unicef for every child office of innovation

SOLAR ENERGY TECHNOLOGIES

Collaboration with Harvard Consulting on Business and the Environment

The Challenge

Energy consumption, of mainly fossil fuel, is driving environmental and **climate crises** globally.

Only 13.5% of global energy comes from renewables in 2021.[1]

Global energy use is predicted to **increase nearly 50%** compared with 2020, mostly due to economic growth and population in non-OECD countries.[2]

Decline in international financial flows to **developing countries** for renewables from $24.7 billion in 2017 to $10.9 billion in 2019.[3]

Key Takeaways

After reading this brief, you will know more about

- Energy produced from renewable sources is now cheaper than fossil fuel in most countries.
- Solar energy is the cleanest, safest, and cheapest source of electricity.
- Solar technologies dominate innovations in the renewable energy sector.
- Solar technologies allow for agrivoltaic farming, contribute towards zero-carbon built environments, and convert sunlight to energy from almost any surface.

Context

As the world transitions towards renewable energy sources, innovations in solar technology play a pivotal role in revolutionizing energy generation. The 2022 IPCC Synthesis Report has identified solar energy as a highly impactful emission reduction and mitigation option.4 Advances in solar technology not only promise cleaner and more sustainable power solutions but also hold the potential to empower underserved communities worldwide. Through accessible and affordable solar innovations, children in these areas gain access to reliable electricity, enhancing educational opportunities and fostering economic development.

Findings

Background

The capacity of solar energy technologies to add value to a range of sectors and to mitigate climate change surpasses other sources of renewable energy:

- **Adaptability:** solar energy systems can grow as demand and consumption increases, and as investment becomes available. In terms of microgrids, new components could be added without requiring major system rework. An off-grid solar system can be fully assembled and tested before delivery to a remote location.
- **Affordability:** establishment and maintenance costs are relatively low compared to other renewable energy sources.
- **Durability:** product lifespan is around 30 years compared to wind turbines with circa 20 years.

Innovation

- **Solar cell technologies** are the critical enablers for solar innovations. Advances in solar cell technologies expand opportunities for novel applications of solar energy, with spillover benefits for many related technologies. (A solar cell is a device that converts light energy into electricity through the photovoltaic effect.)
- **First-generation** silicon-based solar cells, while widely used, are complex and energy-intensive to produce.
- **Second-generation** solar cells are based on thin-film technology where the active layer of PV material is much thinner than with first-generation crystalline silicon (c-Si) solar cells. The manufacturing of these PVs however produces highly toxic by-products.
- **Third-generation** solar cells, including perovskite, organic, and quantum dot PVs, are less costly to manufacture and can be 'tuned' for optimal electricity generation. Perovskite PVs are projected to dominate the solar market in the future.

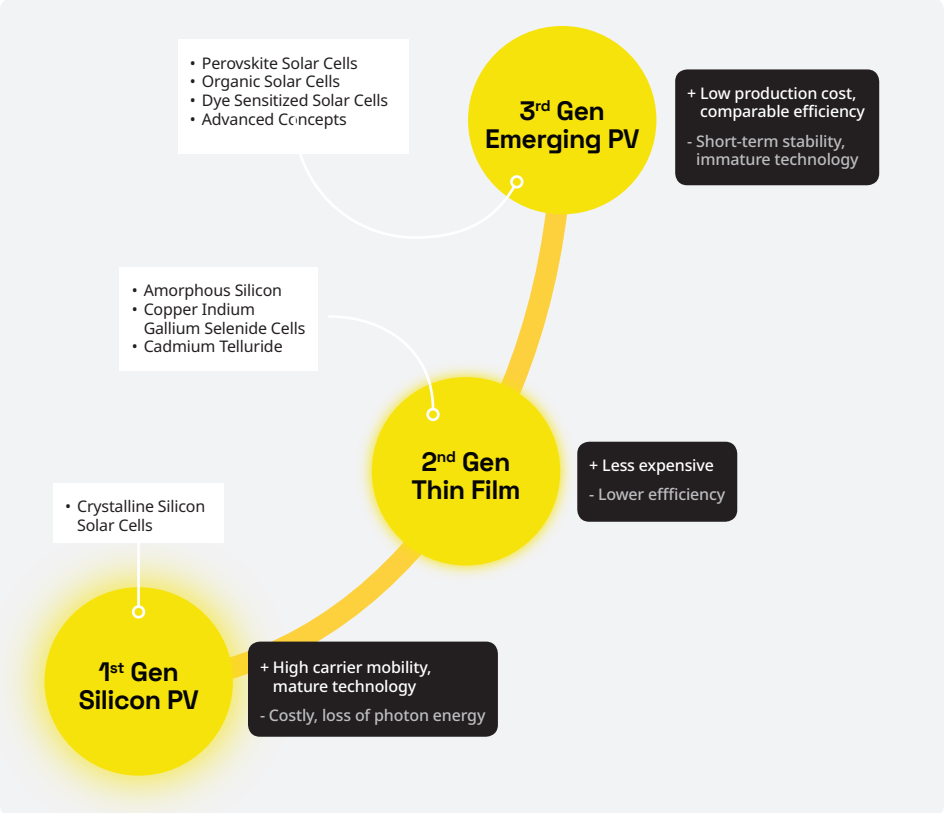

Figure 1: Maturity of solar cell technologies

Source: Pham, H. D., et al., 'Development of Dopant-Free Organic Hole Transporting Materials for Perovskite Solar Cells', Advanced Energy Materials, 1903326, 2020, doi: 10.1002/aenm.201903326.

Innovation (continued)

- Unique properties of third-generation solar cells have enabled cutting-edge solar innovations, such as:
  - Solar film, electronic solar inks printed onto submillimeter-thin plastic sheets. If the solar cells are printed on polyethylene terephthalate (PET), the material can be recycled – an advantage over conventional silicon panels. Solar film is lightweight, flexible, semi-transparent, and cheap to manufacture as the material can be printed using commercial equipment.
  - Solar paint, a liquid with PV properties that allows it to absorb sunlight and convert it into electricity.
  - Solar glass, photovoltaic glazing that encloses solar cells that convert sunlight into renewable energy. Several companies are developing transparent solar glass that can operate with as little as 10 percent sunlight.
  - Solar textile, made by embedding miniaturized solar cells into yarn. Some fabrics absorb sunlight and keep it there as heat. Increased use of wearable, mobile, and electronic textile-sensing devices is driving a need to keep these devices powered without frequent recharging or bulky energy storage.

Impact

Solar technologies contribute to climate change mitigation and disaster risk reduction and accelerate multiple social and economic benefits for underserved communities. Potential application examples are listed below:

Solar film

- Roof-top solar energy systems in low-income countries where traditional silicon panels could be too heavy.
- Recharging systems for electric vehicles and in remote areas.
- Floating solar energy system - a rapidly growing market in Asia.
- Floating covers for dams to reduce water evaporation and generate electricity.
- Integrate into building products, like roofing materials and smart blinds

Solar paint

- Can coat almost any surface and existing structure, thereby leveraging opportunities to generate renewable energy in large-scale development projects.
- Hydrogen solar paint is adaptable to a range of climates, even remote areas far from water.

Solar glass

- Integrate into a building and roofing systems.
- Power heating or cooling system for greenhouses, as well as water desalination.
- Agrivoltaics - turning deserts into productive agricultural land. The global agrivoltaic market is expected to increase significantly due to the limited availability of land for cultivation and the climate crisis.

Solar textile

- Solar canopies, solar tarpaulin, solar tents, and awnings to capture energy for outdoor lighting in remote areas to improve the safety of women and children at night.
- Solar filaments can be woven into the fabric for winter coats, gloves, or other pieces of clothing.
- Shade sails in car parks in urban areas, generating electricity for local communities.

See Insight Report No. 2 for more information, including the potential of next-generation solar PV technologies and the potential applications of novel renewable energy innovations for the humanitarian and development sector..

Opportunities

- A child rights-based approach to renewable, decentralized energy generation can enhance their access to affordable, clean and reliable energy, further enhancing the resilience of vital services such as healthcare (SDG 3) and education (SDG 4), thereby positively impacting the lives of underserved children by ensuring a healthier and more conducive environment for their development.
- The emergence of third-generation PV technologies and novel solar innovations opens up opportunities for humanitarian interventions, post-conflict and post-disaster recovery and reconstruction, and development settings.
- The global community needs to invest in a portfolio of renewable energy innovations across multiple time horizons because better solutions may be available, and what works in the near term may not be effective in the longer term (10 years and beyond) when the conditions for possibility have changed.

Insights Briefs

Innovation Nodes Insights Briefs serve as resource for practitioners and decision makers to quickly get up-to-speed on new and unknown areas of potential innovation for children.

Publication produced by the Innovation Nodes aim to facilitate the exchange of knowledge and stimulate discussion. The findings, interpretations and conclusions expressed are those of the researchers and authors, and do not necessarily reflect UNICEF policies or approaches.

For more information on Innovation Nodes and collaboration opportunities:

Email: innovation@unicef.org

Website: www.unicef.org/innovation/

read the full report

Notes

1. Ritchie, H., M. Roser and P. Rosado, 'Energy', 2022. Note that Ritchie, Roser and Rosado define renewable energy as hydropower, solar, wind, geothermal, wave, tidal and modern biofuels but exclude traditional biomass – which can be an important energy source in lower-income settings.
2. U.S. Energy Information Administration. The International Energy Outlook 2021, <eia.gov/outlooks/ieo/introduction/sub-topic-02.php>, accessed 01 Feb 2023.
3. The Sustainable Development Goals Report 2022: https://unstats.un.org/sdgs/report/2022
4. International Panel on Climate Change, Climate Change 2023: Synthesis Report. A Report of the Intergovernmental Panel on Climate Change, Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds.)]. IPCC, Geneva, Switzerland, 2023.

Suggested citation:
UNICEF, Renewable energy: emerging technologies and innovations. Insight Report No.2, UNICEF Office of Innovation, New York, 2023.