RENEWABLE ENERGY AND TECHNOLOGY

i. 2013 ke data ke mutabiq India ki Coal Production kitni thi? → Around 566 million tonnes thi. (Coal India duniya ka largest producer hai.)				
ii. Non-Conventional Energy Source se kya muraad hai? → Jo traditional sources jaise coal, oil se alag hote hain, jaise solar, wind, biomass, tidal energy.				
iii. 2013 ke data ke mutabiq India ki Per Capita Energy Consumption kya thi? → Around 0.6 tons of oil equivalent (toe) thi. (Developed countries ke comparison mein kaafi kam thi.)				
iv. Solar Constant ki tareef kijiye. → Solar Constant wo amount of solar energy hai jo 1 square meter area par Earth ke atmosphere ke upper layer par receive hoti hai, almost 1361 W/m².				
v. Terrestrial aur Extraterrestrial Radiation mein farq bayan kijiye. →				
Extraterrestrial Radiation: Atmosphere ke bahar receive hone wall energy.				
Terrestrial Radiation: Jab atmosphere mein se hokar ground par pohchti hai to kuch loss ke saath receive hoti hai.				
vi. Solar Collector ki tareef kijiye.				
→ Device jo solar energy ko absorb kar ke heat mein convert karta hai aur use karta hai water ya air ko garam karne ke liye.				
vii. Solar Photovoltaic System ka kya maqsad hota hai? → Sunlight ko directly electricity mein convert karna using solar cells.				
viii. Solar Cell ke hawale se kaunsi statement sahi nahi hai?				
Options dekhte hain:				

(a) Ismein koi moving parts nahi hote – 🔽 (correct)

• (c) Design Modular hota hai – ☑ (correct)

(b) Zyada Maintenance Free/Reliable hota hai -
✓ (correct)

 (d) Sasta aur Efficient hota hai – X (Ye wrong hai, solar cells abhi bhi kaafi costly hote hain aur efficiency limited hoti hai.) → Answer: (d) 				
ix. Wind Power Generator ke liye Wind Speed Range kya hoti hai? → Cut-in speed usually 3–4 m/s hoti hai aur rated speed 12–15 m/s ke beech hoti hai. (Matlab turbine minimum 3-4 m/s par chalna start karta hai aur 12-15 m/s par maximum output deta hai.)				
x. Hydrogen energy ko kis type ke energy source pe consider kiya jata hai? → Secondary Energy Source. (Kyuki hydrogen khud natural form mein easily available nahi hota, isko dusre energy sources jaise water electrolysis ya fossil fuels se produce kiya jata hai.)				
Qn 1 to 10 Hinglish Explanation:				
 1. 2013 me India ka Coal Production kya tha? Answer: 2013 me India ka coal production 566 million ton ke aas paas tha. India duniya ka third largest coal producer tha is time par. 				
2. Non-renewable energy source ka example? Answer: Non-renewable energy wo source hoti hai jo ek baar khatam hone ke baad easily dobara available nahi hoti. Examples: Coal Petroleum Natural Gas				
3. Per Capita Energy Consumption ka matlab? Answer: Matlab ek country me ek person average kitni energy use karta hai. Formula:				

Total energy consumption÷Total population\text{Total energy consumption} \div \text{Total population}

• Isse country ki energy use efficiency ka idea milta hai.

4. Diffuse Radiation kya hota hai?

Answer:

 Jab sunlight directly nahi aati, balki clouds, dust, atmosphere se bichad kar soft light form me aati hai, use Diffuse Radiation kehte hain.

Example:

- Jab cloudy din me halka halka light ground pe padta hai, wo diffuse radiation hota hai.
- 5. Solar Radiation ko measure karne ke liye kya use hota hai?

Answer:

- Solar radiation ko measure karne ke liye Pyranometer use hota hai.
- Ye device direct aur diffuse dono type ki sunlight measure karta hai.
- 6. Solar Collector kya hota hai?

Answer:

 Solar collector ek aisi device hai jo sun ki energy ko collect karta hai aur use heat ya electricity me convert karta hai.

Example:

- . Jo solar water heater me black color ka panel lagta hai, wo ek solar collector hota hai.
- 7. Solar Photovoltaic System kya hota hai?

Answer:

Solar Photovoltaic (PV) system sunlight ko direct electricity me convert karta hai.

Components:

- Solar Panels
- Battery (energy ko store karne ke liye)
- Inverter (DC to AC current banane ke liye)
- 8. Solar Cell ke baare me galat statement konsa hai?

Answer:

- Galat statement hai:
 - "Solar cells ke moving parts hote hain" X
- Solar cells totally stationary hote hain, koi moving part nahi hota.

9. Zenith Angle kya hota hai?

Answer:

 Zenith angle wo angle hai jo sun ke current position aur observer ke directly upar (zenith) ke beech banta hai.

Simple:

Jab sun bilkul sir ke upar nahi hota, tab jo angle banta hai, wo Zenith Angle kehlata hai.

10. 21 June aur 22 December ko Declination Angle kya hota hai?

Answer:

- 21 June ko:
 - Declination angle +23.5° (North ke side tilt hota hai).
- 22 December ko:
 - Declination angle -23.5° (South ke side tilt hota hai).

Short Table for Quick Revision:

Qn Topic Short Answer

1 2013 Coal Production 566 million ton

2 Non-renewable Energy Coal, petroleum, natural gas

3 Per Capita Consumption Ek person ka average energy use

4 Diffuse Radiation Bichri hui sunlight

5 Solar Radiation Measure Pyranometer device

6 Solar Collector Heat ya power collect karna

7 Solar Photovoltaic Light se direct electricity

8 Solar Cell wrong point Moving parts nahi hote

9 Zenith Angle Sun aur zenith ke beech ka angle

10 Declination Angle +23.5° (June), -23.5° (Dec)

Summarized Notes (Thoda Explanation ke Saath)

2. Renewable Energy Applications and Problems

Explanation:

Renewable energy woh hoti hai jo khatam nahi hoti (jaise suraj ki roshni, hawa, paani). Iska use bijli banane, paani garam karne, aur cooking me hota hai.

Applications:

- Solar panels se ghar aur industries me electricity milti hai.
- Wind turbines se remote areas me bijli generate hoti hai.
- Biogas se gaon me cooking fuel milta hai.

Problems:

- Solar panels cloudy ya rainy days me kam kaam karte hain.
- Wind turbines ke liye open aur windy area chahiye.
- Initial cost zyada hoti hai (solar panels, wind turbines lagane me).

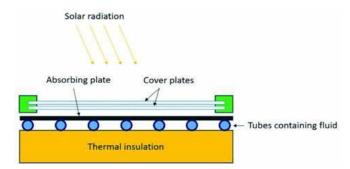
Real-life Example:

Rajasthan ke kuch gaon me solar panels se pura village ki electricity ki demand puri ho rahi hai.

3. Flat Plate Collector

Explanation:

Flat plate collector ek aisa device hai jo suraj ki heat ko absorb karta hai aur usse paani ya hawa ko garam karta hai.



Working:

- Glass cover sunlight andar le aata hai.
- · Neeche ka black surface heat absorb karta hai.
- Pani pipes me flow karta hai aur heat se garam hota hai.

Use:

- Ghar me solar water heater me.
- . Hospitals aur hostels me water heating ke liye.

Real-life Example:

Hotels me solar water heaters lagaye jaate hain jisse raat ke liye bhi paani garam ready rahta hai.

4. Wind Energy Safety and Environmental Effects

Explanation:

Wind energy hawa ke flow se turbines ko ghumake electricity banati hai.

Yeh clean energy source hai (no pollution).

Safety:

- Turbines strong aur stable design ke hote hain.
- Maintenance ke time safety gear use kiya jata hai.

Environmental Impact:

- Pollution nahi hota.
- Birds ko kabhi kabhi nukhsan pahuchta hai.
- Noise pollution bahut kam hota hai.

Real-life Example:

Tamil Nadu ke coastal areas me large wind farms lage hain jo thousands of homes ko green electricity provide karte hain.

5. Energy Reservoirs in India

Explanation:

India me kai natural energy resources milte hain — coal, oil, gas, uranium, etc.

Main Sources:

- Coal: Jharkhand, Odisha, Chhattisgarh
- Oil and Gas: Assam, Gujarat
- Uranium: Jharkhand, Andhra Pradesh
- Hydro Energy: Himachal Pradesh, Uttarakhand

Real-life Example:

Dhanbad (Jharkhand) ke coal mines se pura India ke thermal power plants me fuel supply hota hai.

6. Non-Conventional Energy Sources

Explanation:

Non-conventional sources wahi hote hain jo traditional sources jaise coal/oil ke alawa hote hain. Ye environment friendly aur renewable hote hain.

Examples:

- Solar Energy (Suraj se)
- Wind Energy (Hawa se)

- Tidal Energy (Samundar ki lehron se)
- Geothermal Energy (Zameen ke andar se garmi)

Real-life Example:

Ladakh me geothermal springs ka use garam pani ke liye hota hai.

7. Solar Photovoltaic (PV) Applications

Explanation:

Solar PV system sunlight ko direct electricity me convert karta hai without any moving parts.

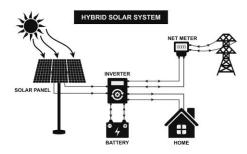
Applications:

- Remote villages me electricity dena
- Solar street lights lagana
- Solar water pumping agriculture ke liye
- Homes aur offices me solar rooftop system

Real-life Example:

Rajasthan ke remote schools me solar PV panels lagake free electricity di gayi hai.

Diagram of Solar Photovoltaic (PV) Applications



8. Biomass Gasifier

Explanation:

Biomass gasifier ek machine hai jo lakdi, ghans, gobar jaise organic waste ko gas me convert karti hai, jisse energy milti hai.

Working:

- Biomass ko heat karte hain oxygen limited environment me.
- Gas banti hai jo generators ya cooking stoves me use hoti hai.

Real-life Example:

Karnataka ke ek village me rice husk ka use karke electricity aur cooking gas dono banayi ja rahi hai.

Final Touch:

- Har jagah simple words use karne ki koshish karo jaise "electricity banani", "pani garam karna", "environment friendly" etc.
- Real-life examples likhne se answers impressive lagte hain.
- Definitions short aur clear rakhni hai.

u QUESTION 9 TO 13 FOR 10 MARKS:

9. Factors Affecting Wind Energy Conversion

Explanation:

Wind energy ka conversion hawa ke flow (speed) aur turbine ke design par depend karta hai.

Main Factors:

• Wind Speed:

Hawa jitni tez chalegi, utni jyada energy milegi. Kam speed par turbine proper work nahi karega.

Air Density:

Thandi jagah (jaise hills) me hawa dense hoti hai, isliye wahan energy conversion achha hota hai.

Height of Tower:

Jitna ucha tower hoga, hawa utni strong milegi. Ground ke paas hawa weak hoti hai.

Blade Design:

Turbine ke blades ka shape aur size energy efficiency ko affect karta hai. Aerodynamic design se output better hota hai.

Real-life Example:

Gujarat ke coastal areas me tall wind turbines lagaye jaate hain taaki strong hawa se maximum electricity generate ho sake.

10. Applications of Geothermal Energy

Explanation:

Geothermal energy zameen ke andar ki heat se milti hai. Isko electricity banane aur heating ke liye use kiya jaata hai.

Applications:

Electricity Generation:

Geothermal plants se turbines ko ghumake electricity produce hoti hai.

Space Heating:

Buildings me heating system ke live geothermal energy use hoti hai (specially cold countries

Greenhouse Heating:

Greenhouse farming ke liye geothermal energy se controlled temperature banaya jaata hai.

Hot Water Supply:

Hospitals, hotels me geothermal heat se pani garam karke supply hoti hai.

Real-life Example:

Iceland me 90% homes geothermal energy se heated hain.

11. Solar Energy Storage Systems

Explanation:

Solar energy din me milti hai, lekin raat me use karne ke liye hume usse store karna padta hai. Storage systems ka kaam hota hai energy ko collect aur preserve karna.

Types of Storage Systems:

• Battery Storage:

Solar panels ki electricity batteries me store hoti hai, jaise lithium-ion batteries.

• Thermal Storage:

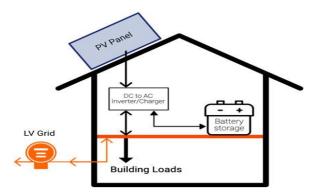
Suraj ki heat ko water tanks ya molten salt me store karte hain, jo raat me use hoti hai.

Mechanical Storage:

Energy ko mechanical form me (pumped hydro, compressed air) store kiya jaata hai.

Real-life Example:

Solar rooftop system ke sath jo batteries lagte hain gharon me, wo raat me lights aur fans ke liye stored electricity provide karte hain.



12. Advantages of Biomass Energy

Explanation:

Biomass energy organic waste materials (lakdi, gobar, fasal ke bache parts) se milti hai. Ye renewable aur environment friendly energy source hai.

Advantages:

Renewable Source:

Biomass kabhi khatam nahi hota kyunki naye plants ugte rehte hain.

Reduces Waste:

Agricultural aur animal waste ka useful energy me conversion hota hai.

• Low Carbon Emissions:

Biomass se pollution kam hota hai compared to coal ya petrol.

Energy Security:
 Local areas me apni energy generate kar sakte hain, kisi aur par depend nahi karna padta.

Real-life Example:

Punjab aur Haryana me fasal ke waste ka use karke biogas plants me energy produce hoti hai.

13. Importance of Non-Conventional Energy Sources

Explanation:

Non-conventional sources jaise solar, wind, tidal, geothermal energy important hain future ke liye, kyunki traditional fuels (coal, oil) limited hain aur pollution badhate hain.

Importance Points:

- Environment Friendly:
 - Pollution kam hota hai, global warming se fight karne me help milti hai.
- Renewable:
 - Suraj, hawa, paani kabhi khatam nahi hote, isliye ye sustainable hain.
- Energy Security:
 - Apna energy source hone se desh ko import karne ki zarurat nahi padti (foreign oil/gas ka kam use).
- Cost Effective (Long Term):
 Pehle investment zyada hai, lekin baad me maintenance cost bahut kam hoti hai.

Real-life Example:

India ka target hai 2030 tak apni 50% electricity renewable sources se generate karna.

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Qr	1 Topic	Key Points
9	Factors of Wind Energy	Wind speed, air density, tower height, blade design
10	Applications of Geothermal Energy	Electricity, space heating, greenhouse heating, hot water
11	Solar Energy Storage	Battery storage, thermal storage, mechanical storage
12	Advantages of Biomass Energy	Renewable, reduces waste, low emissions, energy security
13	Importance of Non-conventional Energy	Environment friendly, renewable, energy security, cost- effective

Qn 2 to 8 Detailed Explanation (Hinglish):

2. Nuclear Power Plant aur Hydroelectric Power Plant ke beech Farak:

Nuclear Power Plant:

- Yahan nuclear fission hota hai, jisme Uranium ya Plutonium ke atoms ko tod kar heat energy produce karte hain.
- Ye heat paani ko steam me badalti hai, aur steam turbines ghumakar electricity generate hoti hai.

Hydroelectric Power Plant:

- Isme water ke flow (river ya dam ke water) se turbines ghoomte hain aur electricity generate hoti hai
- Water ka potential energy → kinetic energy → mechanical energy → electrical energy me convert

Real Life Example:

- Nuclear: Kudankulam Nuclear Power Plant (Tamil Nadu)
- Hydroelectric: Bhakra Nangal Dam (Punjab)

3. Terrestrial Solar Radiation kya hai?

Answer:

- Jo solar radiation sun se nikal kar directly Earth surface tak aati hai usko Terrestrial Solar Radiation bolte hain.
- Isme 3 type ke radiation aate hain:
 - o Direct Radiation (seedha sunlight)
 - Diffuse Radiation (clouds se scattered)
 - o Reflected Radiation (surface se reflected light)

Real Life Example:

- Jab din me clear sky hota hai aur dhoop sidha padti hai, to direct radiation milti hai.
- Jab badal hote hain aur phir bhi light aa rahi hoti hai, to wo diffuse radiation hoti hai.

4. Wind Energy ka Safety aur Environmental Impact:

Safety:

- Blades ghoomne ke wajah se kabhi kabhi bird collision hota hai.
- High wind speed pe blades damage hone ka risk hota hai.
- Human ke liye generally safe hai, bas maintenance important hai.

Environmental Aspects:

- Wind energy pollution free hai (no CO₂ emission).
- Land space use hota hai, lekin agricultural land ke sath compatible hai (khet me bhi windmills lag sakti hain).
- Visual aur noise pollution thoda hota hai (wind turbine ka sound).

Real Life Example:

 Rajasthan aur Gujarat me bade bade wind farms hain jo safe aur eco-friendly energy provide karte hain.

5. Coal Energy Reservoirs kya hote hain?

Answer:

- Earth ke andar jahaan coal ki natural deposits hoti hain, unko Coal Energy Reservoirs bolte hain.
- Coal ek fossil fuel hai jo millions of years me plant matter ke compress hone se bana hai.

Use:

- Electricity generate karne ke liye
- Steel industry me heat provide karne ke liye
- Cement manufacturing me fuel ke roop me

Real Life Example:

 India me Jharia Coalfield (Jharkhand) aur Raniganj Coalfield (West Bengal) famous coal reservoirs hain.

6. Renewable Energy kya hoti hai?

Answer:

- Jo energy sources nature me baar-baar regenerate ho sakti hain unko Renewable Energy kehte hain.
- Ye kabhi khatam nahi hoti, eco-friendly hoti hai.

Types:

- Solar Energy
- Wind Energy
- Biomass Energy
- Hydro Energy
- Geothermal Energy

Real Life Example:

• Solar panels lagake ghar ka electricity bill zero karna renewable energy ka best use hai.

7. Solar Photovoltaic Power ke Applications:

(Ye already upar bhi likha tha, short me phir se:)

Applications:

Ghar ki electricity

- **Solar Street Lights**
- **Solar Water Pumps**
- Remote villages me electrification
- Solar Mobile Chargers

Real Life Example:

India ka Gujarat Charanka Solar Park duniya ke largest solar projects me se ek hai.

8. Biomass Gasifier ka Use:

(Ye bhi upar touch hua tha, ab thoda aur easy me:)

Answer:

- Biomass Gasifier ek machine hai jo wood, husk, ya cow dung jaise biomass ko heat karke gas banata hai.
- Ye gas ko phir electricity generate karne ya cooking ke liye use kar sakte hain.

Benefits:

- Renewable source hai
- Waste ka useful energy me conversion hota hai
- Environment friendly

Real Life Example:

Villages me chhote biomass gasifier lagake pura ek gaon ka light aur cooking ka problem solve kiya ja sakta hai.

Quick Table for Qn 2 to 8 Revision:

Qn Topic Short Answer 2 Nuclear vs Hydro **Nuclear fission vs Water flow** 3 Terrestrial Radiation Sunlight Earth surface tak 4 Wind Energy Safety Bird collision, no pollution 5 Coal Energy Reservoirs Natural coal deposits 6 Renewable Energy Solar, Wind, Hydro, Biomass

7 Solar PV Applications

Homes, Street Lights, Pumps

8 Biomass Gasifier Biomass to useful gas

9. Construction aur Working of Wind Power Generator:

Construction:

- Tower: Ek strong pole hota hai jo blades aur generator ko support karta hai.
- Rotor Blades: Ye air flow (hawa) se energy capture karte hain.
- Nacelle: Iske andar gear box, generator aur control systems hote hain.
- Gear Box: Low speed ko high speed me convert karta hai.
- Generator: Mechanical energy ko electrical energy me badalta hai.
- Controller: System ka smooth operation ensure karta hai.

Working:

- Jab hawa blades pe lagti hai, to blades ghoomte hain (rotation).
- Blades ke rotation se shaft move karti hai, gear box se speed badh jati hai.
- . Generator me mechanical energy ko electrical energy me convert kiya jata hai.
- Phir ye electricity grid me bheji ja sakti hai ya battery me store hoti hai.

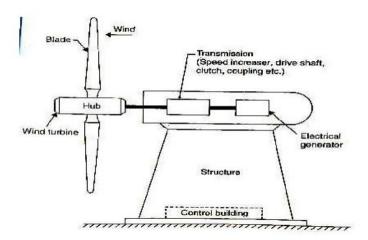


Figure: Wind-Electric generating power plant

Real Life Example:

 Gujarat ka Mupandal Wind Farm (Asia ka sabse bada wind farm) aise hi turbines se electricity generate karta hai.

10. Solar Angle Calculation (Flat Plate Collector ka Angle):

Given:

- Latitude = 28° 35' N
- Time = 9:00 am IST
- Solar angles calculate karne ke liye Declination angle (δ), Hour angle (H), aur Solar altitude angle
 (α) important hote hain.

Solar Tilt Angle:

- Ideal solar panel ka tilt angle ≈ Latitude ± Seasonal adjustment.
- For Delhi (around 28° N):
 - o Summer me: tilt kam (almost horizontal)
 - Winter me: tilt zyada (around 28°-30°) hota hai.

Formula Concept:

- Declination angle (δ): Sun ka Earth ke respect me tilt.
- Hour angle (H): Noon ke time ka difference in degrees (1 hour = 15°).

Simple Understanding:

Flat plate collector ka tilt aise rakhna chahiye taaki maximum sunlight directly panel pe padhe.

Real Life Example:

 Delhi NCR ke homes me solar panels ko around 30° ke tilt pe lagate hain taaki saal bhar maximum efficiency mile.

11. Solar Collector ke Types:

Types of Solar Collectors:

- 1. Flat Plate Collector:
 - o Simple design, low cost.
 - o Mostly ghar ke water heating me use hota hai.
- 2. Concentrating Collector:
 - o Sunlight ko ek point pe concentrate karta hai.
 - High temperature applications ke liye (industrial steam etc.)
- 3. Evacuated Tube Collector:
 - o High efficiency, vacuum tubes use karta hai.
 - o Cold areas ke liye best.

Real Life Example:

- Ghar ke rooftop pe jo black panel lage hote hain water heater ke liye wo Flat Plate Collectors hote hain.
- Industrial plants me solar steam generation ke liye Concentrating Collectors use hote hain.

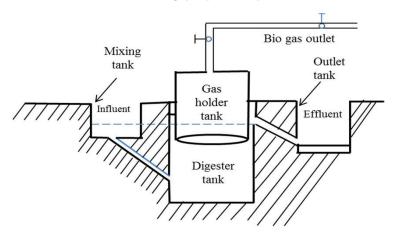
12. Biogas Plant:

Working:

- Kitchen waste, cow dung, agricultural waste ko ek closed tank (digester) me daala jata hai.
- Anaerobic bacteria (oxygen ke bina wale bacteria) ye organic matter ko digest karte hain.
- Is process se methane gas (biogas) nikalti hai jo fuel ki tarah kaam karti hai.
- Baaki ka waste (slurry) ko fertilizer ke roop me fields me daala ja sakta hai.

Advantages:

- Renewable energy hai.
- · Waste ka useful conversion hota hai.
- Environment friendly (no pollution).



Real Life Example:

• Villages me Gaushalas (cow shelters) me biogas plants lagaye jaate hain jisse log cooking ke liye gas use karte hain aur slurry se kheti karte hain.

13. Fuel Cell System aur Geothermal Energy:

Fuel Cell System:

- Ek electrochemical device hai jo hydrogen aur oxygen ka chemical reaction karwa kar electricity generate karta hai.
- Ye pollution free hota hai byproduct sirf water hota hai.

Applications:

- Electric Vehicles (EVs) me.
- Space missions (NASA use karta hai fuel cells).

Real Life Example:

• Toyota Mirai car ek hydrogen fuel cell car hai.

Geothermal Energy:

- Earth ke andar ka heat (core se) nikal kar jab hum energy banate hain to usse geothermal energy kehte hain.
- Geothermal plants Earth ke andar ke hot water ya steam se turbine chala kar electricity generate karte hain.

Real Life Example:

- Puga Valley (Ladakh, India) me geothermal projects chal rahe hain.
- USA ka The Geysers (California) duniya ka largest geothermal field hai.

✓ Quick Summary Table (9-13)

Qn Topic Short Answer

9 Wind Power Generator Blades rotate, generator electricity banata

10 Solar Angle Calculation Collector tilt ≈ 28° for Delhi

11 Solar Collector Types Flat Plate, Concentrating, Evacuated Tube

12 Biogas Plant Waste se gas + fertilizer

13 Fuel Cell System / Geothermal Energy Hydrogen fuel cell, Earth ke andar ka heat

Extra Tip for Exam:

- Har answer me definition + working + advantage + real life example likhna = full marks milte
 hain!
- Diagrams banana zaroori hai jaise Windmill ka simple structure, Biogas plant ka simple flow diagram.