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Green Skills for Sustainable Development: Pathways to a Low-Carbon and Resource- Efficient Economy

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ABSTRACT: Green skills encompass the knowledge, abilities, values, and attitudes required to live and work sustainably. They enable the transition toward a resource-efficient and low-carbon economy by addressing environmental challenges and supporting the creation of green jobs in sectors such as renewable energy, sustainable construction, and waste management. This article examines the conceptual framework of green skills, categorizes them into technical and transversal competencies, and discusses their economic and societal relevance in achieving global sustainability targets, including the United Nations Sustainable Development Goals (SDGs). It further explores sectoral applications, employment prospects, educational pathways, and policy implications for fostering a resilient green workforce in the 21st century.

KEYWORDS: Green skills, sustainable development, low-carbon economy, green jobs, ESG, renewable energy

I. INTRODUCTION

The 21st century is characterized by unprecedented environmental challenges, including climate change, biodiversity loss, pollution, and resource depletion. These challenges have compelled nations to restructure economic systems toward sustainability. International frameworks such as the Paris Agreement emphasize the urgent need to transition to low-carbon, climate-resilient economies. As economies shift toward sustainable development models, the demand for green skills has expanded rapidly. No longer confined to environmental sectors, these competencies are becoming foundational to career development across industries. Green skills thus represent both an environmental necessity and a driver of economic transformation.

II. REVIEW OF LITERATURE

Reports by the *International Renewable Energy Agency (IRENA, 2021)* and *World Bank (2022)* show robust growth in employment opportunities in renewable energy, sustainable infrastructure, and environmental services. Scholars such as *de Haas et al. (2020)* emphasize that existing workforces require re-skilling to avoid displacement and benefit from the green transition. *European Centre for the Development of Vocational Training (Cedefop, 2022)* reveals that employers increasingly value green competencies in recruitment, even for non-environmental roles—signaling a shift in corporate sustainability expectations. *Smith & Smith, 2018)* highlight the role of vocational training in delivering hands-on experience in renewable technologies, retrofitting techniques, and waste management. *Barrie et al. (2021)* identify micro-credentials and short online modules in carbon accounting and ESG reporting as effective tools for adult learners.

III. SIGNIFICANCE OF THE STUDY

The study on green skills holds substantial academic, economic, policy, and societal significance, particularly in the context of accelerating climate change and global commitments such as the United Nations Sustainable Development Goals (SDGs) and the Paris Agreement. Its importance can be understood across multiple dimensions. This study



contributes to the growing body of literature on sustainable development and workforce transformation. The transition to a low-carbon and resource-efficient economy requires a workforce equipped with appropriate competencies and also Highlights the role of green skills in driving economic transformation and industrial innovation, Identifies employment opportunities emerging in renewable energy, sustainable construction, environmental management, and green finance, Emphasizes the need for up skilling and re-skilling to reduce workforce displacement during economic restructuring, Governments worldwide are developing climate policies and sustainability frameworks. This research is significant because it Encourages curriculum reform to embed sustainability across disciplines., supports the integration of green competencies into STEM, business, engineering, and vocational programs, .Promotes lifelong learning and micro-credentialing to address evolving environmental challenges. Beyond economic outcomes, green skills contribute directly to environmental protection and social well-being. The study is important because it:

IV. OBJECTIVES OF THE STUDY

1. To define and conceptualize green skills.
2. To categorize green skills into technical and transversal competencies.
3. To examine their importance in economic transformation and employment growth.
4. To analyze sectoral applications and educational pathways.
5. To discuss challenges and policy implications for sustainable workforce development.

V. METHODOLOGY

This paper is a conceptual based study to develop theoretical approach towards the Green skilling and also based on the secondary data such as literature and approach papers of UNO and other international reputed organizations

VI. DISCUSSIONS

6.1 Concepts of Green Skills

Green skills refer to the knowledge, technical expertise, values, and behavioral attributes necessary to promote environmental sustainability and resource efficiency. They facilitate:

- Reduction of environmental impacts
- Enhancement of energy and resource efficiency
- Adoption of sustainable technologies
- Promotion of environmentally responsible behavior

Importantly, green skills are cross-cutting and apply across all sectors of the economy, from energy and construction to finance and information technology.

6.2. Types of Green Skills

Countries worldwide are committed to reducing greenhouse gas emissions and protecting ecosystems. Achieving international sustainability targets requires a workforce equipped with green competencies. Governments are implementing climate policies, carbon reduction strategies, and environmental regulations that directly increase demand for skilled professionals in sustainability-related fields. Industries are undergoing structural transformation to meet sustainability goals and stakeholder expectations. Businesses now integrate environmental, social, and governance (ESG) standards into their operations. Organizations increasingly seek professionals capable of:

- Reducing carbon footprints
- Optimizing energy and water use
- Implementing sustainable supply chain practices
- Reporting environmental performance metrics

Green knowledge is becoming a competitive advantage in recruitment and career advancement. Emerging technologies such as clean energy systems, electric vehicles, and smart grids require specialized expertise. Green skills intersect strongly with digital competencies, creating hybrid roles in:

- Environmental data analytics



- Sustainable information technology solutions
- Smart infrastructure design
- Climate modeling and forecasting

This integration highlights that sustainability is not separate from technological progress but deeply intertwined with it. Green skills can be broadly categorized into **technical skills** and **transversal (soft) skills**, both of which are essential for sustainable development.

6.2.1 Technical Green Skills

Technical skills involve specialized knowledge required for specific green occupations. These include:

- Renewable energy technology (solar and wind systems installation and maintenance)
- Energy efficiency auditing and retrofitting
- Sustainable building and green construction practices
- Water treatment and resource management systems
- Waste recycling and circular economy implementation
- Sustainability reporting and carbon accounting (ESG frameworks)

These competencies support the implementation of green technologies and ensure compliance with environmental standards and regulations.

6.2.2 Transversal (Soft) Green Skills

Transversal skills are broadly applicable competencies that enhance sustainable decision-making across professions. They include:

- Environmental awareness and stewardship
- Systems thinking and creative problem-solving
- Data interpretation and environmental monitoring
- Communication and collaboration
- Sustainable mindset and ethical decision-making

Such skills enable professionals to integrate sustainability principles into corporate strategies, public policies, and daily practices.

VII. IMPORTANCE IN ECONOMIC TRANSFORMATION AND EMPLOYMENT GROWTH

7.1 Economic Transformation

Green skills are central to the transition toward resilient, low-carbon economies. They foster innovation in renewable energy systems, sustainable infrastructure, and circular production models.

7.2 Employment and Job Creation

The green transition generates new employment opportunities while transforming traditional occupations. Expanding fields include renewable energy, environmental consultancy, sustainable finance, and climate risk management. At the same time, existing workers require reskilling to align with sustainability standards.

7.3 Global Sustainability Imperative

Green skills are indispensable for meeting international climate commitments and achieving the SDGs. Without a skilled workforce, sustainability policies and technological advancements cannot be effectively implemented.



VIII. SECTORAL APPLICATIONS OF GREEN SKILLS:

Green skills are applicable across multiple sectors:

8.1 Energy

Renewable energy engineers, solar and wind technicians, and energy storage specialists drive the clean energy transition.

8.2 Construction and Urban Development

Green architects, sustainable urban planners, and energy auditors design energy-efficient and climate-resilient infrastructure.

8.3 Agriculture and Food Systems

Agro ecology specialists and sustainable food system planners promote productivity while preserving ecosystems.

8.4 Business and Finance

ESG analysts, sustainability officers, and green finance advisors align investments with environmental responsibility.

8.5 Information Technology and Data

Environmental data scientists and smart systems designers develop digital solutions for sustainability monitoring and optimization.

8.6 Manufacturing

Circular economy managers and green materials developers enhance resource efficiency and reduce industrial waste.

IX. EMPLOYMENT GROWTH AND ECONOMIC POTENTIAL:

Labor market trends indicate sustained growth in green jobs due to investments in renewable energy infrastructure, energy efficiency retrofitting, and environmental governance. Key growth areas include:

- Renewable energy installation and maintenance
- Energy efficiency auditing
- Corporate sustainability management
- Climate policy advisory services
- Environmental impact assessment

These trends demonstrate that green skills are a long-term feature of evolving job markets rather than a temporary phenomenon.

X. EDUCATION AND TRAINING PATHWAYS:

Educational institutions and vocational training providers are integrating sustainability into curricula through:

- Green certifications in energy auditing and sustainable building standards
- STEM programs enriched with environmental applications
- Apprenticeships in clean technologies
- Micro-credentials and online sustainability courses
- Corporate re-skilling and up-skilling initiatives

Lifelong learning is essential, as environmental technologies and policies continue to evolve.



XI. CHALLENGES AND OPPORTUNITIES OF GREEN SKILLS:

Challenges

- Unequal access to green education and training
- Insufficient policy and financial support
- Skills mismatches between education and industry demands
- Risk of social inequality during economic transitions

Opportunities

- Investment in inclusive workforce development programs
- Industry–academia collaboration
- Promotion of just transition strategies
- Expansion of interdisciplinary training combining digital and environmental skills

XII. CONCLUSION

Green skills represent a foundational pillar of sustainable development in the 21st century. By combining technical expertise with transversal competencies, individuals can contribute meaningfully to environmental protection, economic resilience, and social well-being. As the global economy advances toward sustainability, embedding green skills into education systems and workforce strategies will be essential for achieving a just and inclusive green transition. The prospects of green skills are not only promising—they are transformative for both career development and global sustainability. The integration of green skills into workforce development strategies is critical for sustainable economic growth. Policymakers, educators, and industry leaders must collaborate to address skills gaps and promote equitable access to green employment opportunities. Furthermore, the intersection of green skills with digital innovation underscores the need for interdisciplinary approaches that combine environmental knowledge with technological proficiency

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