

INNOVATIVE AND AFFORDABLE TECHNOLOGIES FOR RENEWABLE ENERGY TRANSITION IN THE URBAN SPACE

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CITIES AND ENERGY

- Urban space is home to about 55% of the world's population. By 2050, this is expected to increase by 2.5 to 3 billion and comprise two-thirds of the world population.
- For the next three decades, nearly seventy million residents will move to urban areas every year. Most of these new residents will live in small to medium sized cities in the developing world.
- Global annual energy consumption is about 14,000 mtoe. Cities consume about two thirds of the global energy consumption.
- Global CO₂ emissions due to energy use and industrial processes amount to about 37 billion tonnes. Cities are responsible to 71–76% of global energy-related CO₂ emissions.
 - Operation of buildings accounted for 30% of global final energy consumption and 27% of total energy sector emissions
 - Urban transport contributes to 40% of the global transport sector emissions (ie. about 4 billion tonnes of CO₂e)

Role of cities for human habitat is significant. So is its energy consumption and GHG emissions. To address the 1.5C challenge, cities and renewable energy technology based solutions will be the focus.

SELECTED RENEWABLE ENERGY RESOURCES AND TECHNOLOGIES FOR THE URBAN SPACE

- Electricity
 - Solar
 - PV: Roof top, Building integrated, Micro grid
 - Wind
 - Wind: Vertical axis
 - Biomass
 - Biomass: Combustion
- Heating and cooling
 - Solar
 - Thermal: Hot water, air conditioning
 - Biomass
 - Biomass: Combustion
 - Geothermal
 - Biomass: Combustion, gasification, biogas
- Hydrogen
 - Transportation
- Solar PV-T
 - Heating and Electricity
- Passive solar
 - Green roof, design considerations

The resources and technologies are well known. Innovation is necessary considering the city's sector's share of energy, alternatives, etc ³

AFFORDABLE RETs TO MITIGATE EMISSIONS

- Global weighted average total installed cost, capacity factor and levelised cost of electricity trends by technology, 2010 and 2021

	Total installed costs			Capacity factor			Levelised cost of electricity		
	(2021 USD/kW)			(%)			(2021 USD/kWh)		
	2010	2021	Percent change	2010	2021	Percent change	2010	2021	Percent change
Bioenergy	2 714	2 353	-13%	72	68	-6%	0.078	0.067	-14%
Geothermal	2 714	3 991	47%	87	77	-11%	0.050	0.068	34%
Hydropower	1 315	2 135	62%	44	45	2%	0.039	0.048	24%
Solar PV	4 808	857	-82%	14	17	25%	0.417	0.048	-88%
CSP	9 422	9 091	-4%	30	80	167%	0.358	0.114	-68%
Onshore wind	2 042	1 325	-35%	27	39	44%	0.102	0.033	-68%
Offshore wind	4 876	2 858	-41%	38	39	3%	0.188	0.075	-60%

Source: IRENA (2022), *Renewable Power Generation Costs in 2021*.

- Installed costs have reduced for all except for geothermal and hydropower
- Capacity factor has increased for all, except for bio energy and geothermal.
- Levelised cost of electricity has decreased for all except for geothermal and hydropower (fossil fuel ranges from about 0.58 to 1.8 USD/kWh)

The popular RETs: PV, Wind and Concentrated Solar Power (CSP) ⁴

RENEWABLE ENERGY OPTION FOR BUILDING AIR CONDITIONING

- Globally, buildings consume 30-40% of the global final energy consumption
- 30 to 60% of the end use electricity consumption is from air conditioning and cooling.
- IEA estimates that 2/3 of the buildings will have air conditioning by 2050, and the global cooling stock will be 2 ½ times more than in 2020.
- Vapour compression systems requiring 100% electricity could be substituted by vapour absorption systems that will require only 30-40% of electricity, but will require energy input in the form of heat.
- This heat could be provided by solar or bio mass or waste heat.
- A portion of the electricity can also be obtained by PV locally.
- The possibility to use PV/Thermal is yet another option.

These measures can help in (a) reducing electricity (b) reducing emissions, (c) decentralized generation eliminating T&D losses, and (d) Application of IoT can help to optimize and reduce inefficiencies.

RENEWABLE ENERGY OPTION FOR TRANSPORT

- Transport sector contributes to about 17% of global GHG emissions. So, to use a non carbon fuel, hydrogen is one alternative.
- Renewable based electric vehicles appears to be the most promising alternative. Hydrogen fuel cells also offer a zero- carbon emission alternative, it can be produced locally, and can use as portable, stationary and transport.
- However, its production, transportation, and storage is costly and energy-intensive, and there is limited infrastructure for refueling hydrogen vehicles. Its cost is still relatively high compared to EVs.
- Its market is expected to grow from \$1.1 billion in 2020 to \$8.5 billion by 2025; As of 2021, there were over 10,000 hydrogen fuel cell vehicles in operation worldwide, and by 2030, it could reach 10 million.
- Hydrogen fuel cells could help reduce global greenhouse gas emissions by up to 6 billion tonnes per year by 2050.
- Tokyo, Seoul, Hamburg, London, etc plans to integrate hydrogen resource.

These emerging renewable energy based technology options will be necessary to reduce emissions to achieve the 1.5C target.

TO ADVANCE CLIMATE ACTION: A SUMMARY

- The 2023 IPCC Synthesis report notes that “.... In urban areas, observed climate change has caused adverse impacts on
 - human health, livelihoods and key infrastructure.
 - Hot extremes have intensified in cities.
 - Urban infrastructure, including transportation, water, sanitation and energy systems have been compromised by extreme and slow-onset events, with resulting economic losses, disruptions of services and negative impacts to well-being.
 - Observed adverse impacts are concentrated amongst economically and socially marginalised urban residents....”
- To mitigate GHG emissions:
 - Renewables and Innovation: 3 D’s; creation of new and competitive products, services, processes, and systems
 - Support for research, development and demonstration
 - Capacity building and skills development
 - Incentivizing linkages between various stakeholders
 - Providing financial incentives
- Climate mitigation will need to be fought in cities through RETs. We have seen the RETs, their applications and the cost reductions.
- More than 800 cities have set some RE targets, as of 2020. Need to expand⁷



THANK YOU

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