Climate Services for Energy - Role of Climate Data in Power Sector

National Framework of Climate Services (NFCS) Meet, Lavasa, Pune

Technology-Automation AI Machine Learning for Growth and Sustainability

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Meteorological Data - Crucial role in the Energy / Power Sector

Power Sector

- **Power Planning**

  [Infrastructure: Generation, Transmission and Distribution Capacity Planning

  Planning: Generation, Transmission and Distribution
  - Capital Investment
  - Time to Operate and/ or Market
  - Payback period & Feasibility: Cost Benefit Analysis
- **Power Generation** – Production Quantity
  - Raw Material Planning and Readiness
  - Manpower Planning
- **Operation & Maintenance (incld. Power Trading*)**
  - Quantity based on demand – incld. Asset Management
  - Sale and Buy decision making for Generation and Distribution – DAM*, RTM*, etc. vs. PPA

  * **Market price determination**

Historical Data, Current Data and Predicted Data all are equally important

Harnessing the Blessing in disguise - India

- We are a diverse country – Advantage of India‘s diversity
  - Slightly more than 2 hours -> hence it is 14 Hours [Laterally: Like Onsite - Offshore Model in IT Industry]
  - Helps in arresting Sunlight for longer period and instead of storing can be transmitted to neighbouring states/ cities instead of costly storing and losing energy due to technical inefficiency

Climate Impacts on Energy Systems - Key issues for energy sector adaptation

Sr. #	Hydro-meteorological and/or Climate Parameter	Impacts and Usages in Energy Production and Services
1	Air temperature	Turbine production efficiency, Demand (cooling/heating), Demand simulation/modelling, solar PV panel efficiency
2	Rainfall	Hydro-generation potential and efficiency, biomass production, demand simulation/modelling
3	Wind speed and/or direction	Wind generation potential and efficiency, demand simulation/modelling
4	Cloudiness	Solar generation potential, demand simulation/modelling
5	Snowfall and ice accretion	Power line maintenance, demand simulation/modeling
6	Humidity	Demand simulation/modeling
7	Short-wave radiation	Solar generation potential and output, output modeling, demand simulation/modeling

Source: World Bank ESMAP- Energy Sector Management Assistance Program

Climate Impacts on Energy Systems - Key issues for energy sector adaptation

Sr. #	Hydro-meteorological and/or Climate Parameter	Impacts and Usages in Energy Production and Services
8	River flow	Hydro-generation and potential, hydro-generation modelling (including dam control), power station cooling water demands
9	Coastal wave height and frequency, and statistics	Wave generation potential and output, generation modeling, off-shore infrastructure protection and design
10	Sub-surface soil temperatures	Ground source generation potential and output
11	Flood statistics	Raw material production and delivery, infrastructure protection and design, cooling water demands
12	Drought statistics	Hydro-generation output, demand of energy for drought management
13	Storm statistics (includes strong winds, heavy rain, hail, lightning)	Infrastructure protection and design, demand surges
14	Sea level	Offshore Energy / Power operations

Source: World Bank ESMAP- Energy Sector Management Assistance Program

Climate Data – Usages and Importance

- **Load Forecasting – Distribution & Generation**
  - Weather conditions influence power demand patterns [Heating & Cooling Effect & Control]
  - Load forecasting models, helps planning electricity demand due to temperature variations

- **Hydroelectric Power**
  - Hydroelectric power generation depends on water availability and precipitation patterns
  - Data (including rainfall and snowfall forecasts) helps hydropower operators manage reservoir levels and plan generation schedule (in collaboration with other stakeholders)

Climate Data – Usages and Importance

- **Renewable Energy Forecasting**

  [expected energy output and optimize integration of variable resources into the grid]

  - Essential for predicting the availability of renewable energy sources
    - Wind Power - Wind Speed
    - Solar Power - Solar Radiation and Temperature

  - Renewable Energy Site Selection
    - Wind farms or solar installations – Assessment of long-term wind speed and solar radiation patterns at potential sites
    - Viability/ Feasibility and expected energy output

    [Satellite Image Processing to identify barrel land and assess feasibility for Solar/ Wind installation]

Climate Data – Usages and Importance

- **Transmission Line Maintenance**
  - Severe weather conditions lead to damage to transmission lines / towers
  - Meteorological data helps predict the events and schedule maintenance to prevent outages

- **Energy Trading**
  - Energy markets are influenced by weather patterns
  - Traders/ market analysts make informed decisions for energy trading and pricing

Climate Data – Usages and Importance

- **Grid Management**
  - Weather conditions significantly impacts the stability and reliability of the electrical grid.
  - Severe weather events e.g. storms, hurricanes, and extreme temperatures leads to power outages and grid disturbances
  - Meteorological data used to anticipate these events & allow grid operators for preventive measures/ respond

- **Disaster Preparedness**
  - Essential for disaster preparedness and recovery efforts
  - To develop contingency plans for extreme weather events for rapid restoration of power

Climate Data - Few Critical Impacts and Thoughts (Incld. Associated)

- **Power Demand specially Peak Demand Forecasting –**
  National Level and City Level
  - Planning for Infrastructure
  - Generation and Distribution

- **SMART Meter Analytics**
  - Fine-tuning the planning of future infrastructure and hence investment
  - Load Balancing
  - Effectiveness of Micro-grid and Net Export/ Import

- **Block Chain – Trading & AT&C Loss**

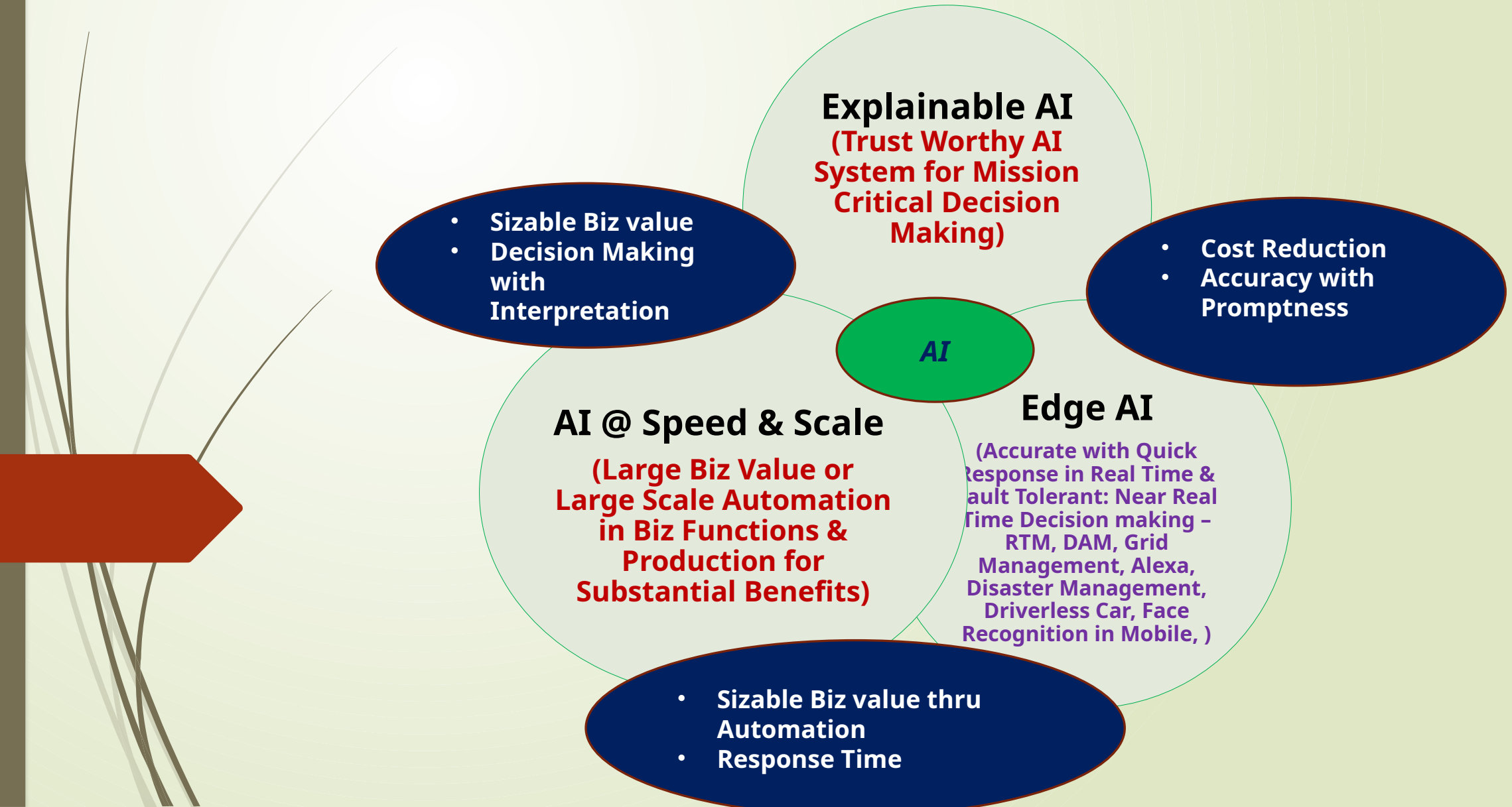
Climate Data - Few Critical Impacts and Thoughts (Incld. Associated)

- **Power Trading**
  - Load Forecasting
  - Power Pricing/ Market Pricing [PPA – Hedging and Challenge for Consumers]
  - Market Cap Price and Energy Starvation

- **Green Energy Transition**
  - Investment
  - Insurance
  - Green Taxonomy –
    EU, China, UK, Canada, Australia, Japan, South Korea, Singapore, USA

AI and Machine Learning: Technology for Analytics and Automation

Contextual Artificial Intelligence & Machine Learning using Climate Data



Technology – Big Data Analytics, Block Chain and AI Machine Learning

Few Nuances and Challenges

Data Visualization – Visibility – Analysis – Prediction – Decision Making

- Power of Technology & Computing Power
  - Big Data
    - Volume of Data
    - Velocity of Data
    - Storage of Data
    - Retrieving of Data
    - Unstructured Data – Image Processing
  - Block Chain – Security vs Carbon Emission /Heat Generation
  - AI Machine Learning

SDG: 17 Sustainable Development Goals

For any query/ clarification or further information please contact

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Thank You