

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

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



Machine Learning



Artificial Intelligence



Big Data Analytics



Image Processing



Internet of Things



RPA

**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** (incl. Power Trading*)
 - Quantity based on demand – incl. 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

- **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)

- **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 barren land and assess feasibility for Solar/ Wind installation]

- **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

- **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 (Incl. Associated)

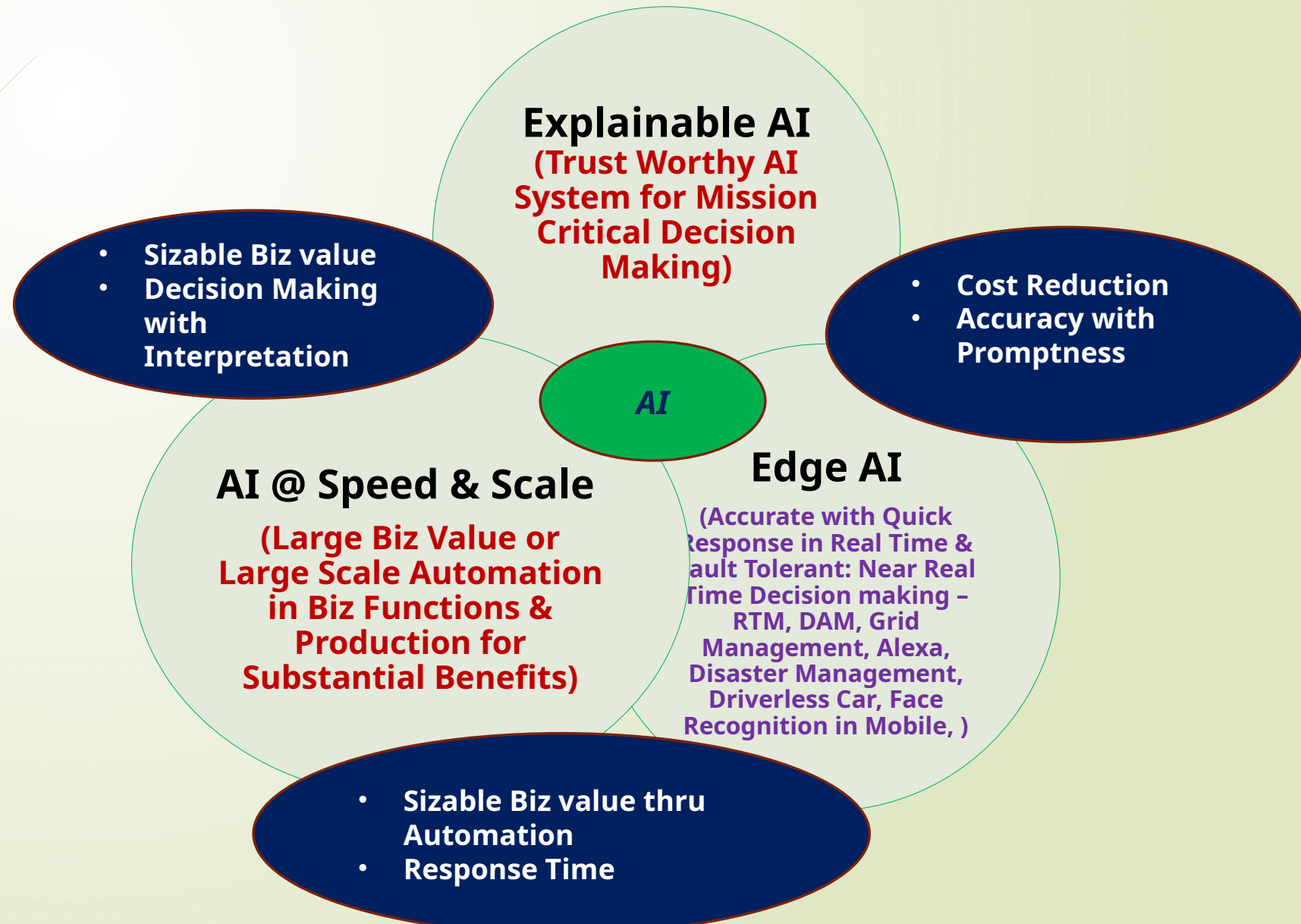
- **Power Demand specially Peak Demand Forecasting –**
National Level and City Level
 - Planning for Infrastructure
 - Generation and Distribution
- **SMART Meter Analytics**
 - Fine-tuning the planning of future infrastructure and hence investment
 - Load Balancing
 - Effectiveness of Micro-grid and Net Export/ Import
- **Block Chain – Trading & AT&C Loss**

Climate Data - Few Critical Impacts and Thoughts (Incl. 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



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



SUSTAINABLE DEVELOPMENT GOALS

1 NO POVERTY

An icon representing a family of four people (two adults and two children) standing together.

2 ZERO HUNGER

An icon of a white bowl with three wavy lines above it, representing steam or food.

3 GOOD HEALTH AND WELL-BEING

An icon showing a white heartbeat line (EKG) ending in a heart shape.

4 QUALITY EDUCATION

An icon of an open book with a pencil resting on it.

5 GENDER EQUALITY

An icon of the gender equality symbol, which is a circle with an equals sign inside, and a cross and a triangle on the right side.

6 CLEAN WATER AND SANITATION

An icon of a water tap with a single drop of water falling from it.

7 AFFORDABLE AND CLEAN ENERGY

An icon of a sun with a power button symbol (a circle with a vertical line) in the center.

8 DECENT WORK AND ECONOMIC GROWTH

An icon of a bar chart with an upward-pointing arrow, symbolizing growth.

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

An icon of three white cubes stacked on top of each other.

10 REDUCED INEQUALITIES

An icon of a double-headed arrow with three horizontal bars in the center, representing balance or equality.

11 SUSTAINABLE CITIES AND COMMUNITIES

An icon of several stylized city buildings of varying heights.

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

An icon of a white infinity symbol, representing a continuous cycle.

13 CLIMATE ACTION

An icon of an eye where the pupil is a globe of the Earth.

14 LIFE BELOW WATER

An icon showing three wavy lines representing water and a fish swimming below them.

15 LIFE ON LAND

An icon of a tree with two birds flying in the sky above it.

16 PEACE, JUSTICE AND STRONG INSTITUTIONS

An icon of a white dove holding an olive branch, with a gavel below it.

17 PARTNERSHIPS FOR THE GOALS

An icon of five interlocking circles, representing a network or partnership.

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प्रावीण्यं परोपवृत्तिश्च

NFCS – IMD Delhi & Pune, MoES, GOI, at Lavasa Pune on 5-6 Oct 2023

For any query/ clarification or further information please contact

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Thank You