Challenges in Renewable Energy

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ENERGY CLASSIFICATION

ENERGY CAN BE CLASSIFIED BASED ON THE CRITERIA

- **PRIMARY ENERGY AND SECONDARY ENERGY** (OIL, GAS, BIOMASS & ELECTRICITY, STEAM)
- **COMMERCIAL ENERGY AND NON-COMMERCIAL ENERGY** (ELECTRICITY, COAL PEROLEUM PRODUCT, WOOD COW DUNG)
- **RENEWABLE AND NON-RENEWABLE**
- RECENTLY, INDIA STANDS 4TH IN SOLAR PV DEPLOYMENT ACROSS THE GLOBE AS ON END OF 2021. SOLAR POWER INSTALLED CAPACITY HAS REACHED AROUND 61.97 GW AS ON 30TH NOVEMBER, 2022. PRESENTLY, SOLAR TARIFF IN INDIA IS VERY COMPETITIVE

- DESPATCHABLE POWER >> COAL CAN PROVIDE
- SOALR >> OFFGRID IS OK

- WHILE CHINA, INDIA AND NUMEROUS SOUTHEAST ASIAN COUNTRIES EXPERIENCED ROBUST GROWTH IN ELECTRICITY DEMAND IN 2023, ADVANCED ECONOMIES POSTED SUBSTANTIAL DECLINES DUE TO A LACKLUSTRE MACROECONOMIC ENVIRONMENT AND HIGH INFLATION, REDUCING MANUFACTURING AND INDUSTRIAL OUTPUT.

SUSTAINABLE ENERGY SOURCE

SUSTAINABLE ENERGY CONVERSION

SUSTAINABLE ENERGY UTILIZATION

WASTE UPCYCLE

1. Sustainable Energy Sources

Solar Energy

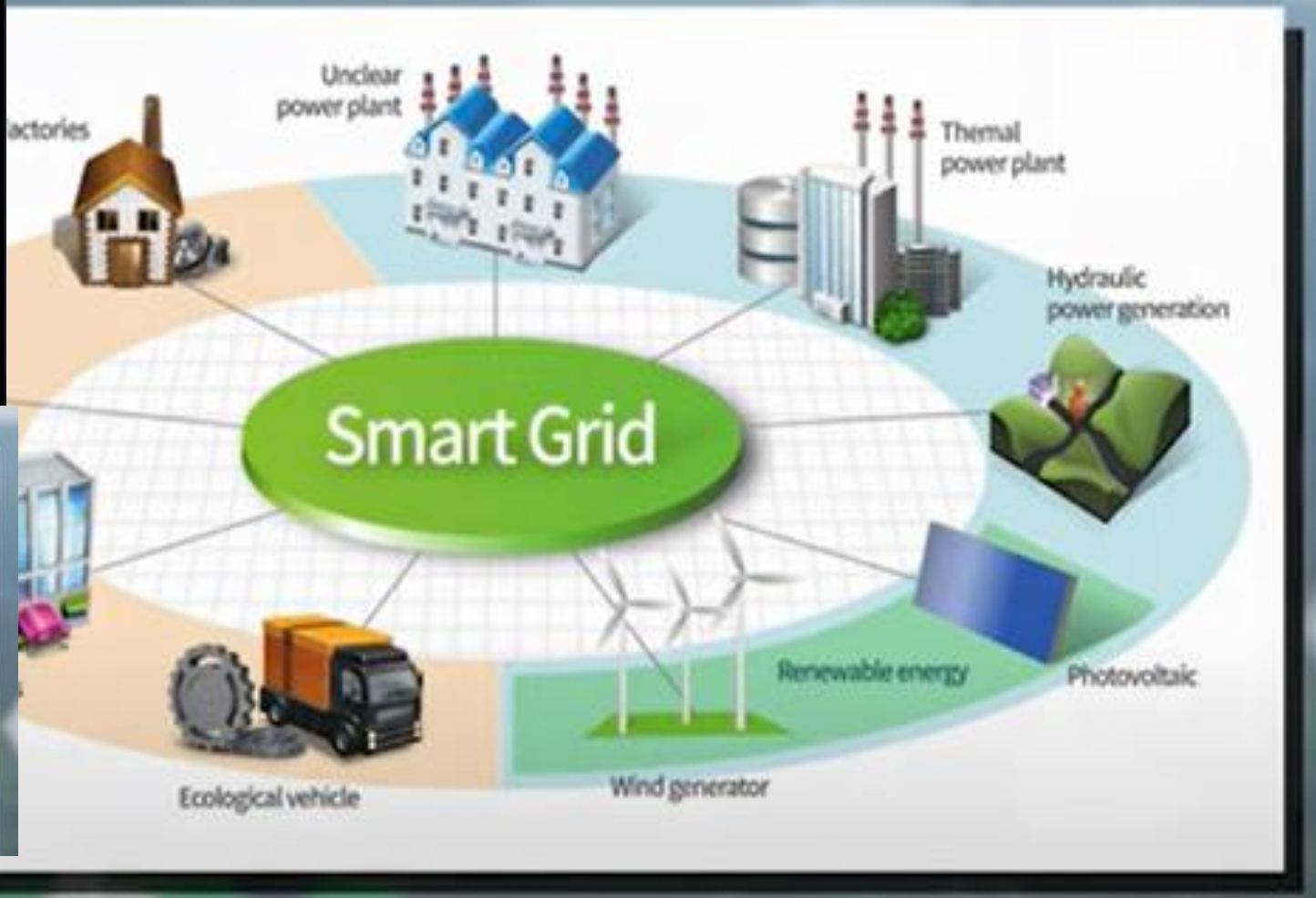
Wind Energy

Water Energy

Biomass Energy

2. Sustainable Energy Conversion

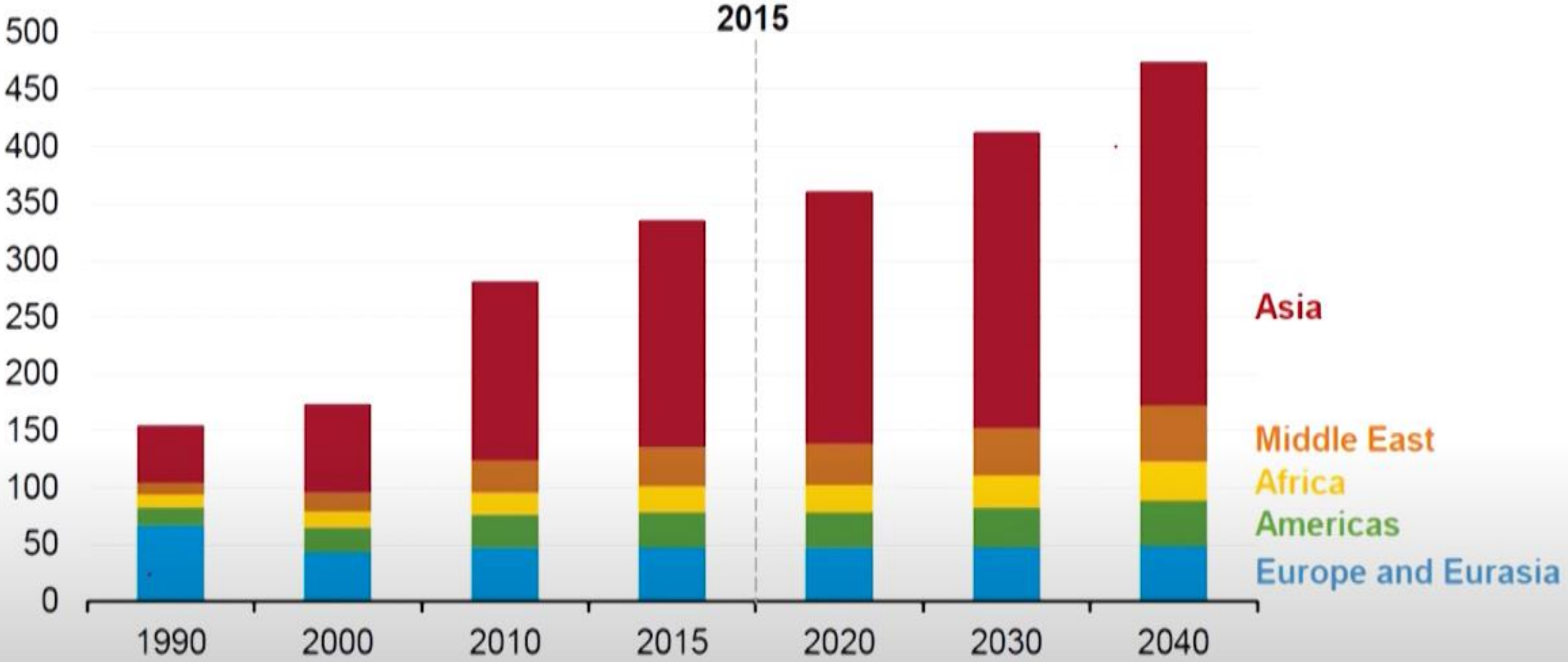
3. Sustainable Energy Utilization



4. Waste to Energy

World energy scenario

Non-OECD energy consumption by region

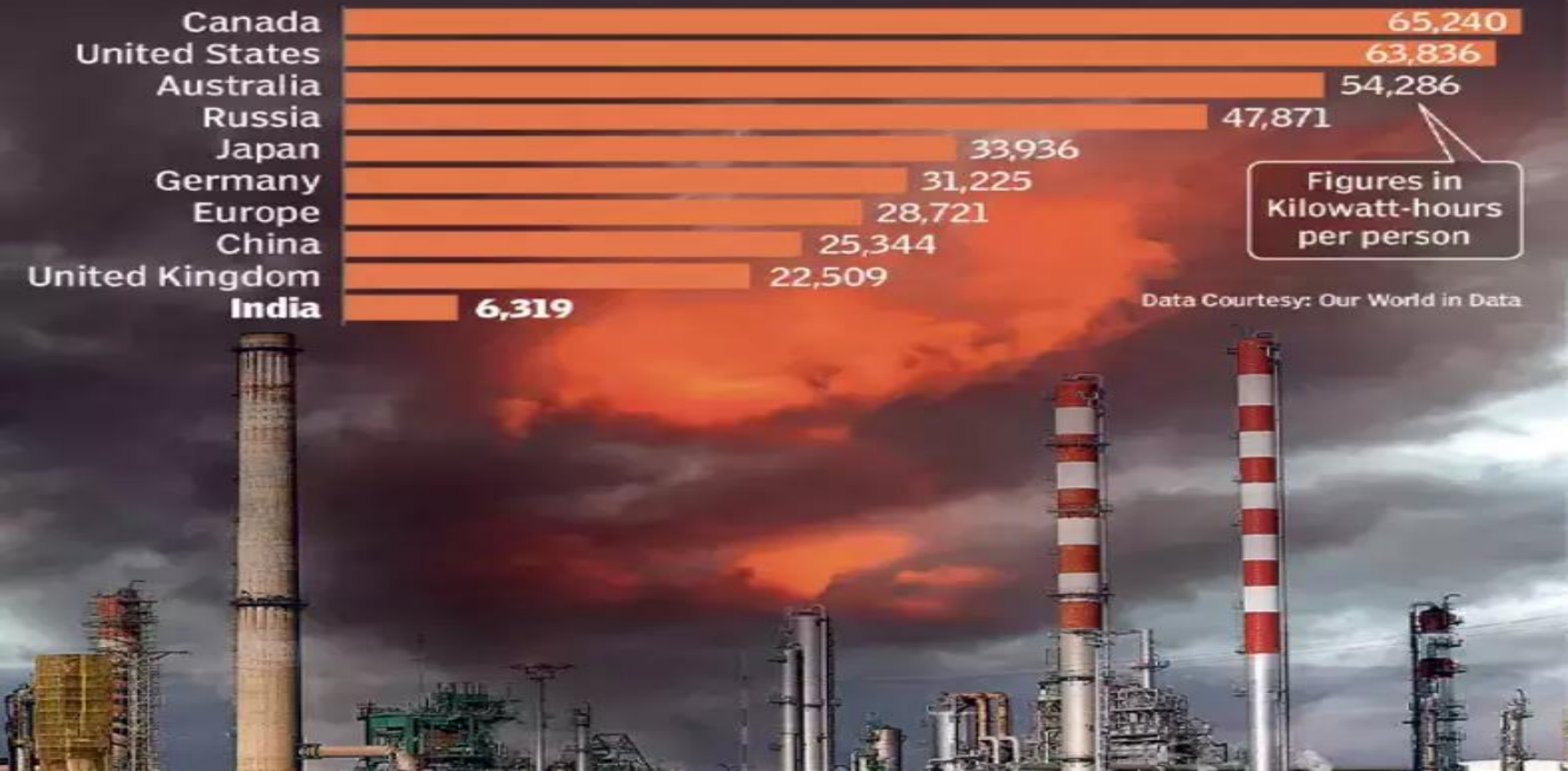


International Energy Outlook 2017

U.S. Energy Information Administration

AS THE WORLD WARMS: FOSSIL FUEL CONSUMPTION GLOBALLY

Despite the science, developed economies still lead in the average consumption of energy from coal, oil and gas (kilowatt-hours per person) as recorded in 2022



MAJOR CHALLENGES IN RENEWABLE ENERGY

INTERMITTENCY AND VARIABILITY

- RENEWABLE ENERGY SOURCES ARE SUBJECT TO FLUCTUATION DUE TO WEATHER CONDITIONS OR TIME OF DAY. THIS INTERMITTENCY POSES CHALLENGES TO GRID STABILITY AND NECESSITATES EFFECTIVE ENERGY STORAGE SOLUTIONS TO STORE EXCESS ENERGY DURING PEAK PRODUCTION FOR USE DURING LOW-GENERATION PERIODS.

COST AND ECONOMICS:

- WHILE RENEWABLE ENERGY COSTS HAVE DECREASED SIGNIFICANTLY OVER THE YEARS, INITIAL CAPITAL INVESTMENTS REMAIN HIGH. ADDITIONALLY, THE LEVELIZED COST OF ELECTRICITY (LCOE) FOR RENEWABLES MUST BE COMPETITIVE WITH FOSSIL FUELS TO ENCOURAGE BROADER ADOPTION. CONTINUED ADVANCEMENTS IN TECHNOLOGY AND ECONOMIES OF SCALE ARE CRUCIAL FOR COST REDUCTIONS.

INFRASTRUCTURE AND GRID INTEGRATION:

- THE TRANSITION TO RENEWABLE ENERGY REQUIRES EXTENSIVE INFRASTRUCTURE DEVELOPMENT, INCLUDING EXPANDING TRANSMISSION NETWORKS TO CONNECT REMOTE RENEWABLE RESOURCES TO POPULATION CENTERS. UPGRADING EXISTING GRIDS TO ACCOMMODATE BIDIRECTIONAL POWER FLOW AND BALANCING SUPPLY AND DEMAND IS VITAL FOR SMOOTH INTEGRATION.

PUBLIC ACCEPTANCE AND POLICY SUPPORT:

- RENEWABLE ENERGY PROJECTS OFTEN FACE OPPOSITION, KNOWN AS NIMBY (NOT IN MY BACKYARD) SENTIMENT, DUE TO CONCERNS ABOUT VISUAL IMPACTS, NOISE, OR POTENTIAL ENVIRONMENTAL CONSEQUENCES. FURTHERMORE, INCONSISTENT GOVERNMENT POLICIES AND REGULATORY BARRIERS CAN HINDER RENEWABLE ENERGY GROWTH. ENSURING PUBLIC ACCEPTANCE AND PROVIDING STABLE POLICY FRAMEWORKS ARE ESSENTIAL FOR OVERCOMING THESE CHALLENGES

ADVANCEMENTS IN ENERGY STORAGE:

- ENERGY STORAGE TECHNOLOGIES PLAY A CRITICAL ROLE IN ADDRESSING INTERMITTENT RENEWABLE ENERGY GENERATION. BATTERIES AND GRID-SCALE STORAGE SYSTEMS ENABLE THE EFFICIENT UTILIZATION OF EXCESS ENERGY DURING HIGH-GENERATION PERIODS. ADDITIONALLY, THE USE OF HYDROGEN AS AN ENERGY CARRIER SHOWS PROMISE FOR LONG-DURATION STORAGE AND DIVERSE ENERGY APPLICATIONS.

SMART GRIDS AND DIGITALIZATION:

- IMPLEMENTING SMART GRIDS ENABLES EFFICIENT DEMAND-SIDE MANAGEMENT, FACILITATING LOAD BALANCING AND REDUCING ENERGY WASTE. DIGITALIZATION IMPROVES GRID OPTIMIZATION, REAL-TIME MONITORING, AND CONTROL, ENHANCING THE INTEGRATION OF RENEWABLE ENERGY SOURCES AND MAXIMIZING THEIR UTILIZATION. SMART GRIDS ALSO ENABLE THE SEAMLESS INTEGRATION OF ELECTRIC VEHICLES, FURTHER PROMOTING CLEAN ENERGY ADOPTION.

RESEARCH AND DEVELOPMENT:

- CONTINUED INVESTMENT IN RESEARCH AND DEVELOPMENT IS VITAL FOR OVERCOMING RENEWABLE ENERGY CHALLENGES. IMPROVING THE EFFICIENCY AND PERFORMANCE OF RENEWABLE TECHNOLOGIES, DEVELOPING NEW MATERIALS AND TECHNOLOGIES, AND EXPLORING INNOVATIVE APPROACHES WILL DRIVE PROGRESS IN THE FIELD. COLLABORATION BETWEEN INDUSTRY, ACADEMIA, AND GOVERNMENTS IS KEY TO FOSTERING INNOVATION.

GRID FLEXIBILITY AND VIRTUAL POWER PLANTS

- : GRID FLEXIBILITY REFERS TO THE ABILITY TO BALANCE SUPPLY AND DEMAND FLUCTUATIONS IN REAL TIME. VIRTUAL POWER PLANTS (VPPS) INTEGRATE MULTIPLE RENEWABLE ENERGY SOURCES, ENERGY STORAGE SYSTEMS, AND DEMAND RESPONSE MECHANISMS. BY AGGREGATING THESE RESOURCES, VPPS CAN OPTIMIZE ENERGY GENERATION AND CONSUMPTION, ENHANCE GRID STABILITY, AND PROVIDE ANCILLARY SERVICES TO SUPPORT THE OVERALL GRID OPERATION.

BLOCKCHAIN TECHNOLOGY

- : BLOCKCHAIN TECHNOLOGY OFFERS POTENTIAL SOLUTIONS FOR ENERGY SECTOR CHALLENGES, INCLUDING ENHANCING TRACEABILITY AND TRANSPARENCY IN RENEWABLE ENERGY TRANSACTIONS, OPTIMIZING PEER-TO-PEER ENERGY TRADING, AND ENABLING MORE EFFICIENT GRID MANAGEMENT. SMART CONTRACTS AND DECENTRALIZED PLATFORMS CAN FACILITATE SECURE AND AUTOMATED ENERGY TRANSACTIONS, EMPOWERING CONSUMERS TO PARTICIPATE IN THE ENERGY MARKET.

ADVANCED MONITORING AND PREDICTIVE ANALYTICS

- DEPLOYING ADVANCED MONITORING SYSTEMS AND PREDICTIVE ANALYTICS IN RENEWABLE ENERGY INSTALLATIONS CAN OPTIMIZE PERFORMANCE, DETECT FAULTS, AND FACILITATE PREDICTIVE MAINTENANCE. REAL-TIME MONITORING OF RENEWABLE ENERGY ASSETS ALLOWS FOR EARLY DETECTION OF ISSUES, ENABLING PROMPT ACTIONS TO PREVENT SYSTEM FAILURES AND MAXIMIZE ENERGY GENERATION.

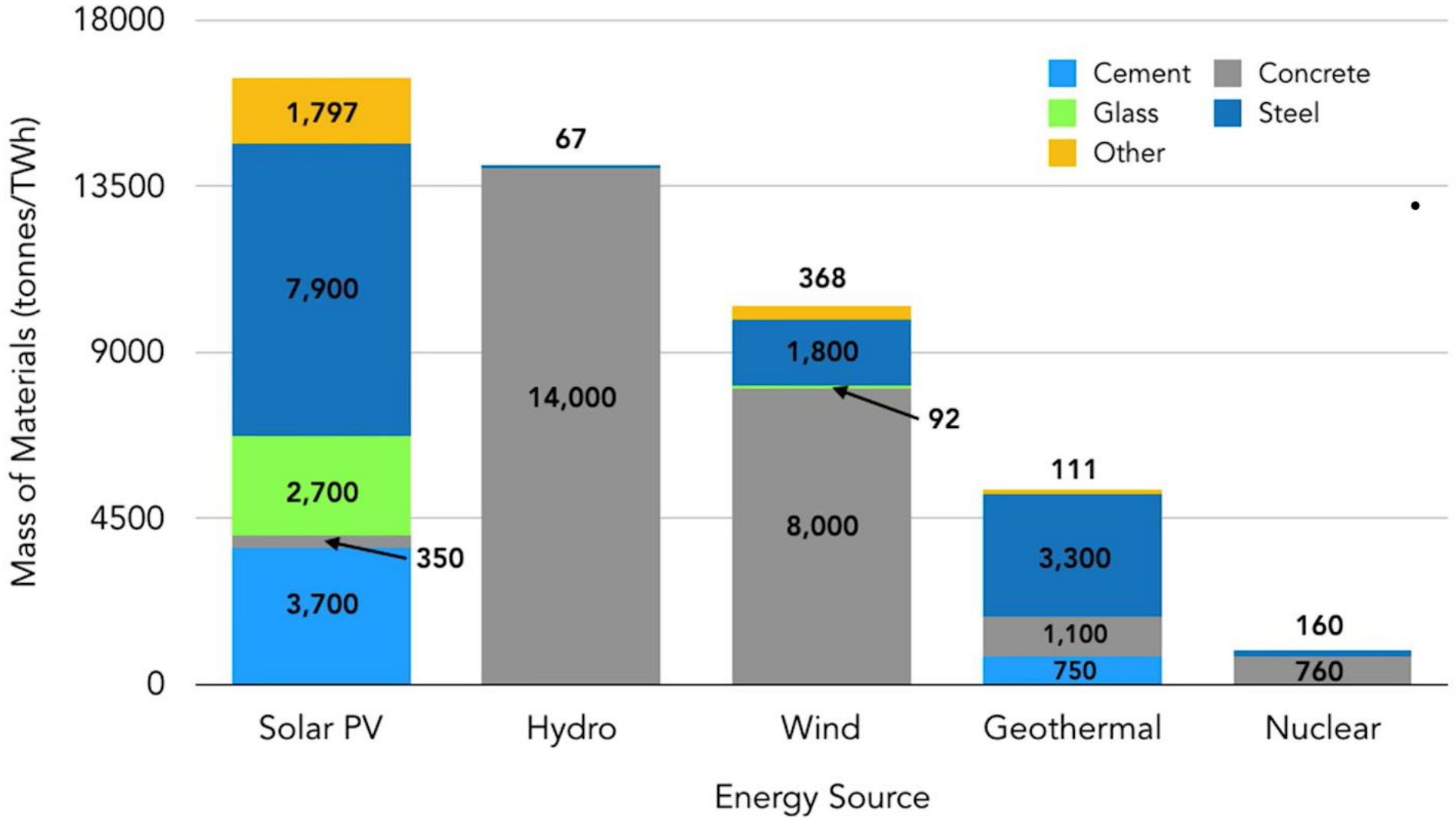
ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

- ARTIFICIAL INTELLIGENCE (AI) AND MACHINE LEARNING (ML) ALGORITHMS CAN OPTIMIZE RENEWABLE ENERGY GENERATION AND CONSUMPTION BY ANALYZING VAST AMOUNTS OF DATA. AI AND ML CAN ENABLE ACCURATE WEATHER FORECASTING FOR RENEWABLE ENERGY GENERATION, OPTIMIZE ENERGY DISTRIBUTION AND STORAGE, AND IMPROVE LOAD FORECASTING, ENHANCING GRID MANAGEMENT AND EFFICIENCY.

CONCLUSION

- RENEWABLE ENERGY OFFERS A PROMISING PATHWAY TO A SUSTAINABLE FUTURE, BUT IT IS NOT WITHOUT ITS CHALLENGES.
- OVERCOMING ISSUES OF INTERMITTENCY, COST, INFRASTRUCTURE, AND PUBLIC ACCEPTANCE REQUIRES COLLABORATIVE EFFORTS, TECHNOLOGICAL INNOVATION, AND SUPPORTIVE POLICIES.
- BY INVESTING IN RESEARCH AND DEVELOPMENT, IMPROVING ENERGY STORAGE SOLUTIONS, ADVANCING GRID INTEGRATION TECHNOLOGIES, AND FOSTERING PUBLIC AWARENESS, WE CAN NAVIGATE THE CHALLENGES AND UNLOCK THE FULL POTENTIAL OF RENEWABLE ENERGY.
- THE PATH TO A SUSTAINABLE FUTURE LIES IN OUR COLLECTIVE COMMITMENT TO ADDRESSING THESE CHALLENGES AND EMBRACING THE TRANSFORMATIVE POWER OF RENEWABLE ENERGY.

Materials throughput by type of energy source



ENVIRONMENTAL PROGRESS

"Quadrennial Technology Review: An Assessment of Energy Technologies and Research Opportunities," Table 10. September 2015. United States Department of Energy. Nuclear and hydro require 10 tonnes/TWh and 1 tonne/TWh of other materials, respectively, but are unable to be labeled on the graph.


THANK YOU