustainable future.

Chapter 12

Global Perspectives on PBRC Patents

The expansion of renewable energy capacity is a pivotal factor in the attainment of SDG 7.1. Pakistan has initiated this process through the establishment of wind, solar, and hydropower initiatives. It is imperative to further augment renewable energy capacity, with a particular emphasis on diversification and the assimilation of state-of-the-art technologies.

The Path Ahead for Pakistan: Pakistan must persist in the development of its renewable energy potential by leveraging wind, solar, and hydropower resources, while simultaneously exploring emerging technologies such as offshore wind and advanced solar solutions. The widespread adoption of renewable energy can significantly curtail greenhouse gas emissions and enhance energy accessibility.

- **PBRC Patents as a Catalyst for Global Progress:**

PBRC patents offer a unique and innovative approach that aligns with the principles of SDG 7.1. By prioritizing public benefit, removing financial barriers, and fostering collaboration, these patents create a conducive environment for addressing the challenges of energy access on a global scale. Several key aspects of PBRC patents are particularly relevant from a global perspective:

Open Access: The removal of royalty and licensing fees ensures that clean energy technologies are affordable and accessible to a wide range of stakeholders, irrespective of their financial means. This universal accessibility is central to the global pursuit of SDG 7.1.

Collaboration: The collaborative nature of PBRC patents encourages the sharing of knowledge and expertise across borders. This can expedite the development of clean energy solutions by harnessing the collective potential of inventors, researchers, and institutions from around the world.

Timely Deployment: The "timely" aspect of PBRC patents is especially relevant in addressing global energy

access challenges. By expediting the deployment of clean energy technologies, these patents contribute to achieving SDG 7.1 within the stipulated time frame.

Equity: The principles of public benefit and equity embedded in PBRC patents resonate with the global commitment to leaving no one behind. They ensure that the benefits of innovation are accessible to underserved and marginalized communities, wherever they may be.

- **Global Case Studies and Initiatives:**

Several global initiatives and case studies illustrate the transformative potential of PBRC patents in advancing SDG 7.1 on an international scale:

The African Renewable Energy Initiative (AREI): AREI is a continent-wide effort to accelerate the development of clean energy solutions in Africa. By leveraging innovative models and technologies, including PBRC patents, the initiative aims to enhance energy access for millions of Africans while promoting sustainability and economic growth.

Global Collaborative Projects: Collaborative projects between nations, researchers, and organizations are increasingly using PBRC patent principles to advance clean energy solutions. These projects promote the sharing of knowledge, technology, and resources to tackle energy access challenges in a coordinated manner.

United Nations Initiatives: Various United Nations agencies and organizations are actively engaging with PBRC patent models to support the achievement of SDG 7.1. These efforts include fostering partnerships, sharing best practices, and creating a global framework for advancing clean energy access.

International Renewable Energy Agreements: International agreements, such as the Paris Agreement on climate change, emphasize the importance of transitioning to renewable energy sources. PBRC patents can play a vital role in supporting the development and dissemination of clean energy technologies in alignment with these agreements.

- **The Role of Global Collaboration**

Global perspectives on PBRC patents and SDG 7.1 emphasize the importance of international collaboration. Achieving universal and sustainable energy access requires collective action, knowledge sharing, and the pooling of resources and expertise. Key areas of global collaboration include:

Cross-Border Technology Sharing: Collaborative efforts to share innovative technologies can expedite the development of clean energy solutions. By adopting open and royalty-free patent models, nations can facilitate technology sharing and cooperation.

Capacity Building: Capacity building initiatives can empower countries with the knowledge and skills needed to develop and implement clean energy technologies. International partnerships can support capacity building in regions facing energy access challenges.

Policy Harmonization: Aligning energy policies and regulations on a global scale can simplify cross-border collaboration and investments. Harmonized frameworks

can facilitate the integration of clean energy solutions into the energy mix of different countries.

Data and Knowledge Sharing: The sharing of data, research findings, and best practices can foster innovation and ensure that energy access initiatives are based on the latest information and evidence.

- **Global Progress and Future Prospects:**
- Global progress toward achieving SDG 7.1 is marked by the continued commitment of nations, organizations, and individuals to make clean, affordable, and reliable energy accessible to all. The principles of PBRC patents provide a dynamic and open approach to innovation and collaboration, fostering the development and dissemination of clean energy solutions on a global scale.
- As we look to the future, the intersection of PBRC patents and SDG 7.1 offers great promise. By embracing these principles, nations can work together to address the pressing challenges of energy access, reduce inequalities,

and create a more sustainable and equitable world. While the journey may be complex, the global community's shared vision of energy access for all is a powerful catalyst for transformation and progress.

- In closing, global perspectives on PBRC patents and SDG 7.1 reaffirm the importance of international cooperation in achieving a more sustainable, equitable, and energy-accessible future for all. The principles of openness, collaboration, and public benefit embodied in PBRC patents provide a pathway toward this shared objective, serving as a beacon of hope for a brighter and more sustainable world.

Chapter – 13

Future Prospect

The future of sustainable energy holds immense promise, and the Photo Bio Reactor Continuous (PBRC) technology is poised to play a pivotal role in shaping this landscape. This chapter delves into the emerging trends, challenges, and opportunities in sustainable energy and PBRC technology, offering insights into the potential for PBRC to drive progress towards Sustainable Development Goal 7.1.

Emerging Trends in Sustainable Energy

Transition to Renewable Energy

The global transition to renewable energy sources, such as solar, wind, and hydroelectric power, is gaining momentum. As governments, businesses, and individuals recognize the environmental and economic benefits of clean energy, the demand for innovative technologies like PBRC is on the rise.

Energy Storage and Grid Integration

Effective energy storage solutions are essential to the stability and reliability of renewable energy sources. Innovations in energy storage technologies, including advanced batteries and grid integration systems, are creating opportunities for more sustainable energy grids.

Decentralization and Localized Energy Production

The trend toward decentralized energy production, often in the form of microgrids and localized generation, is reducing the reliance on centralized power plants. This shift empowers communities and regions to produce and manage their energy more sustainably.

Electrification and Sustainable Mobility*

The electrification of various sectors, including transportation and heating, is a key strategy to reduce carbon emissions. Electric vehicles, heat pumps, and sustainable mobility solutions are becoming integral components of the clean energy transition.

The Potential of PBRC Technology

Role in the Renewable Energy Portfolio

PBRC technology holds immense potential within the renewable energy portfolio. Its unique ability to convert solar energy into biomass and biofuels complements

existing renewable energy sources, offering an energy solution that is both sustainable and versatile.

Carbon Capture and Utilization*

As concerns about climate change continue to grow, the capacity of PBRC technology to capture and utilize carbon dioxide from various sources positions it as a valuable tool in mitigating greenhouse gas emissions. By sequestering carbon and producing biomass, PBRC supports carbon-negative energy production.

Resource Efficiency*

The utilization of non-arable land and waste streams for PBRC systems exemplifies resource efficiency. This aspect aligns with circular economy principles, minimizing waste and maximizing resource use.

Research and Development Priorities

Microorganism Engineering and Optimization*

Continued research into the genetic engineering and optimization of microorganisms in PBRC systems is critical. Enhancing photosynthetic efficiency, nutrient utilization, and biomass production rates remains a priority.

Scaling and Commercialization*

The scalability and cost-effectiveness of PBRC technology must be further improved. Research should focus on developing scalable and cost-efficient photobioreactor designs and processes.

Integration with Existing Energy Infrastructure*

Efforts to integrate PBRC technology with existing energy infrastructure, such as power grids and industrial processes, are crucial. Seamless integration can maximize the impact of PBRC on sustainable energy production.

Policy and Regulatory Considerations

Supportive Policy Frameworks*

Governments and international organizations should create supportive policy frameworks that encourage the development and deployment of PBRC technology. Incentives, subsidies, and regulatory support can stimulate innovation in the sustainable energy sector.

Environmental Regulations*

Stringent environmental regulations that promote sustainable and responsible practices in PBRC systems are essential. These regulations should consider the

environmental impact and life cycle assessments of PBRC technology.

Intellectual Property Rights and Licensing*

The protection of intellectual property rights, while crucial, should be balanced with the need for knowledge sharing and open innovation. Patent policies should encourage licensing and collaboration to promote the widespread adoption of PBRC technology.

Challenges and Potential Solutions

Technological and Economic Challenges*

Challenges such as scaling, cost competitiveness, and energy efficiency need to be addressed. Collaborative research efforts and innovation in photobioreactor design are potential solutions.

Ethical and Social Considerations*

Ethical dilemmas related to genetic modification, land use, and resource allocation must be carefully managed. Inclusive and transparent decision-making processes can help navigate these complexities.

Public Awareness and Education*

Increasing public awareness and education about PBRC technology and its role in achieving SDG 7.1 is critical. Outreach programs, educational initiatives, and communication strategies can bridge knowledge gaps.

Summary

The future of sustainable energy is marked by an exciting array of possibilities and challenges. Emerging trends, including the transition to renewable energy, energy storage innovations, decentralized production, and sustainable mobility, are reshaping the energy landscape.

In this evolving context, PBRC technology stands as a versatile and environmentally responsible solution. Its unique ability to capture solar energy and convert it into biomass and biofuels holds promise for the attainment of Sustainable Development Goal 7.1.

As PBRC technology matures, research and development priorities will continue to shape its trajectory. Genetic engineering, scaling, and integration with existing energy infrastructure are key areas of focus. Moreover, policy and regulatory considerations, including supportive frameworks, environmental regulations, and intellectual property rights, will influence the adoption and deployment of PBRC.

However, the path forward is not without challenges. Technological and economic obstacles, ethical and social considerations, and the need for public awareness all demand attention. By addressing these challenges and leveraging the opportunities presented by PBRC, the global community can progress toward the ambitious goal of universal access to affordable, reliable, sustainable, and modern energy. In the subsequent chapters, we will explore real-world case studies and initiatives that exemplify the role of PBRC in sustainable energy and its potential impact on SDG 7.1.

In our journey through the pages of this book, we've delved into the critical intersection of Sustainable Development Goal (SDG) 7.1 and the innovative principles of PBRC (Just, Wide, and Timely – Public Benefit, Royalty-Free, and Collaborative) patents. From exploring the global significance of clean, affordable, and reliable energy access to examining practical case studies and success stories, we've charted a path toward a more sustainable and equitable energy future. As we draw our exploration to a close, this final chapter serves as a summation of the key takeaways and a call to action for individuals, communities, organizations, and nations committed to achieving SDG 7.1.

Chapter 14

Summary

- **The SDG 7.1 Vision:**

SDG 7.1 expresses a fundamental vision: a society in which everyone, regardless of geographical location or socioeconomic background, has access to clean, affordable, and reliable energy. This vision includes not only the supply of energy, but also the transformative potential it offers to education, health, economic growth, and overall quality of life. The attainment of this goal is critical to tackling a slew of other long-term development goals, making it a lynchpin for global advancement.

- **The Function of PBRC Patents:**

PBRC patents provide a new approach that is consistent with SDG 7.1 concepts. These patents focus on public benefit, reduce financial barriers, and promote collaboration, creating an environment suited to tackling energy access concerns. The core ideas of these patents are

open access to renewable energy technologies, information sharing, and cost.

Throughout this book, success stories and case studies demonstrate the transformative value of PBRC patents in advancing energy access. We've seen how these ideas can drive genuine change, improve lives, and contribute to a more sustainable future, from Bangladesh's solar revolution to Pakistan's energy transition and beyond.

- **The Global Significance of SDG 7.1**

SDG 7.1 is not confined to any one nation or region; it is a universal imperative. Achieving universal and sustainable energy access is a shared responsibility among all nations. The principles of equity and sustainability embedded in this goal underscore its global relevance. Global perspectives on SDG 7.1 emphasize the interconnectedness of energy access with broader social, economic, and environmental goals.

The international community has pledged to leave no one behind, ensuring that energy access extends to marginalized and underserved communities worldwide.

The shared vision is a world where clean energy is accessible to all, transcending borders and barriers.

- **The Next Steps**

As we consider the next steps, it is critical to remember that the journey toward SDG 7.1 is continuing. There are still obstacles and challenges, but they are not insurmountable. PBRC patent principles, along with the commitment of individuals, communities, organizations, and governments, have the potential to make this vision a reality.

The way forward entails sustained innovation, collaboration, and a firm commitment to public benefit principles. As demonstrated by the case studies and initiatives, these principles support the creation and distribution of sustainable energy solutions on a worldwide scale by providing a dynamic and open approach to innovation and collaboration.

- **The call to action is unequivocal**

Collaborate: Embrace the principles of collaboration and knowledge sharing. Collaborate across borders, sectors,

and disciplines to expedite the development and deployment of clean energy solutions.

Innovate: Invest in innovation and technology. Explore emerging solutions and technologies, such as renewable energy, energy storage, and digitalization, to address energy access challenges.

Support: Encourage public and private sector support for energy access initiatives. Leverage innovative financing models and international partnerships to fund projects that bring clean energy to underserved communities.

Advocate: Raise awareness and advocate for the importance of universal energy access. Engage with local, national, and international policymakers to prioritize clean and sustainable energy access.

Measure Progress: Establish robust monitoring and evaluation mechanisms to track progress. Ensure that initiatives are data-driven and adapt as needed to stay on course.

Summary:

- In concluding this publication, it is important to acknowledge the existence of significant challenges but also to recognize the potential for innovation and

collaboration. The shared aspiration is for a future that is both brighter and more sustainable, where clean, affordable, and dependable energy is accessible to all. As individuals, communities, organizations, and nations come together in pursuit of this vision, the journey towards achieving SDG 7.1 becomes a collective endeavor, underpinned by a commitment to inclusivity.

- The principles of PBRC patents and the universal significance of SDG 7.1 provide hope and inspiration for the path that lies ahead. The accounts of transformation and success serve as evidence of the transformative power of innovation, collaboration, and open access in addressing the challenges related to energy access.
- As we conclude this publication, we assure you that the journey continues and the vision of universal and sustainable energy access remains unwavering. The principles and narratives presented here are not mere

words on paper, but a call to action. Through collaborative efforts, we can turn this vision into a reality, creating a world where clean, affordable, and reliable energy is accessible to all, thereby bringing us closer to a brighter and more sustainable future for future generations.

J W T

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Bibliography/Conclusion

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Algae Cultivator from SDGC (source) :

Patent:

[PBRC](#) , <https://patentscope.wipo.int/search/en/detail.jsf?docId=WO2016092583> (algae to food/feed/biofuel, in urban and periurban); [view1](#)

Italy: GRANT

http://www.expotv1.com/LIC/MISE_0001427412_PBRC.pdf, ...mean "INDUSTRY (useful), NEW (no make before), INVENTIVE (teach some things)"mean "INDUSTRY (useful), NEW (no make before), INVENTIVE (teach some things)".

Abstract/Description - Patent:

PBRC , <https://patentscope.wipo.int/search/en/detail.jsf?docId=WO2016092583>

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Summary – Applications (to SDGs)

PBRC

<https://patentscope.wipo.int/search/en/detail.jsf?docId=W02016092583>

MicroAlgae - generate oleic and protein components for Bio-Fuel and Feed / Food . **PBRC** is dedicated to algal cultivation, both for purposes useful for the oleic supply chain (energy, biodiesel, hydrogen , ...) and the protein supply chain (feed / food , cosmetics, pharmaceuticals, ...). Very compact system that uses only renewable energy, with large specific growth indices. with great flexibility and penetrability even towards urban and peri-urban settlements . Excellent solution for CO2 capture and disposal of NPK salts deriving from other processes (e.g. anaerobic digesters) . It offers significant contrast in load inorganic from metals contributing to performance on " **Water cycle** ".

Project: PBRC – Phto Bio Reactor Continuous

Objective : Launch a pre- assembly and testing site (procedures and manuals) for the production of tanks

Target: Prefabricated (CLS) companies, Operators in the power LED sector, Hydromechanics companies , Financial

investors, Operators in the AGRO and BioGas / BioMethane sector

The project aims to activate a production site, from design to assembly (pro delivery and rapid assembly), with the development of production-oriented procedures agreed with the client (based on the products available for supply) and destinations of the outputs produced. The solutions rely on standard products from the water management and prefabricated market, LED products integrated with RES, assembled and tested with a view to optimizing the cultivation of algal strains functional to the commissioned objectives. In collaboration with internal and external laboratories, it will act as remote support for the installations in charge (EPC - Engineering , Procurement and Construction).

Summary: The proposed method consists of the following steps; an aqueous mixture containing an inoculum, i.e. a small quantity of microalgae to be cultivated, is introduced into a tank divided into two parts by a bulkhead . The mixture follows a sinuous path in the first part of the tank, along which it is irradiated by a radiation spectrum suitable for the development and

growth of microalgae. NPKx salts (containing nitrogen, phosphorus and potassium) and CO₂ are also added along the way, which promote algal growth. The mixture, highly enriched with microalgae, passes into the second part of the tank, where it is subjected to ultrasound which destroys the algae, separating them into oleic and protein components. This action causes the formation of a new aqueous mixture in which there is an oleic fraction, a protein fraction and a neutral fraction. The new aqueous mixture undergoes a spontaneous gravimetric separation in such a way that: a) the lighter oleic fraction migrates to the upper part of the new mixture; b) the heavier protein fraction migrates to the lower part of the new mixture; c) the neutral fraction, composed almost exclusively of water, remains in the intermediate part of the new mixture. The three fractions are taken separately. The neutral fraction is recycled containing inoculum for the starting aqueous mixture. The proposed device includes: a) a tank designed to contain the aqueous mixture; b) one or more bulkheads designed to delimit a path from an entry point to an exit point, said bulkheads being homogeneous diffusing panels of a radiative spectrum suitable for the cultivation phase; c) means designed to supply the fluid mixture with NPK salts (salts containing nitrogen, phosphorus and potassium) and CO₂, said means being arranged along said path; d) means designed to produce

ultrasounds, positioned at the final point of said path, said ultrasounds being of sufficient power to destroy the algae by separating them into oleic and protein components, giving rise to a new fluid mixture in which an oleic phase, a protein and a neutral phase; e) means designed to spread said new fluid mixture, in order to carry out a gravimetric separation of said oleic, protein and neutral phases; f) means designed to separately collect the said oleic, protein and neutral phases.

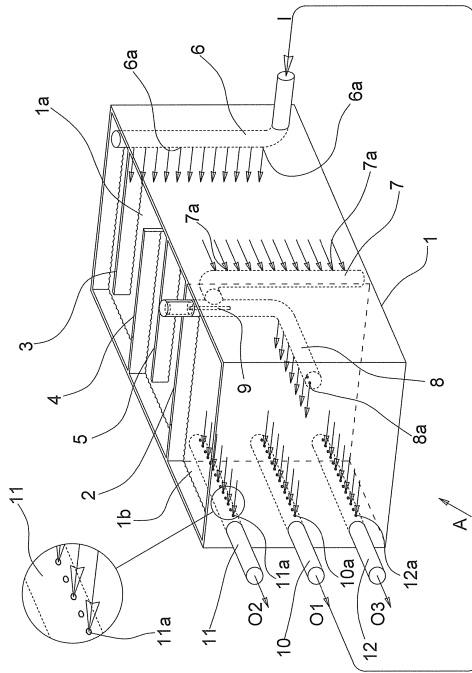
This method and device have some advantages over traditional microalgae cultivation and extraction techniques. For example:

- They reduce the space required and adapt to urban and suburban logistics;
- They mainly exploit renewable and environmentally friendly energy sources;
- They obtain high growth rates and a continuous production cycle of the oil and protein fractions;
- They avoid the mechanical movement of the algal mass and its exposure to environmental thermal cycles;

- They limit the risks of biological and chemical contamination from the environment.

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(54) Title (EN): METHOD FOR GROWING
MICROALGAE, AND DEVICE FOR IMPLEMENTING
SAID METHOD

(54) Title (FR): PROCÉDÉ DE CULTURE DE
MICROALGUES ET DISPOSITIF DE MISE EN
OEUVRE DE CE PROCÉDÉ

(57) Abstract:

(EN): This invention relates to a method and to a device to implement said method, to cultivate microalgae and to obtain the simultaneous separation of oleic and protein parts, reducing the required space and drawing mainly from renewable energy sources.

(FR): La présente invention concerne un procédé, et un dispositif permettant de mettre en oeuvre ledit procédé, de culture de microalgues et d'obtention de la séparation simultanée des parties oléiques et protéiques, réduisant l'espace nécessaire et utilisant principalement des sources d'énergie renouvelable. Le procédé est caractérisé par le fait qu'il comprend les phases suivantes : • ledit mélange aqueux, contenant ledit inoculum, suit un trajet (B) d'un point d'entrée (C) à un point de sortie (D), le long duquel il est irradié par un spectre de rayonnement approprié au développement et à la croissance desdites microalgues; • le long dudit trajet (B) des sels NPK (contenant de l'azote, du phosphore et du potassium) et du CO₂ y sont ajoutés, ces

ajouts, conjointement à la diffusion dudit spectre de rayonnement, provoquant une croissance intense desdites algues ; • ledit mélange, fortement enrichi de micro-algues, est inondé d'ultrasons qui détruisent les algues adultes, les séparant en composants oléiques et protéiques, ladite action provoquant la formation d'un nouveau mélange aqueux dans lequel une fraction oléique et une fraction protéique sont présentes ; • ledit nouveau mélange aqueux est soumis à une séparation gravimétrique spontanée de telle sorte que : • une fraction oléique, plus légère, migre dans la partie supérieure dudit nouveau mélange ; • une fraction protéique, plus lourde, migre dans la partie inférieure dudit nouveau mélange ; • une fraction neutre composée presque exclusivement d'eau reste dans la partie intermédiaire dudit nouveau mélange ; • lesdites trois fractions sont prises individuellement. Le dispositif (A) est caractérisé par le fait qu'il comprend : • un bassin (1) adapté pour contenir ledit mélange aqueux ; • un ou plusieurs déflecteurs (3, 4, 5) montés de façon à délimiter un trajet (B) d'un point (C) à point (D), ledit ou lesdits

défecteurs (3, 4, 5) étant des panneaux diffuseurs du spectre de rayonnement homogènes, appropriés à la phase de culture ; • un moyen adapté pour fournir, audit mélange fluide, des sels NPK (sels d'azote, de phosphore et de potassium) et du CO₂, ledit moyen étant disposé le long dudit trajet (B) ; • un moyen (9) adapté pour produire des ultrasons, positionné au niveau du point final (D) dudit trajet (B), lesdits ultrasons étant d'une puissance suffisante pour détruire les algues adultes en les séparant en composants oléiques et protéiques, donnant lieu à un nouveau mélange fluide dans lequel sont présentes une phase oléique, une phase protéique et une phase neutre ; • un moyen adapté pour diffuser ledit nouveau mélange fluide, afin de mettre en œuvre une séparation gravimétrique desdites phases oléique, protéique et neutre ; • un moyen adapté pour collecter séparément lesdites phases oléique, protéique et neutre.

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Declaration of inventorship (Rules 4.17(iv) and 51bis.1(a)(iv)) for the purposes of the designation of the United States of America