MINUTES OF THIRTEENTH MEETING OF FORUM OF REGULATORS (FOR) "TECHNICAL COMMITTEE FOR IMPLEMENTATION OF FRAMEWORK ON RENEWABLES AT THE STATE LEVEL"

Venue	:	Hotel JehanNuma Palace 57, Shamla Hill, Bhopal, Madhya Pradesh 462013
Date	:	4th August 2017
List of Participants	:	At **Annexure (enclosed)**

1. Madhya Pradesh Chairperson Shri Birdi welcomed all attendees at the meeting. Shri A.S.Bakshi, Member CERC, thanked the Chairperson, Member and officials of MPERC for their warm hospitality and seamless logistics for the meeting.
   Shri Bakshi stated that the Committee has come a long way since its inception, and conveyed the progress achieved to Chairperson MPERC.
2. He mentioned that as various States issue Draft Forecasting & Scheduling Regulations for renewables, FOR Secretariat should send in comments on the drafts to the State Commissions. He also stated that review of implementation of regulations by States should be done at regular intervals.
3. ShriS.K.Chatterjee underscored the need for consistency in regulations at the Central and State level. Regulations on Forecasting & Scheduling, Ancillary Services and Reserves should be complimentary at the inter-State and State level.
4. He also updated the Committee regarding the technical support offered by USAID under the Greening the Grid program. USAID will be hiring a consultant who will provide ongoing technical assistance to the Committee.

Discussions on the Agenda

I. Update on SAMAST implementation, Forecasting & Scheduling Regulations

1) MP SLDC made a presentation (attached as ***Annexure-I***) on the status of implementation of ABT and DSM at the State level. The presentation included statistics on ABT meters, accounting, scheduling, etc.
2) ABT Meters:MP SLDC informed that about 1120 Nos. of ABT meters of 0.2s accuracy class have been installed at different interface as summarized in their presentation.
3) Scheduling & Despatch:MP SLDC performs scheduling of Intra State entities and also coordinates scheduling of Inter State Generating Stations (ISGS)

&IPPs in which they have share. DSM framework in MP has been in effect since 2008. Deviation for every intra-state entity is determined at rate as per CERC DSM Regulations. MP has a surplus of Rs.500 crores in the State DSM pool.

4) Given apprehensions of West Bengal on state pool potentially going into negative, it was decided that Shri Soonee will coordinate a meeting of WB and MP SLDCs/SERCs, so MP can illustrate solutions to gaps in implementation of DSM at the state level.
5) MP SLDC also informed that they are in the process of commissioning new integrated ABT, OA and MIS system which is expected to be completed by end of November 2017.
6) State of MP has submitted a DPR to PSDF to update the software for accounting, and has received a funding to the tune of INR 3.6 crores.
7) Further, they highlighted that as on 1 July 2017, total grid integrated RE installed capacity in MP is 3567 MW.
8) The State has also implemented metering for 106 out of 112 RE pooling stations. Forecasting and scheduling is taking place for 87 of these pooling stations. Solar plants selling inter-state are following CERC Regulations in this regard (presentation at ***Annexure-II***).
9) Shri Bajpai, Member MPERC, stated that Draft Ancillary Services Regulations are ready. Shri Bakshi appreciated leadership of Madhya Pradesh in implementation of various regulations. Shri Bakshi also said that establishment of State Power Committees should be prioritized.
10) Andhra Pradesh member Shri Rao said that the DPR for implementation of SAMAST costing Rs. 52.7 Crores was submitted. The State has been informed that the PSDF Committee has approved allocation of Rs. 11 crores. POSOCO representatives were requested to examine afresh and facilitate disbursement of funds from PSDF as per request of AP Transco.
11) Karnataka member ShriRaju stated that the State SLDC would like to visit Gujarat and MP to understand various aspects of implementation as well as preparation of DPR.
12) Maharashtra member Shri Lad said that the DPR has been approved and tender has been announced. He also said that the draft of forecasting-scheduling regulations is ready and shall be issued soon.
13) MPERC Secretary Shri Saxena updated the Committee that the public hearing on forecasting-scheduling regulations was held on 20th June. The final regulations are under process and shall be finalized soon.
14) Andhra Pradesh member Shri Rao also states that the State is ready to issue the final regulations on this front, expected to be notified by 16th August 2017.
15) Gujarat member Shri Thakkar stated that Gujarat shall issue the final regulations for RE forecasting & scheduling soon.

16) It was discussed that FOR Secretariat shall write a letter to other states to speed up the process on these two fronts. The Committee requested to Shri Soonee that he lead sub-groups at the State level to oversee implementation of SAMAST.
17) It was concluded that in future meetings, other States of the region where the meeting is held may be invited as special invitees.

II. Optimization of Hydro Resources

1) Shri Soonee from POSOCO presented(***Annexure-III***) on Optimization of Hydro Resources, in the context of balancing the grid with large scale integration of renewable energy. In this context, POSOCO has released a Report on "Operational Analysis for Optimization of Hydro Resources & facilitating Renewable Integration in India".
2) He emphasized the need for tariff framework that values flexibility, and specifically in context of hydro resources, peaking of the hydro plants. He stated that hydro should be given some incentive for peaking. Out of 45 GW of installed hydro capacity in the country at present, 16 GW are ISTS projects and currently have tariff signals for this.
3) The balance capacity in States needs appropriate tariff framework. If done right, he estimated that country as a whole can get significant peaking hydro capacity. This would also enhance load factors of thermal plants by ensuring that hydro plants are not run during off-peak hours. For this, States need to adopt CERC principles of two-part tariff for hydro along with provision for reckoning target availability based on declared capacity at least for three hours during the peak period.
4) Shri Soonee recommended that hydro plants should be allowed to provide ancillary services.
5) It was discussed that CEA should provide technical advice on procuring turbine types. Shri Soonee mentioned that Pelton turbines are most grid-friendly.
6) It was deliberated that Model Regulations for Hydro Plants for the States should be evolved, that'll include the revised tariff structure, including that for pumped storage. POSOCO will facilitate and present the status in the next meeting.
7) It was discussed that POSOCO should organize a meeting with hydro generators to discuss silt and inflow forecasting.
8) It was also requested that in future meetings, analysis of hydro resources of the host state may be presented for a fruitful discussion and finalization of next steps.

III. Reduction of losses and maintaining Grid Stability by Active Network Management – Presentation by SGS/Enzen

1) A presentation was made by SGS/Enzen (***Annexure-IV***) highlighting grid balancing with the help of their product 'Active Network Management (ANM)'. It has been designed for Real time, fast acting and coordinated control of flexible network elements like renewables and Distributed Energy Resources (DERs) for increasing the overall network efficiency and maintaining grid balance.
2) Various benefits of ANM were highlighted like:
    - Reduction in technical losses
    - Minimizing curtailments of RE
    - Avoid network augmentation
    - Increasing hosting capacity
    - Time reduction in connecting new RE
    - Improving system balance
3) Further, they highlighted various case studies covering topics like technical losses, reverse power flows (due to rooftop), reactive power from solar farms, flexible connections for new wind capacity with transmission optimization, etc.
4) The presentation was appreciated by the Committee.

IV. Demand Pattern Analysis

1) Shri Soonee presented detailed analysis of demand patterns at the national level followed by a deep dive for the State of MP (placed at ***Annexure- V***).
2) He highlighted how demand patterns vary across different States, as well as by season and time-of-the-day within a State. This knowledge and insight can help the States better plan their generation capacity as well as ensuring quality of supply.
3) He demonstrated plots offering insight into the shifting morning/evening peak times for the State of MP over the last several years. Several other charts on demand met, peak and lean demand as % of peak demand, daily load factor, etc. were presented.
4) With examples, he demonstrated how complementarity between two states can be utilized for better utilization of generation sources,e.g. peak demand of MP vs peak demand of Delhi.
5) He also emphasized the importance of examining the Load Duration Curve for every State at the time of decision-making for new procurement of power. Market trends should also be analyzed before power procurement planning. He expressed concern over signing of PPAs by states without a thorough analysis, in which case they suffer from heavy fixed charge payment while not purchasing power from the extra plants.

The meeting ended with a vote of thanks by the Chair.

Annexure: List of Participants at the Thirteenth Meeting of the FOR Technical Committee held on 04.08.2017 at The Jehan Numa Palace, Bhopal

Sl.No.	Names of Members, Invitees & other participants	Designation
1.	Mr. A.S. Bakshi, Member, CERC	Chairman-Technical Committee
2.	Mr.A.B.Bajpai, Member, MPERC	Member
3.	Mr.D.B.ManivalRaju, Member, KERC	Member
4.	Mr. P.J. Thakkar, Member, GERC	Member
5.	Mr. Deepak Lad, Member, MERC	Member
6.	Mr.P.Rama Mohan, Member, APERC	Member
Special Invitees		
7.	Mr.DevrajBirdi, Chairperson, MPERC	
8.	Dr. M.K. Iyer, Member, CERC	
9.	Mr. S.K. Soonee, Advisor, POSOCO	
10.	Mr. S.C. Shrivastava, Chief (Engg.), CERC	
11.	Dr.S.K.Chatterjee, Joint Chief(Regulatory Affairs), CERC	
12.	Ms. Shruti Deorah, Advisor RE, CERC	
13.	Mr.K.K.Parbhakar, Chief Engineer, MP SLDC	
14.	Mr.S.S.Patel, Superintendent Engineer, MP SLDC	
15.	Mr.VivekPandey, Chief Manager, WRLDC, POSOCO	
16.	Mr.HyltonBenett, Smart Grid Solutions	
17.	Ms.PreetiMalhotra, Enzen Global	
18.	Mr.ShravanaHansari, Enzen Global	

UPDATE ON STATUS OF IMPLEMENTATION OF "SAMAST" RECOMMENDATIONS IN MADHYA PRADESH

By – Chief Engineer
SLDC, MPPTCL, Jabalpur.

"SAMAST" Report `recommends to have uniform approach by all the states on Scheduling, Accounting, Metering and Settlement of Transactions in Electricity.

Implementation of Intra State ABT in MP

- MPERC notified Balancing & Settlement Code (BSC) 2009 on 23rd Oct 2009.
- BSC come into force from 1st Nov 2009 and apply on all Intra-State Entities within the geographical area of MP.
- Intra-State ABT implemented in MP w.e.f. Nov 2009.
- Prior to Nov 2009, Mock billing under Intra State ABT had been performed by MP SLDC for (2) years and several orientation programmes and workshops were conducted for stake holders (Discoms, Gencos, IPPs & OACs).
- MP was the first state to implement full fledged ABT mechanism in India.

Activities performed under Intra State ABT

I. Scheduling and Despatch

II. Energy Metering

III. Energy Accounting and Settlement, which includes preparation and issuance of following :

a) State Energy Account (SEA).
b) State DSM Account (SDSMA).
c) State Reactive Account (SRA).
d) MP Transmission loss computation.

IV. All the scheduling data, metering data and energy accounts are uploaded on SLDC website – www.sldcmpindia.com in public domain for Intra State entities.

Activities performed under Intra State ABT Cont…..

- At present Scheduling, Metering , Energy Accounting and Settlement is being done through ABT system installed at SLDC during 2008.

- The data from ABT meters installed at various interface points is received through AMR system installed during 2016. Prior to installation of AMR system, the ABT meter data were downloaded by intra state entities and sent through email to SLDC on monthly basis.

- Energy Accounts are prepared and issued on monthly basis.

Status of Energy Metering

- ABT Compliant Energy Meters are installed for recording active and reactive energy at all the interface points between –

  - Generating Stations –Transmission / Distribution Utilities (G-T) – 177 Nos.
  - Transmission - Distribution Utility (T-D) – 729 Nos.
  - Inter State Transmission System – Intra State Transmission System (ISTS-STU) – 70 Nos.
  - Open Access Customers – Transmission (OAC-T/D) -22 Nos.
  - Renewable Energy Generators (pooling station wise) - Transmission / Distribution System - 122 Nos

Total 1120 Nos ABT meters of 0.2s accuracy class have been installed at various interface points in MP.

Scheduling and Despatch

- All the scheduling activities under day ahead scheduling as well as real time revisions in line with BSC 2015 and IEGC are done by SLDC Control Room.

- Implemented schedules are maintained by general shift staff of SLDC.

- SLDC performs the scheduling of Intra State entities and also coordinates scheduling of Inter State Generating Stations (ISGS) & IPPs in which State have share. The details of the entities are as under –

i. Conventional Generating Stations – 20 Nos State Sector Generating Stations & 2 Nos Intra State IPPs, Total -22.
ii. Inter State Generating Stations and IPPs in which States have Share – 25 Nos.
iii. Distribution Licensees - Discoms -3, SEZ-1 & Railways -1, Total -5
iv. Inter & Intra State Open Access Customers connected at 132 KV & above – 22 Nos.
v. Renewable Energy Pooling Stations – 122 Nos.

Existing ABT system

- The existing ABT system installed in year 2008 is also SAMAST compliant.
- The existing ABT system has outlived its useful life.
- The hardware of the existing system has become obsolete and it is difficult to maintain.
- The existing system has limited feature and difficulty is being faced to implement new regulatory provisions.

New Integrated ABT, OA and MIS System

SLDC is in a process of commissioning of new integrated ABT, OA and MIS system which is expected to be completed by end of November 2017 including 3 months parallel run with existing system.

Integrated ABT, Open Access and MIS Project under Implementation at SLDC

Module- I : Availability Based Tariff (ABT)

- Entity Management
- Scheduling and Despatch
- Metering Module
- Energy Accounting Module
- Renewable Energy Generation Module
- Formula Builder Module
- Billing, Collection and Disbursement Module

Module- II : Short Term Open Access

- Entity Management
- Management of Types of Transactions
- Open Access Process and Charges
- Detail reports / configuration of the STOA customer

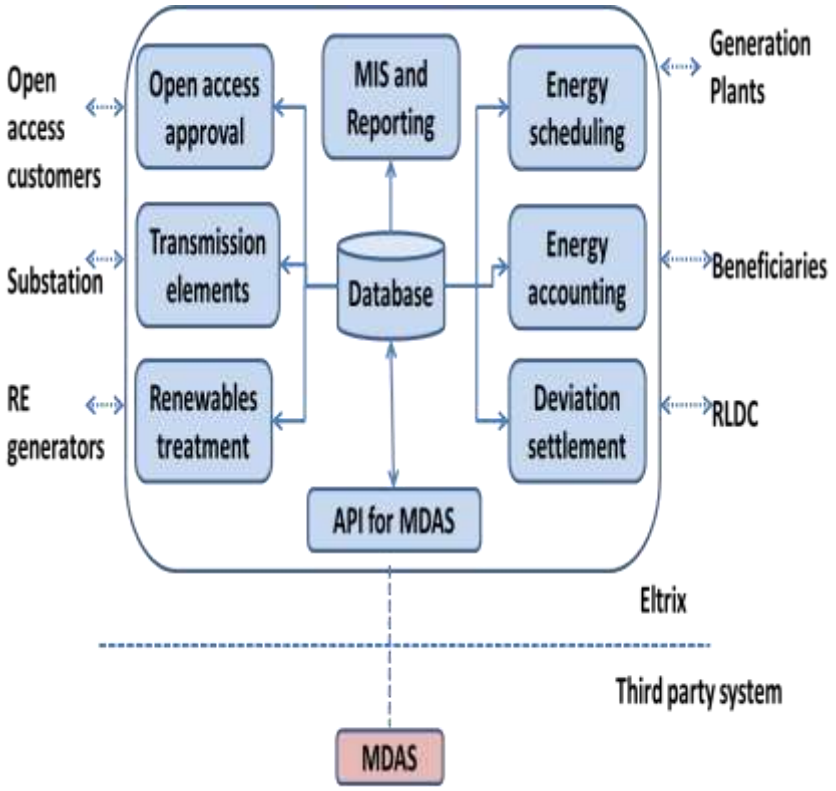
Module- III : Management Information System

- Daily Report
- Monthly Report
- Annual Report
- Management of shut down of transmission elements/ computation of availability.

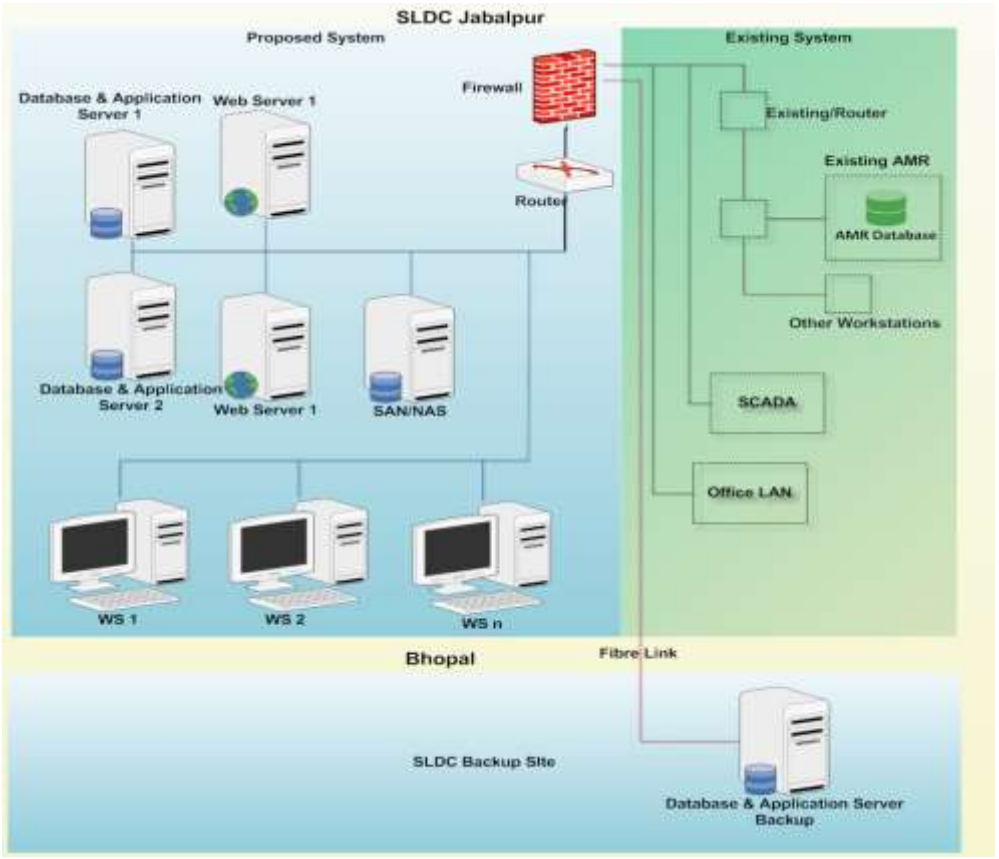
SAMAST : MP SLDC APPROACH

INTEGRATED SYSTEM FOR ABT, OA, SCHEDULING, OUTAGE PLANNING, RENEWABLE & MIS

Scope of project



System Architecture



Project Cost : 3.02 Cr. Project Completion : Nov 2017 Funding: PSDF Grant

Integrated ABT, Open Access and MIS Project under Implementation at SLDC

The new system shall have following additional/advanced features :

- Web based scheduling.
- Integration with existing AMR system.
- Availability of Meter-wise/block-wise ABT meter data of each intra state entities on SLDC website.
- Registration, web-based/online processing of application for STOA along with online tracking of open access charges.
- Web based MIS including daily/monthly/annual reports, online management of outage of transmission elements.
- Billing, collection and disbursement of charges under intra state ABT mechanism.
- Forecasting, Scheduling and Deviation settlement of wind and solar generators.
- REC mechanism and Integration of RE generators with MP grid,

Integration of Renewable Energy Sources

Total Installed Capacity of 3567 MW from Renewable Energy Sources, as on 01.07.2017, integrated with MP grid is–

- Small Hydro Including SSGS Hydro (65MW) : 80.7 MW
- Biomass : 60.5 MW
- MSW :- 11.5 MW
- Biogas – 2.4 MW
- Wind – 2427.91 MW (Pooling Stations – 73 Nos)
- Solar including Captive – 983.99 MW (Polling Stations – 39 Nos)

Total RE installed Capacity – 3567 MW

MPNRED Target by 2022 - Wind – 6.2GW and Solar – 5.67GW

Telemetry and Forecasting Status of Wind and Solar

Type	Installed Capacity	No. of Pooling Stations	Telemetered (Nos.)			Forecasting Available
			RE End	S/S End	Net	
WIND	2427.91	73	60	56	67	51
SOLAR	983.99	39	35	37	39	36
Total	3411.9	112	95	93	106	87
%			84.82	83.04	94.64	77.68

GREEN ENERGY CORRIDOR SCHEME (PHASE-I)

(ANTICIPATED COMPLETION YEAR 2018-2019)

To evacuate power from anticipated RE capacity addition, MPPTCL has conducted system studies & identified required transmission system strengthening and interconnection works for upcoming RE projects.

Sl.No.	Particulars	Nos./ Ckt. Km
1	400kV New Substations (Mandsaur, Sagar, Ujjain)	3 Nos.
2	400kV Line	690 Ckt. Km
3	400kV Reactors	3 Nos.
4	220kV New Substations (Sendhwa,Jaora,Gudgaon,Kanwan,Ratangarh, Susner,Sailana) (220kV S/s Suwasara excluded)	7 Nos.
5	220kV Line	1164 Ckt. Km
6	132kV Line	1128 Ckt. Km
7	132/33kV Addl. Transformer (Nalkheda, Vijaypur)	2 Nos.

Recommendations: SAMAST

Sr. No.	Summary of Recommendation	Summary of Status of Compliance
1	Demarcation of Interface boundary & identification of Pool Members	All the entities connected at transmission level of intra State System has been identified and made pool members as the intra State ABT has already implemented in the State w.e.f. Nov 2009.
2	Adequate Interface Energy Meters with AMR infrastructure	ABT main & check Meters at Generating Stations, IPPs, OA customers have already installed with AMR facility. Other recommendations are complied except the following :- (1) At T-D interface points, only main meter is installed on LV side of 220KV/33KV and 132KV/33KV transformers, as per regulatory provisions of State Commission. (2) Installation of more meters to ensure N-2 or N-1-1 security and meters having 5 minutes interval and frequency resolution of 0.01 Hz, shall be taken up after notification of relevant regulation.

Recommendations: SAMAST

Sr. No.	Summary of Recommendation	Summary of Status of Compliance
3	Ex-Ante Scheduling	Scheduling mechanism is in place as per recommendations and already covered under MPERC Balancing and Settlement code(BSC) 2015. -- 5 min scheduling shall be implemented after notification by appropriate commission. -- Ex-post facto changes are required to implemented in accordance with ex-post facto changes made by WRPC
4	Uniform Energy Accounting System	Implemented Schedule as reference for energy accounting, computation of deviation accounts, computation of transmission losses is being done by SLDC as per recommendations. Transmission losses are computed on monthly basis and in near future the same shall be computed at block level.
5	Simple, robust, scalable but dispute-free settlement system	Settlement system is in place for all the intra state entities except RE generators for which no Regulatory provision exists.
6	Administration of transmission losses	State Transmission losses are being computed on monthly basis and applied in n+2 month for scheduling.

Recommendations: SAMAST

Sr. No.	Summary of Recommendation	Summary of Status of Compliance
7	Transmission Charges	complied
8	Reactive Energy Pricing	Reactive Energy Pricing is linked with voltage and being computed on day wise cumulative for high and low basis. However time block wise computation shall be implemented on issue of regulation.
9	STOA Registry and Clearing Agency	Presently the STOA registry/applications/process is being carried out manually. However after implementation of New integrated ABT, OA and MIS project, IT based facilities for STOA shall be available.
10	Transparency	complied. The monthly meter wise energy data of Discoms is available on SLDC website. However block wise data for each entities and formula for computation of energy shall be made available on website after implementation of new ABT,OA and MIS system.

Recommendations: SAMAST

Sr. No.	Summary of Recommendation	Summary of Status of Compliance
11	Integrity and Probity of Accounts	Comparison of meter data with SCADA data, assessment of bad data based on the history / joint meter reading is in practice. Checking / verification of implemented schedule & energy accounts by entities and reporting of errors within a period of 15 days is in place. However, process of Internal and External Audit needs to be developed and put in place.
12	Disbursal and Clearing	complied
13	Statutory Compliances	complied
14	Payment Security Mechanism and Risk Mitigation	Reconciliation of payment and receipt and Payment Security through Suitable Financial Instruments is being carried out.
15	Archival and Utilization of Energy Meter Data	complied
16	Logistics for SAMAST	Basic IT Infrastructure is in place since Nov 2009, however NEW Integrated ABT, OA and MIS system shall have advance features in updated technology, i.e web based scheduling, online submission and processing of STOA applications, reports etc. The new system also includes comprehensive AMC support from vendor.

Recommendations: SAMAST

Sr. No.	Summary of Recommendation	Summary of Status of Compliance
17	Adequacy of Human Resource	Present activities are managed through existing man power resources as posting of personnel against the additional sanctioned posts is awaited. SLDC personnel's are being imparted training on relevant subject from time to time.
18	Governance Structure	Presently SLDC is performing scheduling, metering and energy accounting as per BSC 2015. Consequent changes shall be implemented after notification of regulation.
19	Facilitating enhanced Grid Security and Economic Despatch	System operation is being carried out in accordance with grid code and grid standards. Merit order despatch principle is in place. Other recommendations shall be implemented after notification of relevant regulation.
20	Implementation of Dispatch with Ancillary Services	Shall be implemented after notification of SERC regulation.

THANK YOU

MADHYA PRADESH ELECTRICITY REGULATORY COMMISSION BHOPAL

Status on Implementation of Deviation Settlement Framework for Renewable in Madhya Pradesh

4th Aug, 2017

Introduction

- In its 57th meeting held on 16.12.2016 in Raipur, the FOR has endorsed the Model Deviation Settlement Regulations for States
- Conveyed by FOR through letter dated 16th March, 2017
- Accordingly, draft Regulations framed and public notice issued on 26.05.2017 for obtaining comments from various stakeholders by 16.06.2017

Introduction

- Public hearing was held on 20.06.2017
- On requests some of the stakeholders, they were allowed to submit comments by 30.06.2017
- 14 comments were received till cut off date
- Regulations are under finalization

Report
on
Operational Analysis for Optimization of Hydro Resources & facilitating Renewable Integration in India

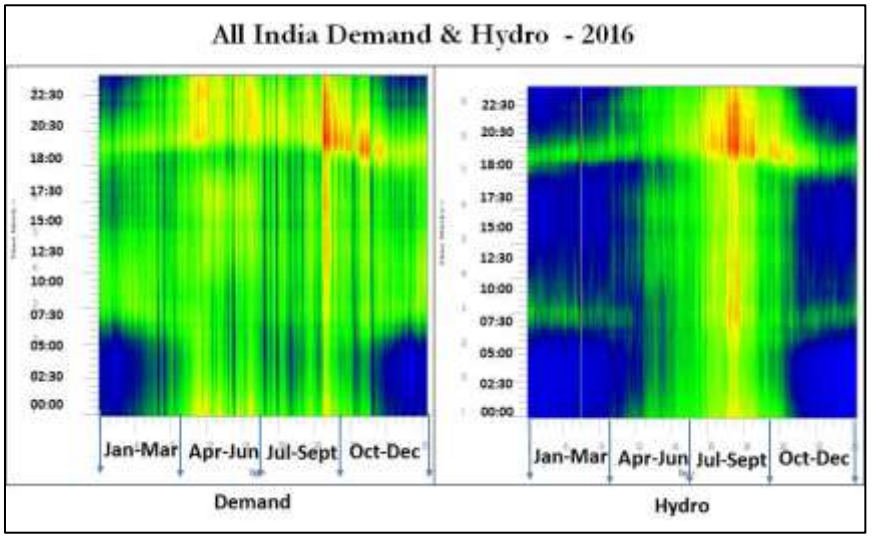
Forum of Load Despatchers
India

June 2017

Motivation

- **Sub optimal operation of some hydro generators**
  - JS (Transmission), MoP Meeting with BBMB in Nov 2016
  - Scope for optimization & flexible operation along with economic gains
  - Requirement of flexibility in view of large scale Renewable Integration

- **Hydro Power - a source of flexibility & reliability**
  - Overload capability
  - Fast ramping
  - Peaking support
  - Voltage Regulation
  - Black Start Capability



- **Constitution of FOLD Working Group**

Process

Survey of hydro power stations

- 35 GW (79%) out of 44.5 GW
- 149 hydro stations
- 486 generating units

Consultation with hydro generators / State Load Despatch Centres

- Appreciation of constraints
- Philosophy of dispatch

Big Data Analysis

- 9 Years Data Analysis
- 38 Million Data Points
- Data Visualization

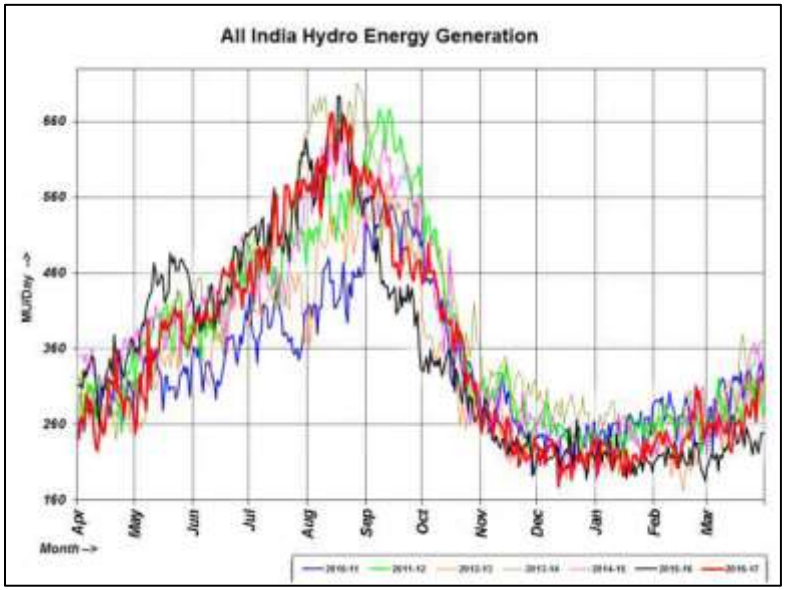
Brain Storming in FOLD Meetings

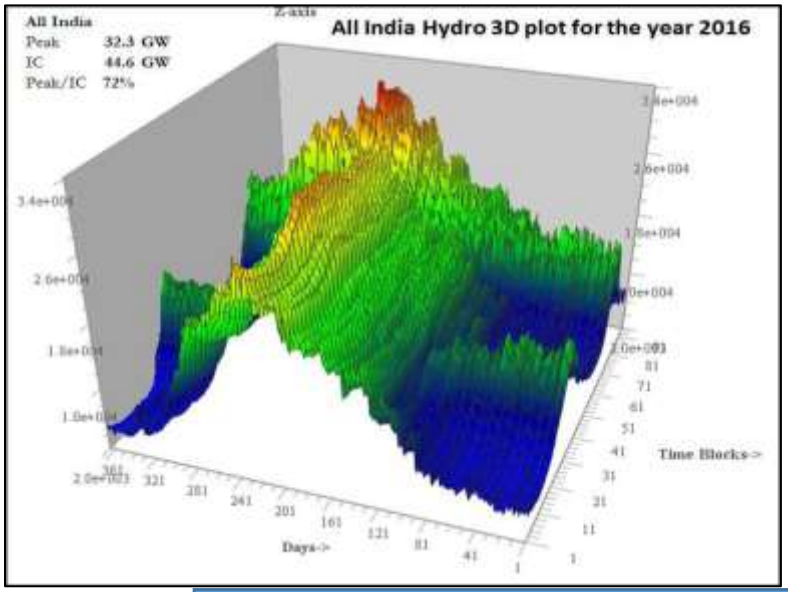
- 6 months work
- Around 50 Contributors
- More than 1000 man hours

Summary of Findings

- **Defining Flexibility Indices**
  - Peaking, Ramping & Capacity Utilization
  - Flexibility Indices as a metric for improvement
  - Plants having multi part tariff performing better

- **Operational Performance**
  - Peak Hydro Support 30 GW in high hydro season & 18-20 GW in lean hydro season against IC of 45 GW
  - Seasonal Hydro Flexibility
  - 87 tested for black start
  - 25 Stations out of 150 have synchronous condenser facility to be harnessed

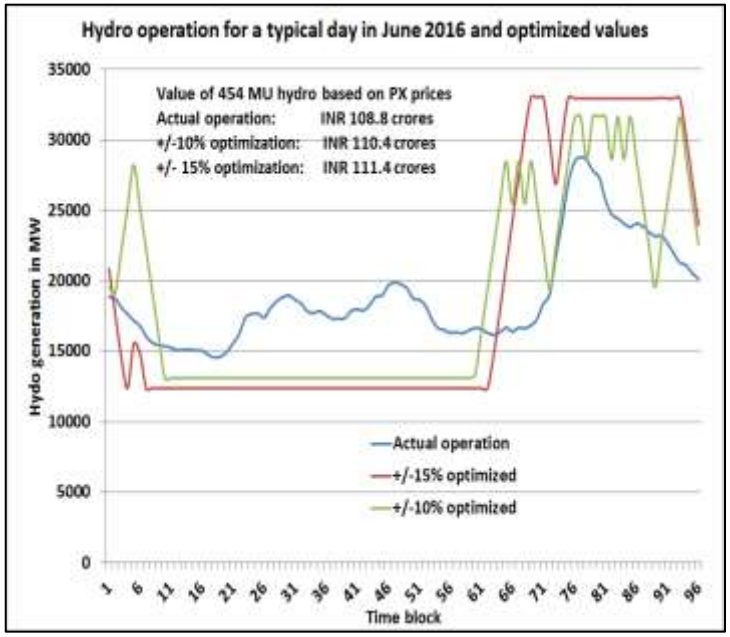


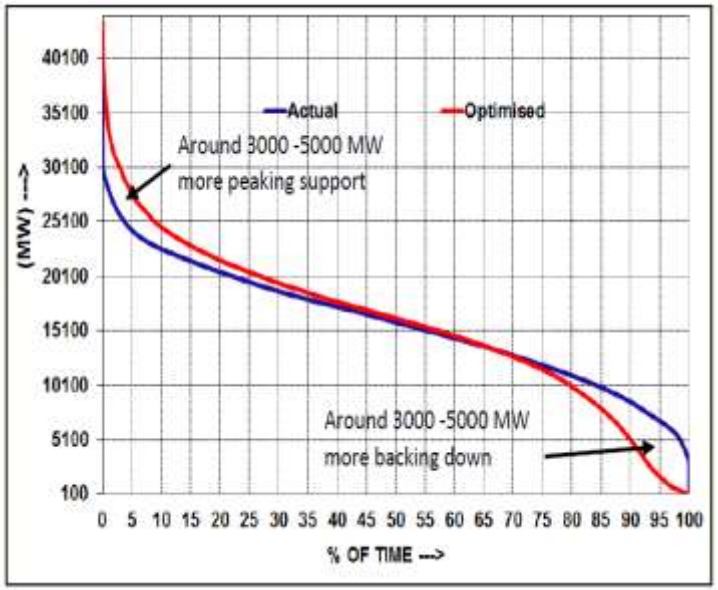


Summary of Findings

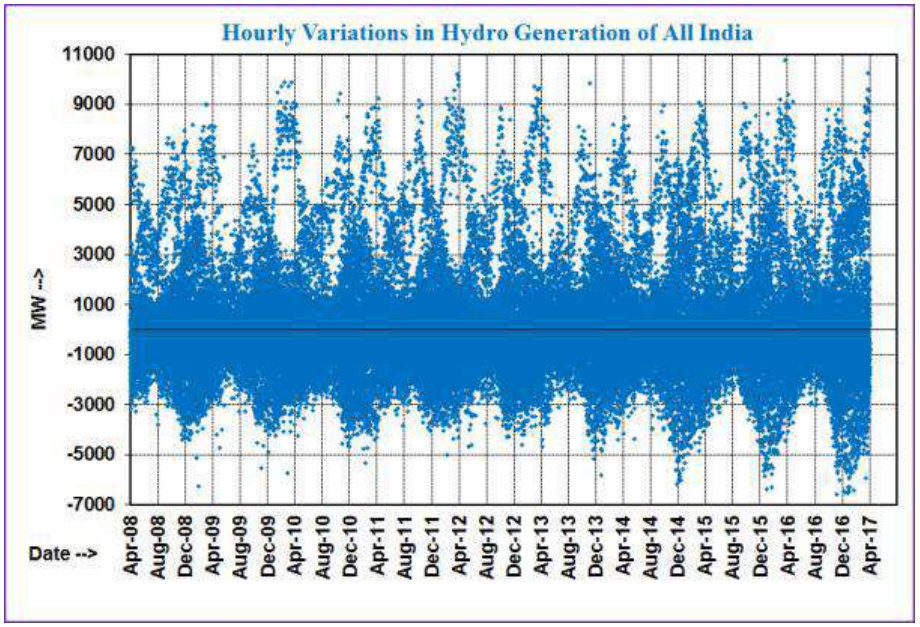
- **Valuing Hydro**
  - 128 BU of annual hydro generation ~ Rs 30000 Cr
  - 32 BU Reservoir energy content worth ~ Rs 7500 Cr
  - Around Rs 600 Cr (2%) economic gains with further optimization

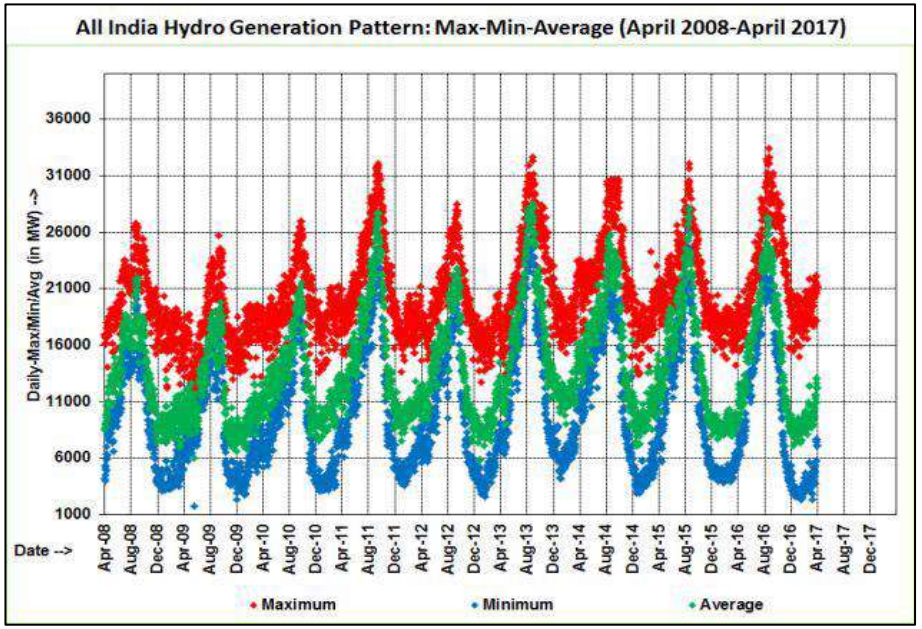
- **Optimization based on Production Cost Modelling**
  - 5 GW Extra Peaking Support during peak
  - 4 GW Extra Backing down during off peak
  - Overall flexibility enhanced





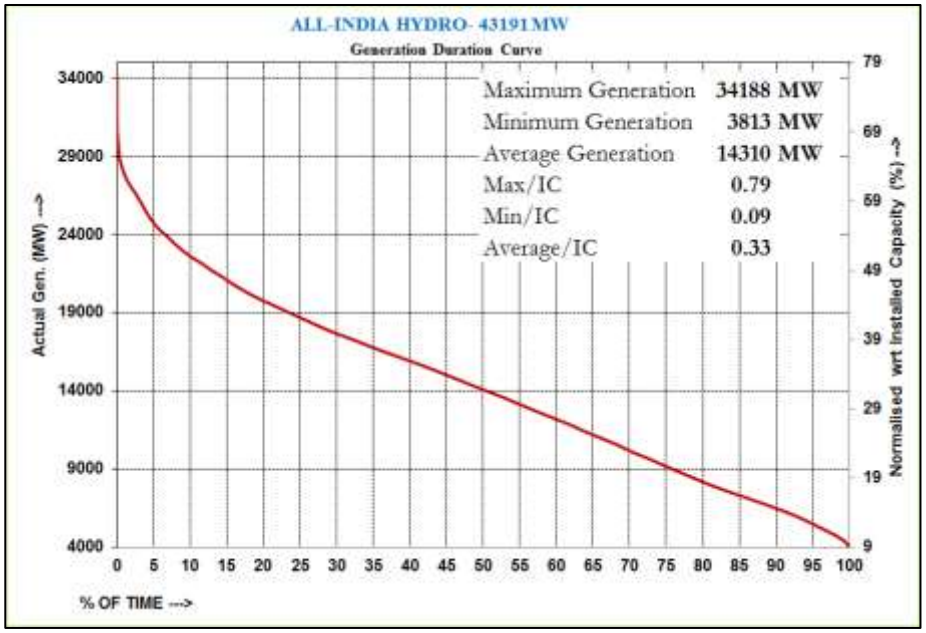
Flexibility Analysis of Hydro Generation

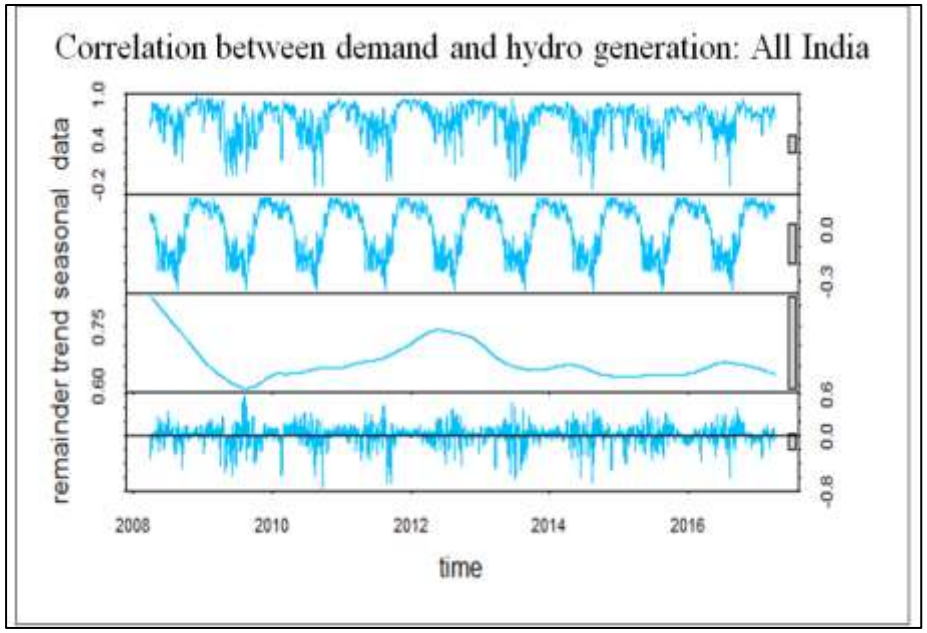




- Seasonality in Hydro Variation / Max / Min /Average Generation
- Less Variation in High Hydro Season
- More Variation in Low Hydro Season
- More scope for peaking support and off peak backing down

Flexibility Analysis of Hydro Generation





- Max Gen : 34 GW
- Min Gen : 4 GW
- Average Gen : 14 GW
- Max/IC : 0.79
- Min/IC : 0.09
- Average/IC : 0.33

- Seasonal Decomposition to identify trend and seasonality
- Decreasing Correlation between Demand and Hydro Generation
- Higher Correlation during lean hydro season

Key Recommendations

- Optimization & Incentives for Flexibility
- Coordinated Scheduling & Despatch
- Multi Part Tariff
- Inflow Forecasting
- Revisiting Hydrological Constraints
- Ancillary Services from hydro power stations
- Transmission planning impacting hydro flexibility
- Silt Forecasting & Coordinated Flushing
- Review of standards
- Renovation & Modernization

Report Outline

- Introduction
- Pattern Analysis & Survey
- Flexibility Metrics
- Flexibility Assessment
- Pumped storage Capability
- Constraints in Hydro Generation
- Tariff Structure
- Scheduling & Despatch
- International Experience Recommendations

265 Pages
10 Chapters
20 Appendices
112 Figs
31 Tables

Thank You !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Active Network Management
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Presentation Outline

- Emerging Trends – Indian Market Context
- Implications and What Is Needed
- Active Network Management
- High Level Architecture
- Implementation Use cases
- Demo
- Conclusion

Smarter Grid Solutions

- ✓ Founded in 2008 to fill a market gap for ICT solutions to solve new energy system problems
- ✓ Over 10 years in development in collaboration with utility customers and one of Europe's leading power systems universities (University of Strathclyde)
- ✓ HQ in Glasgow with offices in New York, California and London
- ✓ 50+ staff including 40 engineers (9 PhDs, 17 Masters, 15 Honours degrees) dedicated to the development and deployment of Active Network Management and real-time control systems for DSOs and developers
- ✓ Pioneers of Active Network Management technology which can be applied to DER Management Systems and Microgrids

Customers


NORTHERN
POWERGRID


AVANGRID


NREL
NATIONAL RENEWABLE ENERGY LABORATORY


Power
Stream


WESTERN POWER
DISTRIBUTION
Serving the Midlands, South West and Wales


SOUTHERN CALIFORNIA
EDISON
An EDISON INTERNATIONAL Company


Scottish & Southern
Electricity Networks

conEdison

Southern
Company


ELEXON


UK
Power
Networks


SP ENERGY
NETWORKS


BERKELEY LAB


Northern Ireland
Electricity
Networks

Enzen

smarter grid solutions

enzen

Exclusively focussed on **Energy & Utility** sector

Industry specific **Expertise & Frameworks**

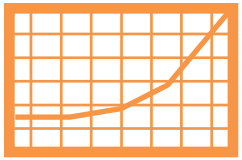
Knowledge & **Innovation** led

Outcome based models delivering customer value

Smart Grid technology integrators delivering **Operational Excellence**

Revenue Growth

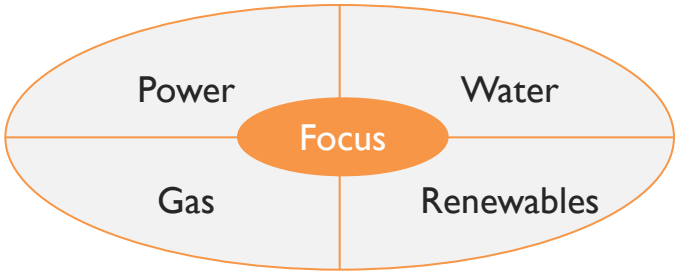
Compound annual growth rate (CAGR) of 75% since inception



Employees

Globally: 3,000+

Industry orientation



Locations

Globally: 20+

Customers

Globally: 155+

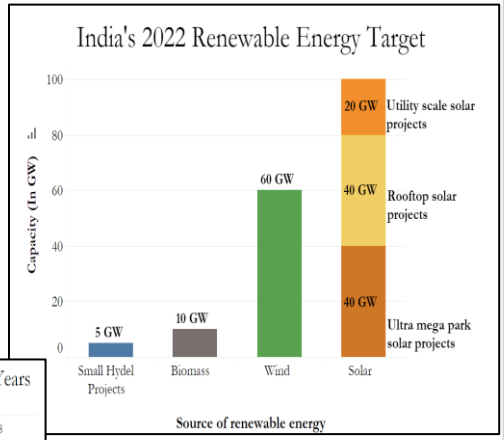
Business Units

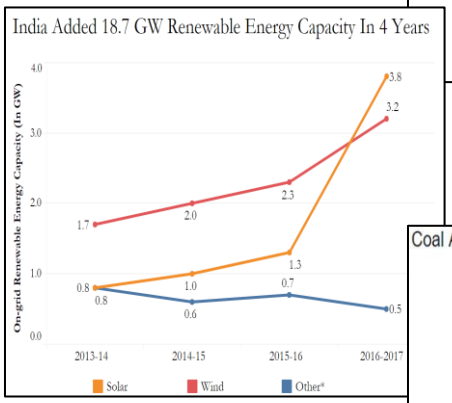
1. Business Transformation
2. Business Operations
3. Energy and Water
4. Digital Enterprise

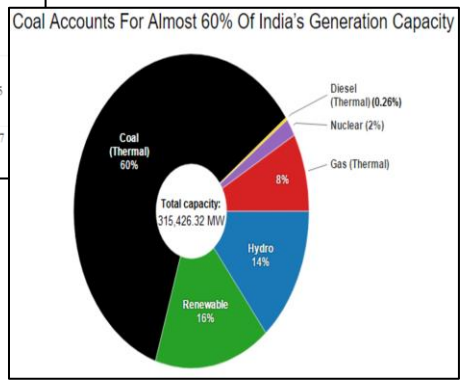
Indian Market Context

Emerging Trends

- 175GW of renewables by 2022
- All cars to be electric by 2030
- Green energy corridors and grid strengthening
- Curtailment of renewables
- Changes to rooftop PV policy and tariffs







Some Implications

- Technical
  - **Renewable Energy Curtailments due to stability and congestion concerns**
  - **Changing Load Profiles – EV charging and increased demand**
  - **Voltage and Reactive Power balance**
  - **Reverse power flows from high volume of unplanned energy sources at distribution level**
  - **Power congestion on interconnectors**
  - **Inertia and Frequency fluctuation**
  - **Thermal capacity constraints**
- Commercial
  - **Capacity sharing –** Increasing generator units, decreasing run hours per unit
  - **Competitive market for Ancillary Services** e.g. reactive power and frequency response

The Market Challenge

- Continued safe and reliable supplies
- Minimise the cost impact of multiple short term grid connections "***a non-Wires alternative***"
- Increase operational efficiency
- Maximise penetration of clean technologies

What Becomes Important?

smarter grid solutions

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Fast-acting	Time-bounded	Predictable
Repeatable	Fail safe	Easy to integrate
Automated	Secure	Flexible

Active Network Management (ANM)

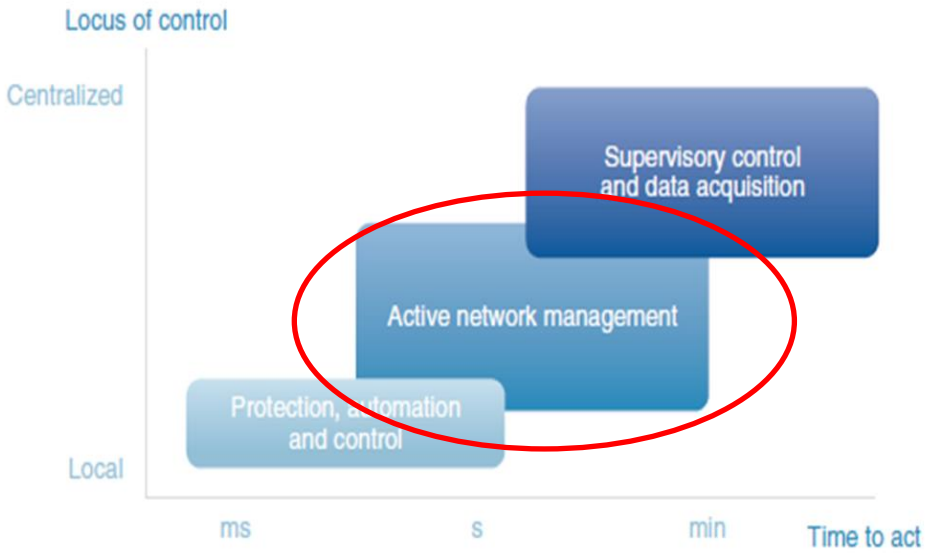
smarter grid solutions

enzen

- Real time, Fast-acting, Deterministic, Coordinated control of flexible network elements like DERs for increasing the overall network efficiency and maintaining grid balance.
- Enables efficient grid balance and control by considering both the device(s) level and grid level information.
- Actively manages network devices within their safe operational limits, and ensuring the overall grid stability.

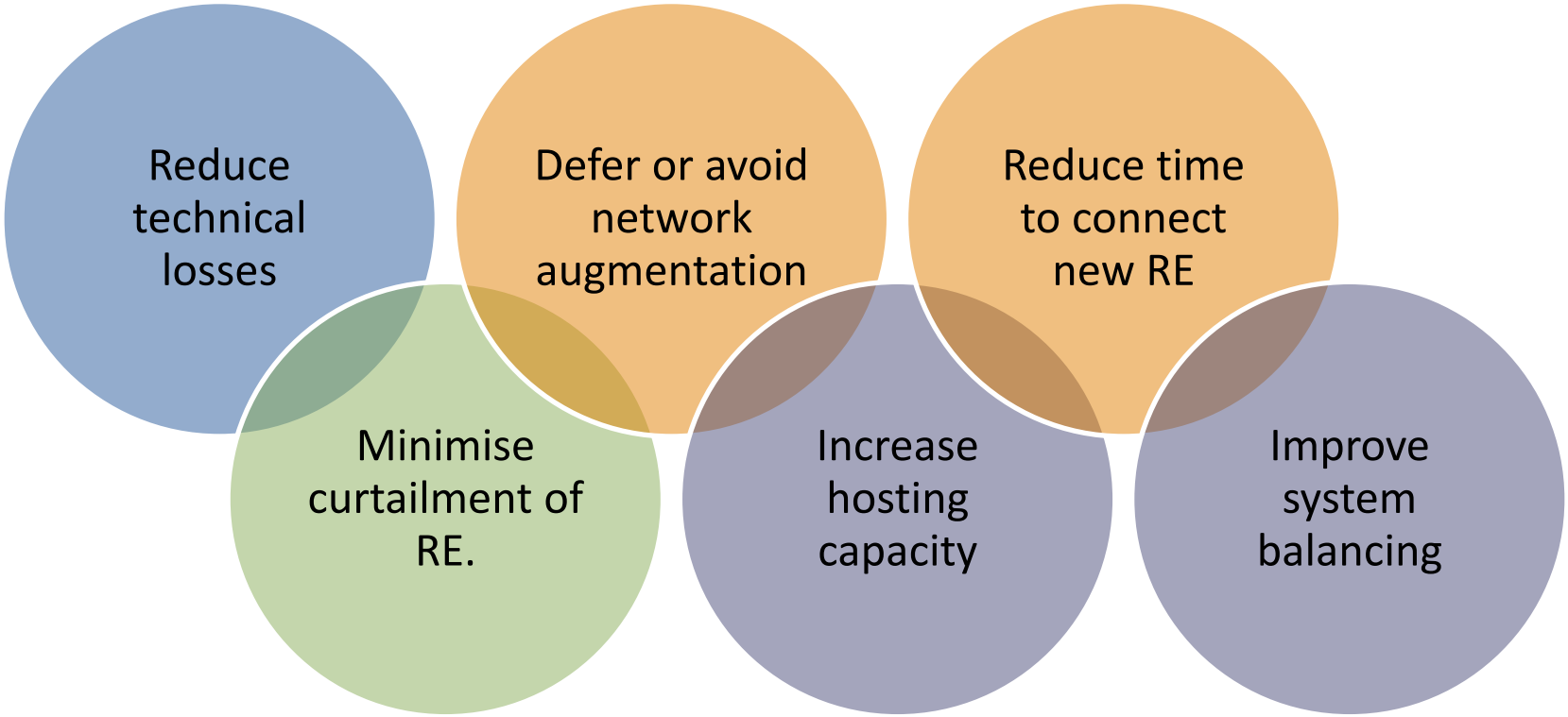
Active Network Management ensures the overall grid balance in a reliable and efficient way

Where ANM Fits in Network Operations

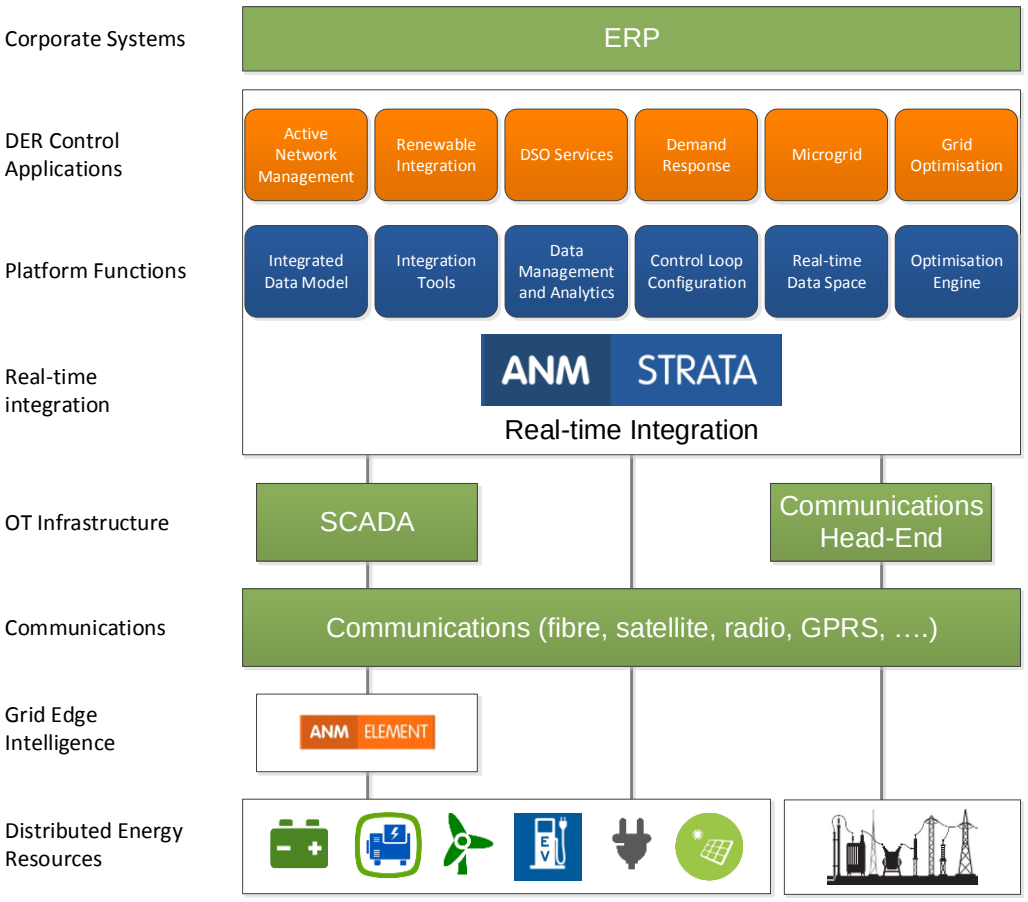


- **A new tool for energy and power networks complementing EMS, DMS and SCADA**
- **Purpose built with IoT technology to run unique high speed power system algorithms**
- **Easily integrated with other systems and sources of data - very little new field equipment**

The Benefits of ANM



High Level Architecture and Features



DETERMINISTIC

FAIL-TO-SAFE

RELIABLE, AVAILABLE AND RESILIENT

APPLICATION FRAMEWORK

HOST MULTIPLE SMART APPLICATIONS AND SCALABLE TO 1000s OF DEVICES

MULTIPLE DEVICE TYPES AND CONTROL ACTIONS

FLEXIBLE, SCALABLE PLATFORM

EXTENSIVE RANGE OF INTEGRATION ADAPTERS

FIELD DATA AGGREGATION

DEDICATED DATA ENGINEERING AND CONFIGURATION TOOLS

DEDICATED USER DEFINED LOGIC CAPABILITY FOR DATA PRE-PROCESSING

LOCALISED DATA MANAGEMENT

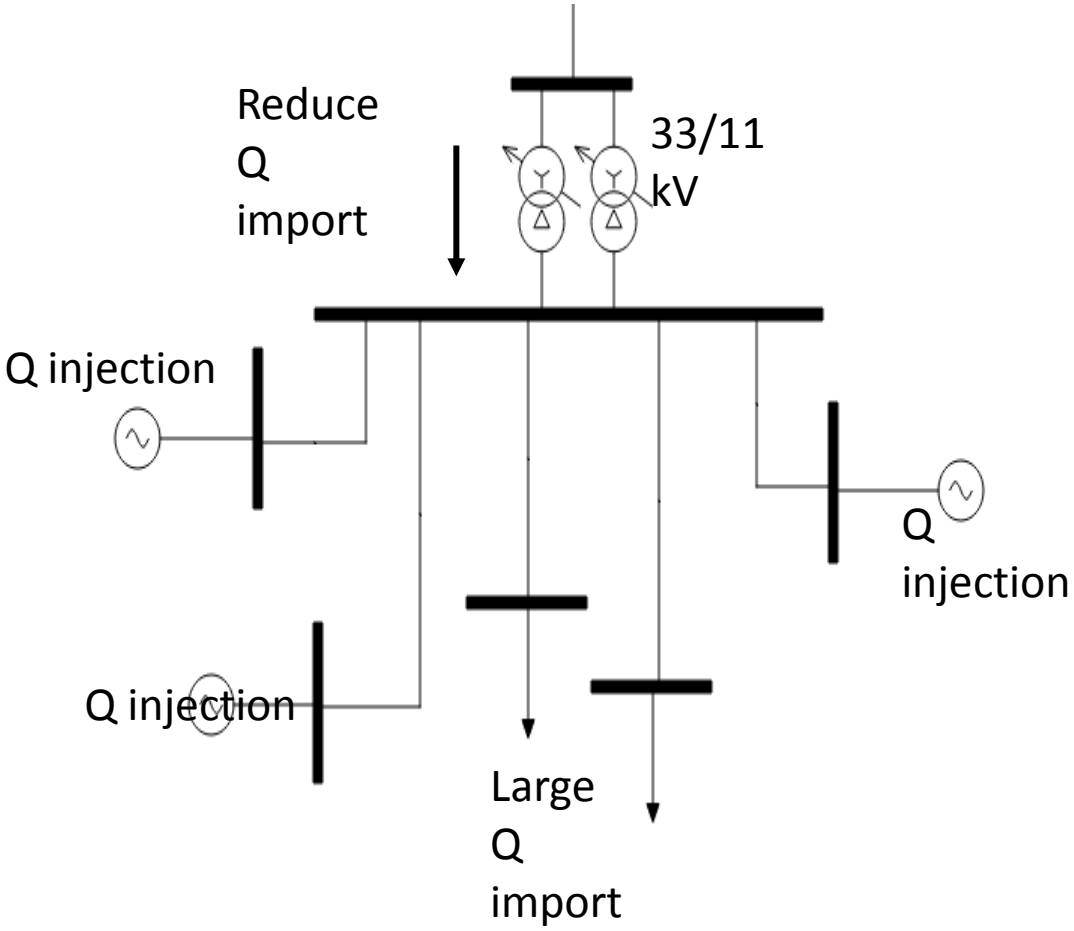
What is Required

- Pilot project in India to demonstrate the concept, and benefits
  - Use case where ANM helps in your day-to-day operations
  - Support from IPP to implement and demonstrate the benefits
  - Support from regulatory to take from pilot demonstration to regulation.

Use Case Implementations

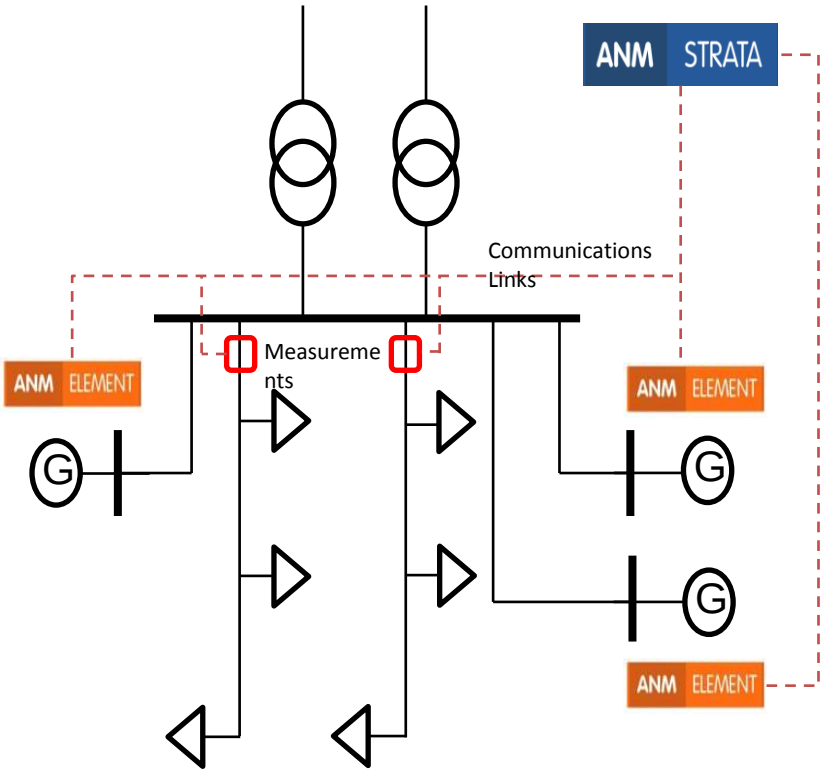
Technical Losses

- Significant MVAr import from upstream
- Little reactive compensation available in grid
- Solar inverters can provide real and reactive power
- Reactive power can be produced without impacting real power export



Technical Losses

- Monitor real and reactive power flow through feeders in real-time
- ANM Element monitors generator export in real-time
- Communications links facilitate data transfer to ANM Strata
- ANM Element responds to reactive power set-points from ANM Strata



Expected Benefit:

~Rs 1M per year in OPEX

~Rs 10M in Capex.

Accelerated RE Penetration

Challenge

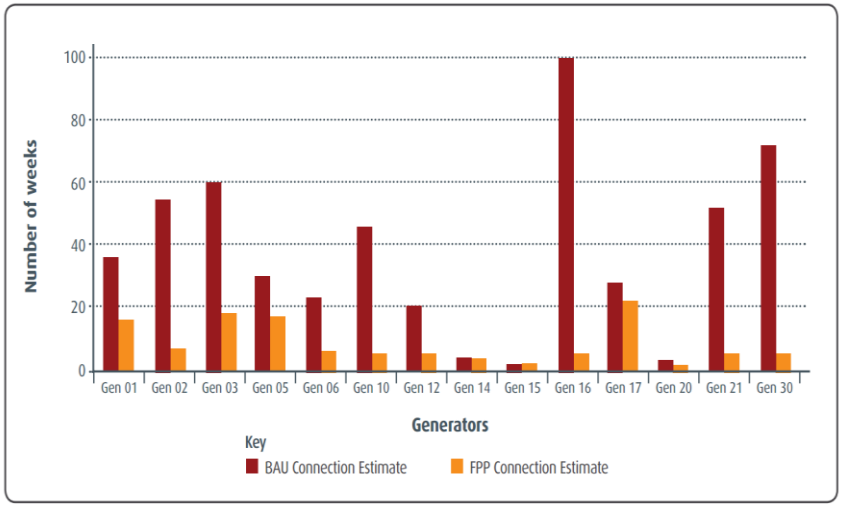
UKPN were experiencing huge volume of connection applications for renewable generation in Cambridgeshire. The resulting connection offers were expensive, and the works required resulted in long timescales before connection. UKPN sought a means of providing cheaper and faster connections for generators

Solution

Managed connections for generators based on real-time control

Benefits

- Average cost saving of **£6.9m** per project
- Average connection time saving of **29 weeks**
- Increase in hosting capacity



Hosting Capacity

Challenge

Scottish and Southern Energy Distribution (SSEPD) sought cost effective alternative to traditional grid upgrades (new subsea cable) to accommodate high demand for wind generator connections, despite network being at full capacity.

Solution

Actively-managed grid connections for distributed generation using Active Network Management

Benefits

- Operational since November 2009
- **Allowed additional 20 generators (24 MW) to connect**
- 103% electricity demand met by renewables in 2013
- **Project developers saved £30 million**

Orkney Isles Background Information

- 70 islands off North coast of Scotlan
- ≈1000 sq km and 21,000 inhabitants
- Winter peak demand of 31 MW
- Summer minimum demand of 6 MW
- Connected to mainland UK via 33kV subsea cables

Generator	Size (MW)	Production Factor *after* Curtailment
1	0.9	37.1%
2	2.3	47.7%
4	4.5	45.4%
5	0.9	37.2%
6	0.9	40.1%
7	0.9	40.8%
9	0.9	31.8%
10	0.9	34.0%

View the live system:

http://anm.ssepd.co.uk/

Scheduling and Optimisation

Challenge

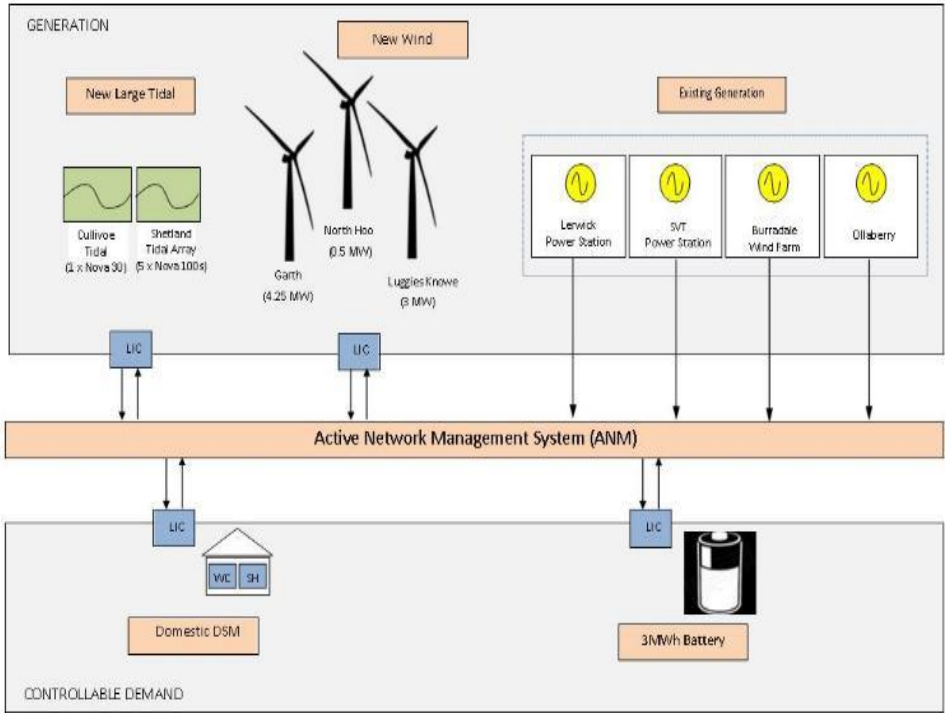
The Shetland Islands are electrically isolated from mainland UK, and have a reliance on old, inefficient diesel generation. There is a contractual arrangement with an existing gas terminal and 3.6 MW of wind. There was no capacity for more renewable generation.

Solution

ANM system deployed to smooth demand curve, utilise available technologies, maximise renewable generation capacity, and alleviate constraints, lop peaks, and fill troughs. The system controls: energy storage, domestic DSM, wind and tidal generation. It incorporates scheduling into the control.

Benefits

- **8.5 MW** of renewable generation connected on to the Shetland Network
- **Extra 9.32 GWh** of renewable energy generated on to the network (March 2016 – February 2017), **10% of demand** and saving **£1.0m per annum**



Asset Utilisation

Challenge

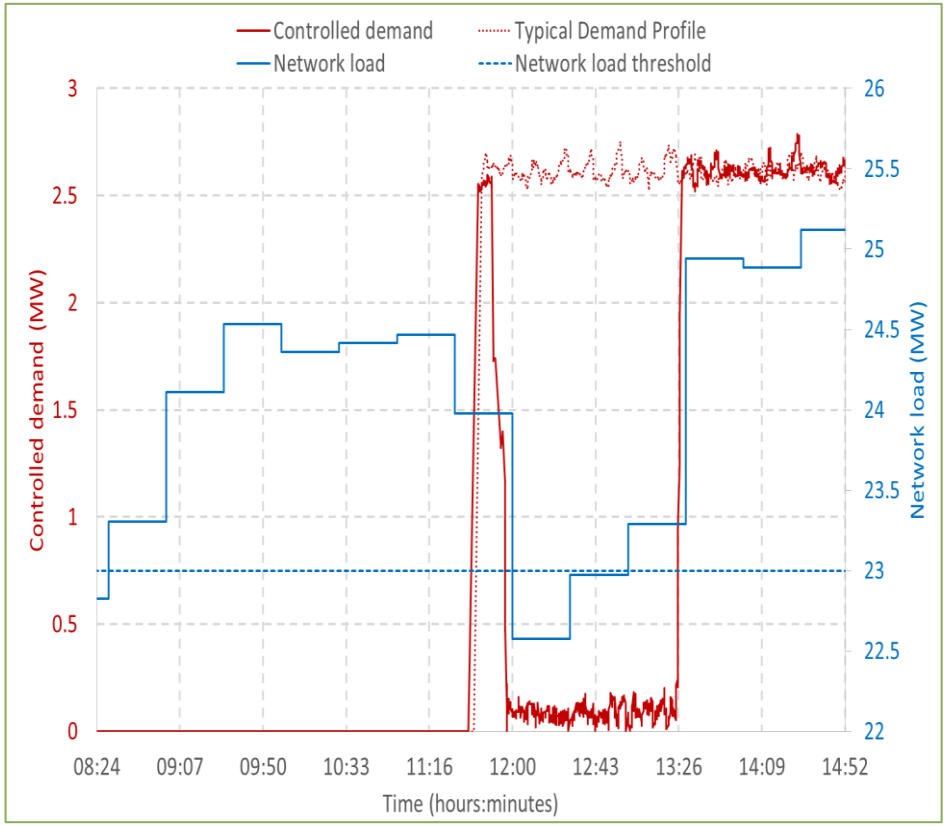
Need to integrate variety of different DR assets managed directly and indirectly to provide peak load relief.

Solution

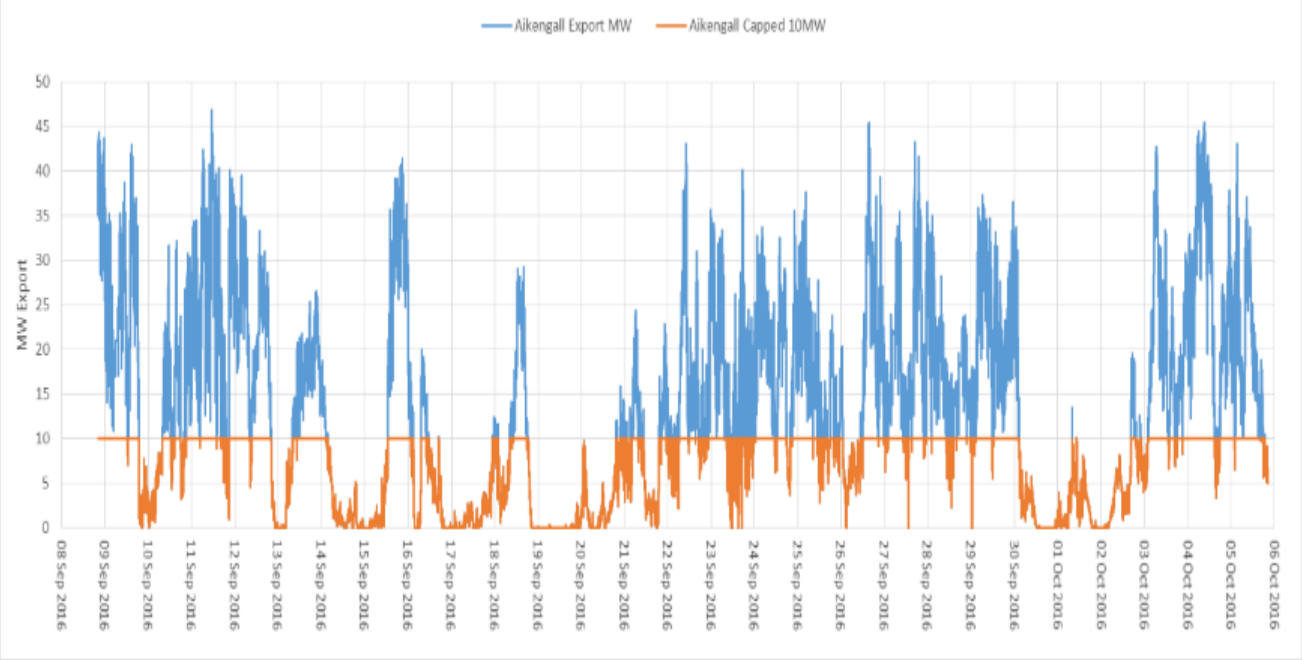
ANM to manage EV charging networks, DG assets and multiple aggregators. Total of ~70 different DR assets across 5 constrained transformers.

Benefit

- ~£50m saving for replacement transformers



Avoiding Outages and Curtailment



- Existing firm generator had 10 MW cap under N-1 conditions at GSP transformer
- ANM deployed retrospectively to actively manage generator under N-1 conditions
- Increased energy yield (the energy under the blue line – the orange line is the export with a SPS)

Improved network modelling

Challenge

Plan, deliver, install, configure, test, maintain, and support the integration and testing of SGS Distribution Control System product(s).

Services will be performed in SCE's Advanced Technology laboratory in Westminster, CA and at the Cambden substation in Santa Ana, CA (and other test substations at discretion of SCE).

Solution

The Distributed Control System is a real-time end-to-end control and dispatch platform providing constraint management and Distributed Energy Resource (DER) coordination against multiple measured constraints.

The system provides for the following key functional elements:

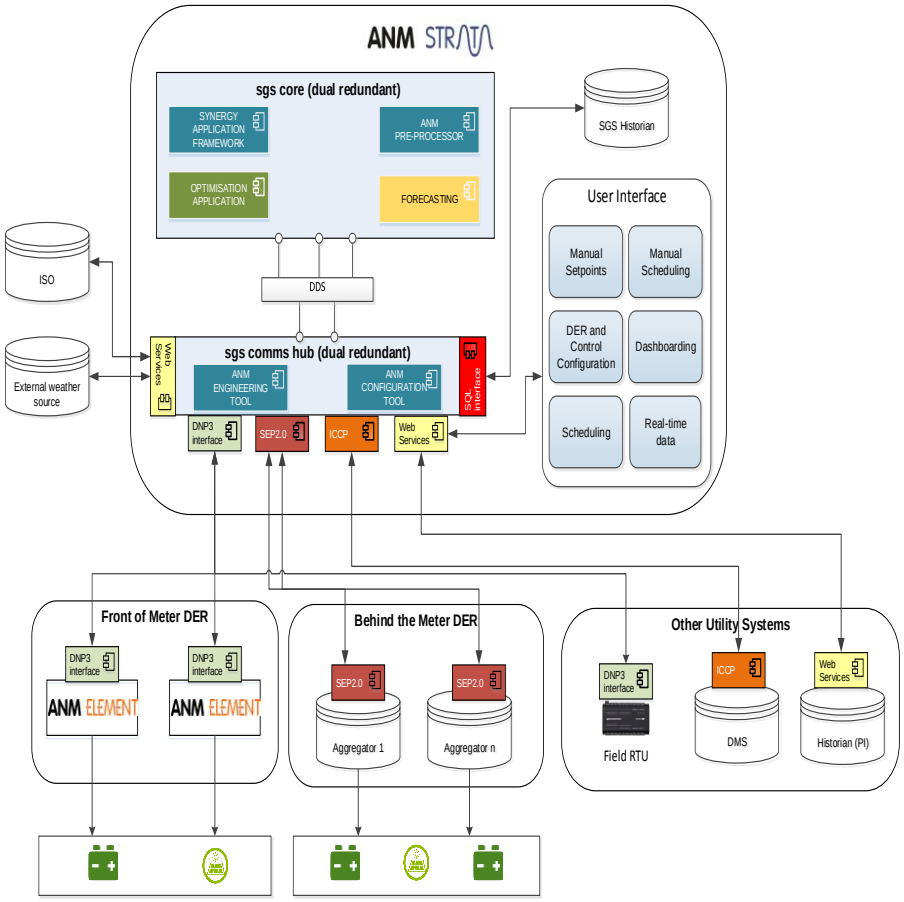
- DER forecasting
- Optimization & Scheduling
- Microgrid
- Constraint Management

Benefit

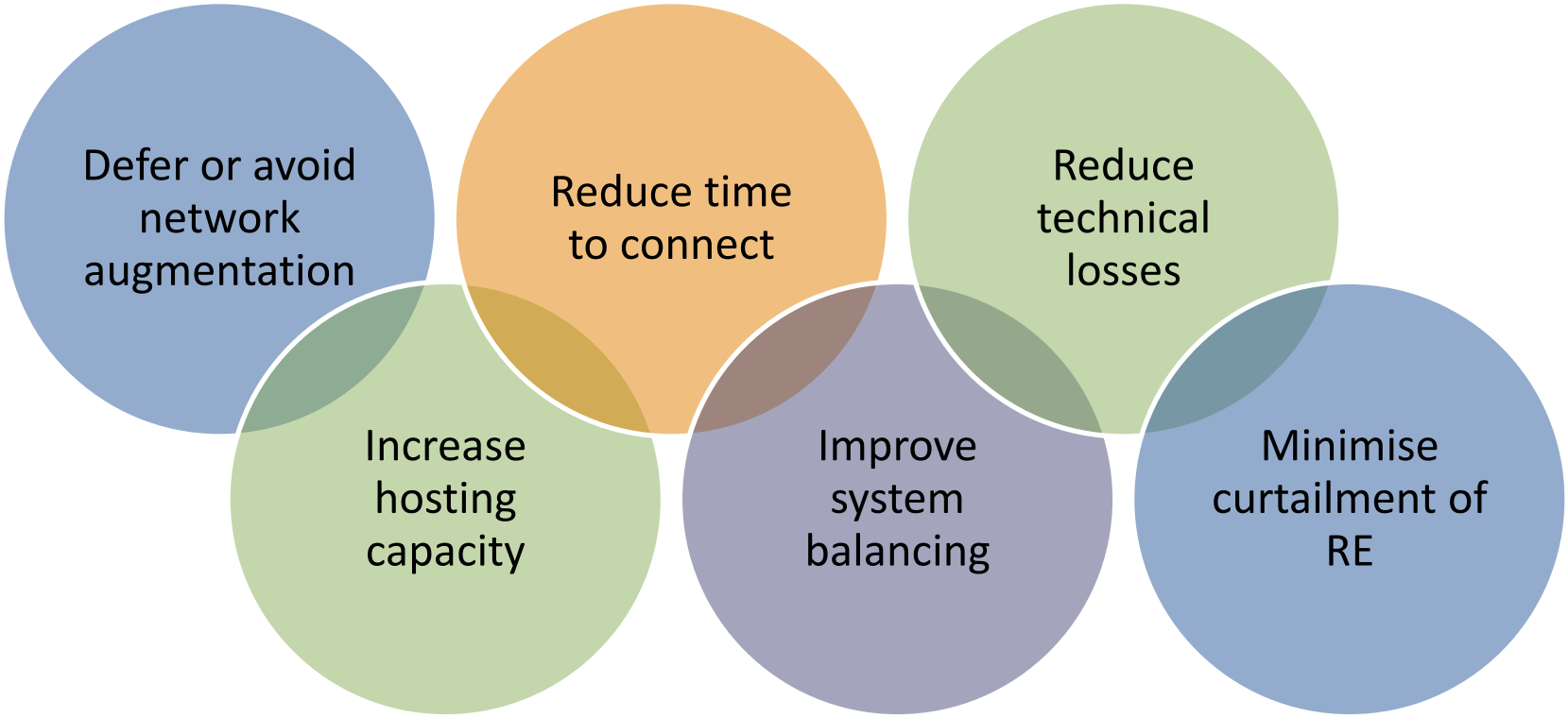
Proof of readiness of DSO platform to co-optimize multiple use cases

Facilitates utility transition to transactive energy system

Massively increased DER penetration

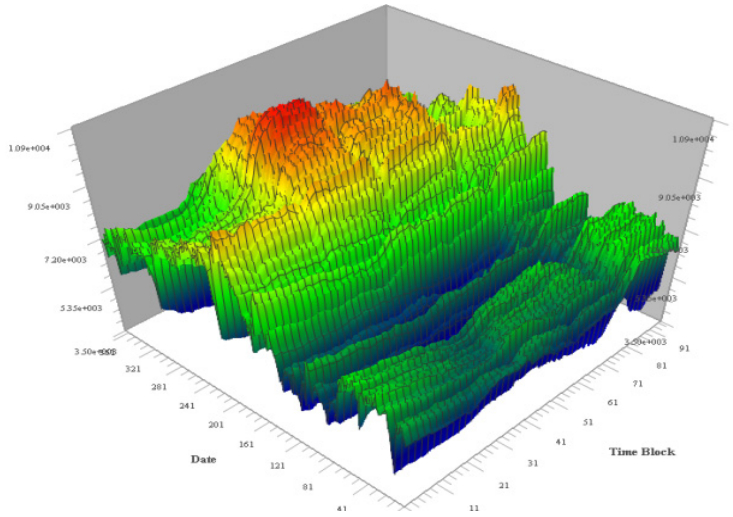


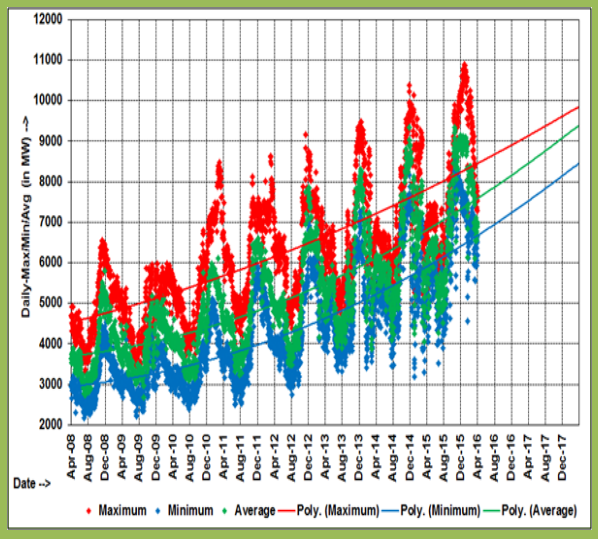
The Benefits of ANM



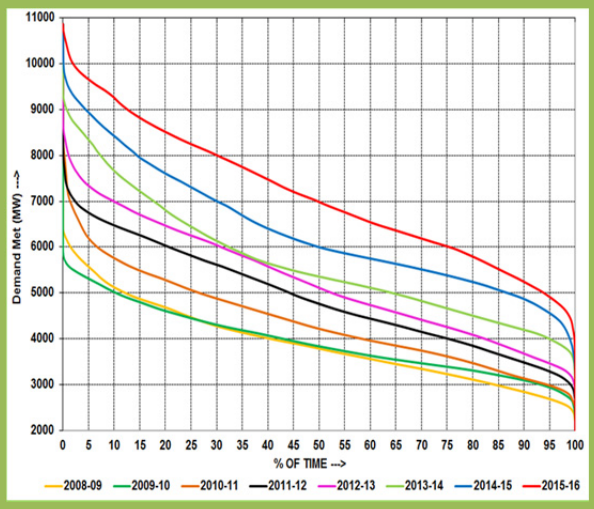
What is required?

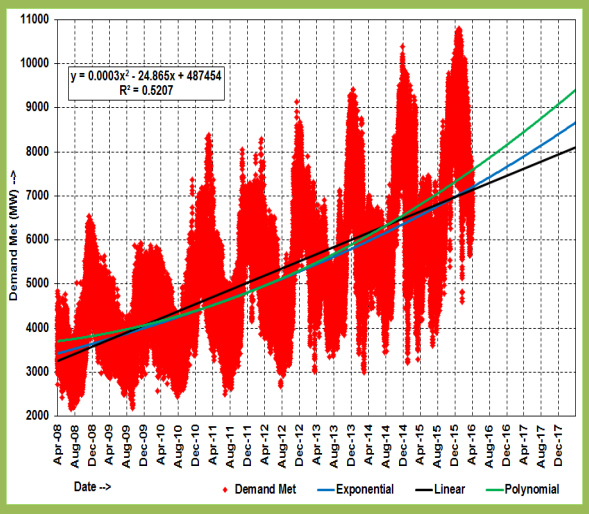
Support for Non Wires Alternatives	• Active Network Management • Energy Storage • Curtailment of renewables (e.g. 5% Rule in Germany)
Support for innovation	• Technical and commercial
Support network flexibility	• Pilot projects in India to prove the market and the concept • Support for the DISCOMs when they embrace ANM



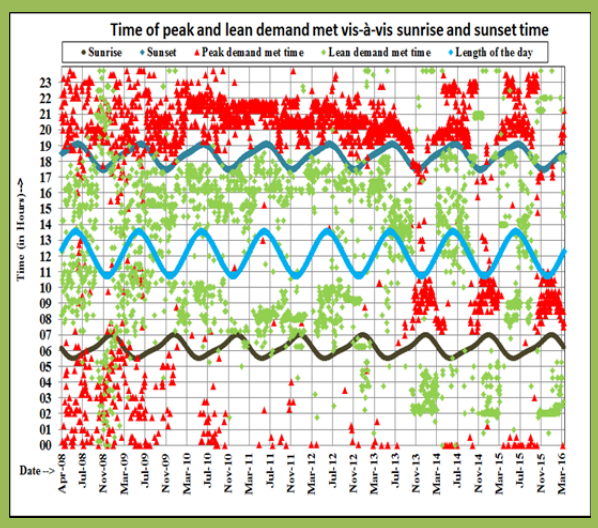


Electricity Demand Pattern Analysis





Volume-II



Power System Operation Corporation Ltd.

2016

Electricity Demand Pattern Analysis

MADHYA PRADESH

Volume-II

2016

Power System Operation Corporation Limited

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New Delhi-110016

Executive Summary

Power Sector is a key infrastructure facilitating the overall socio-economic progress of the country. The Indian electricity grid is one of the largest synchronous power system networks in the world. It has an installed generating capacity of about 307 GW as on 31.10.2016.

State, Regional and National Load Despatch Centres (SLDCs, RLDCs and NLDC), as mandated by the Electricity Act 2003, carry out the supervision and control of Indian electricity grid. The decision of system operators in SLDCs, RLDCs and NLDC greatly depends on the visualization and situational awareness through data or information available in real time through the Supervisory Control and Data Acquisition System (SCADA), Energy Management System (EMS) as well as the Wide Area Measurement System (WAMS).

Real-time data is being stored at different levels of load despatch centres. NLDC, at the national level, has been archiving the real-time data since 2008. A report on "Electricity Demand Pattern Analysis" has been prepared in order to extract wisdom from the statistical analysis of eight (8) years' time-series data.

This report aims to provide insights towards diurnal, seasonal and yearly pattern of electricity demand. This report also attempts to look at the load curves through analysis of time series data. This report provides useful information on demand pattern, decomposition of demand data into seasonal and trends etc at an all India level, each of the five (5) regions and thirty four (34) states/UTs. This information will be helpful in generation, transmission and distribution planning by the central and state level power system planning agencies. It also provides useful insight into socio-economic aspect of a particular UT/state/ region.

Big data analytics presented in this report give a deep insight into the past patterns and provide a basis for future projections. Therefore, the data presented in the report is also a valuable input for research by the academia and the industry along with the various stakeholders.

Compilation of report used more than 38 million (total number) data samples as a whole, about fifty (50) different types of graphs and a total of one thousand and sixty five (1065) graphs. This report is compiled in two volumes. Volume-I covers the analysis of demand met patterns of the five regions and the country as a whole. Volume-II contains thirty four (34) sub-volumes one for each of the states and union territories of India.

Similar exercise replicated at the intra state level would provide a sound basis for planning at the intra state level for various infrastructure projects.

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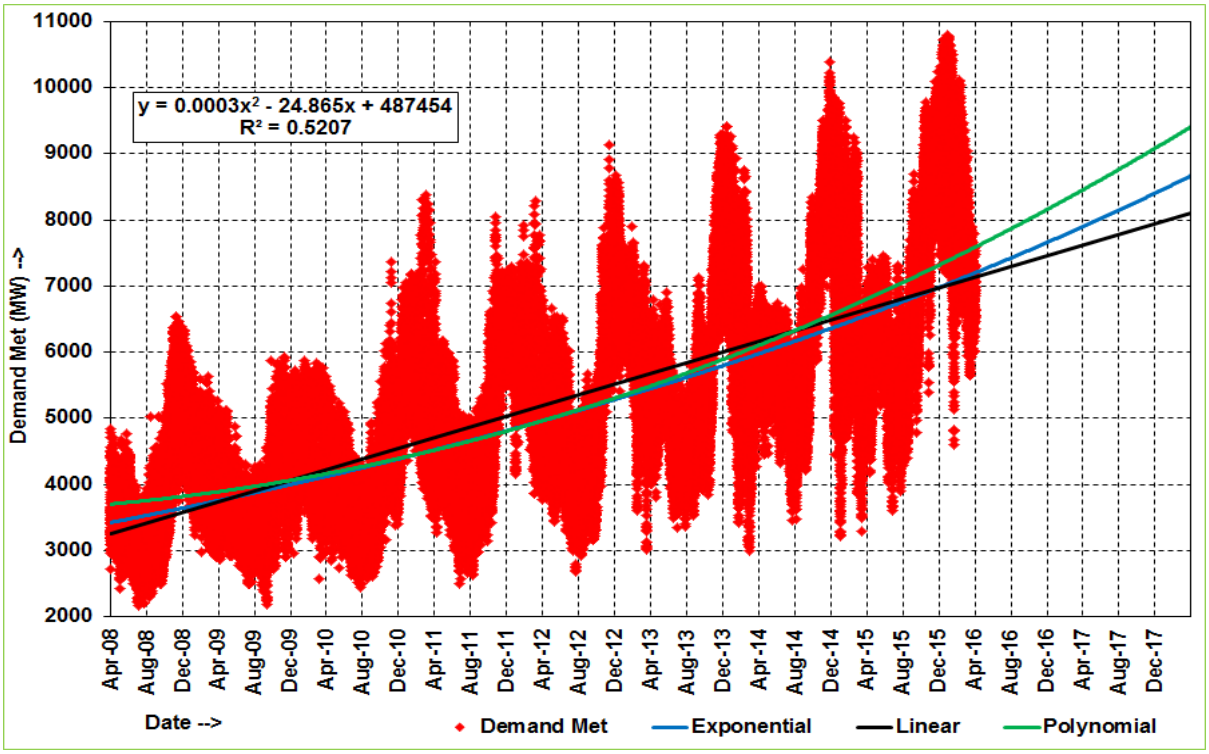
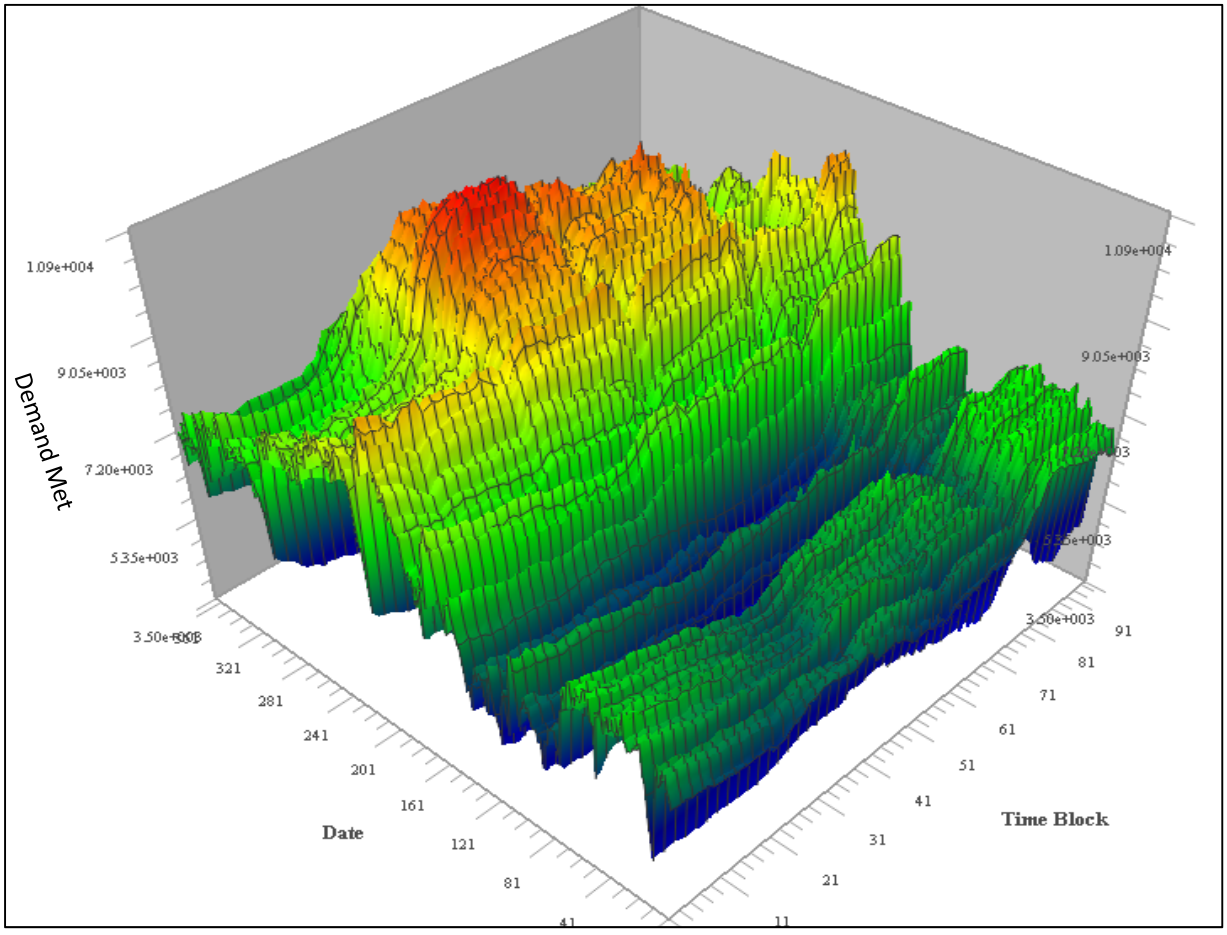
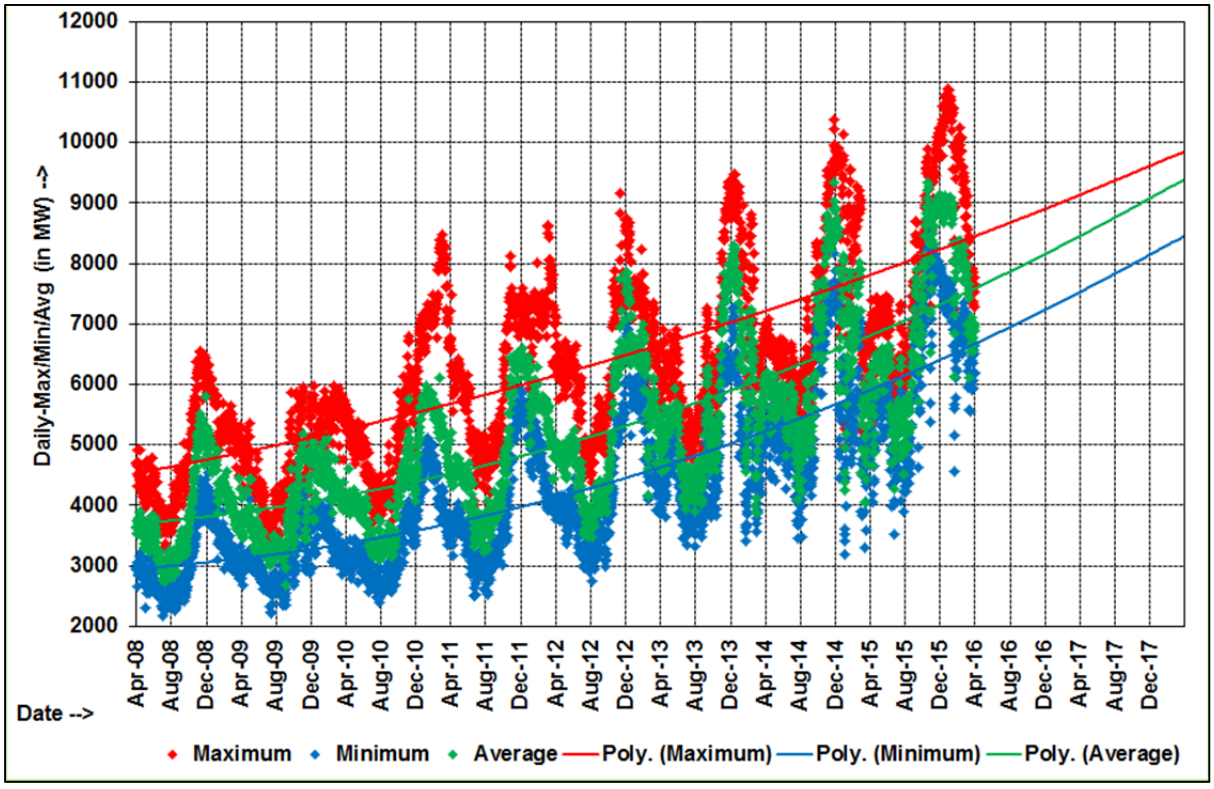


1.2. 3-D plot of annual demand met (2015-16):



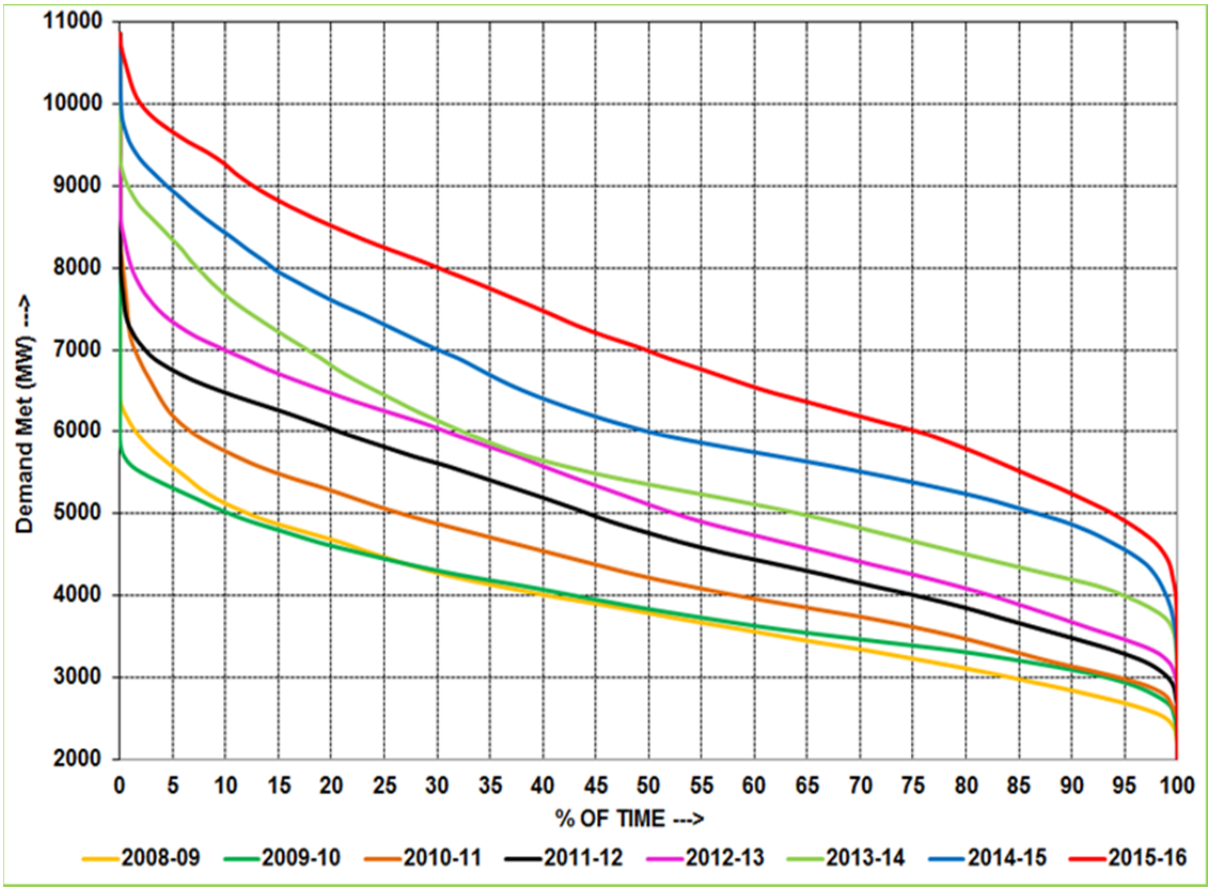
Madhya Pradesh

2. Daily maximum, minimum and average demand met pattern:



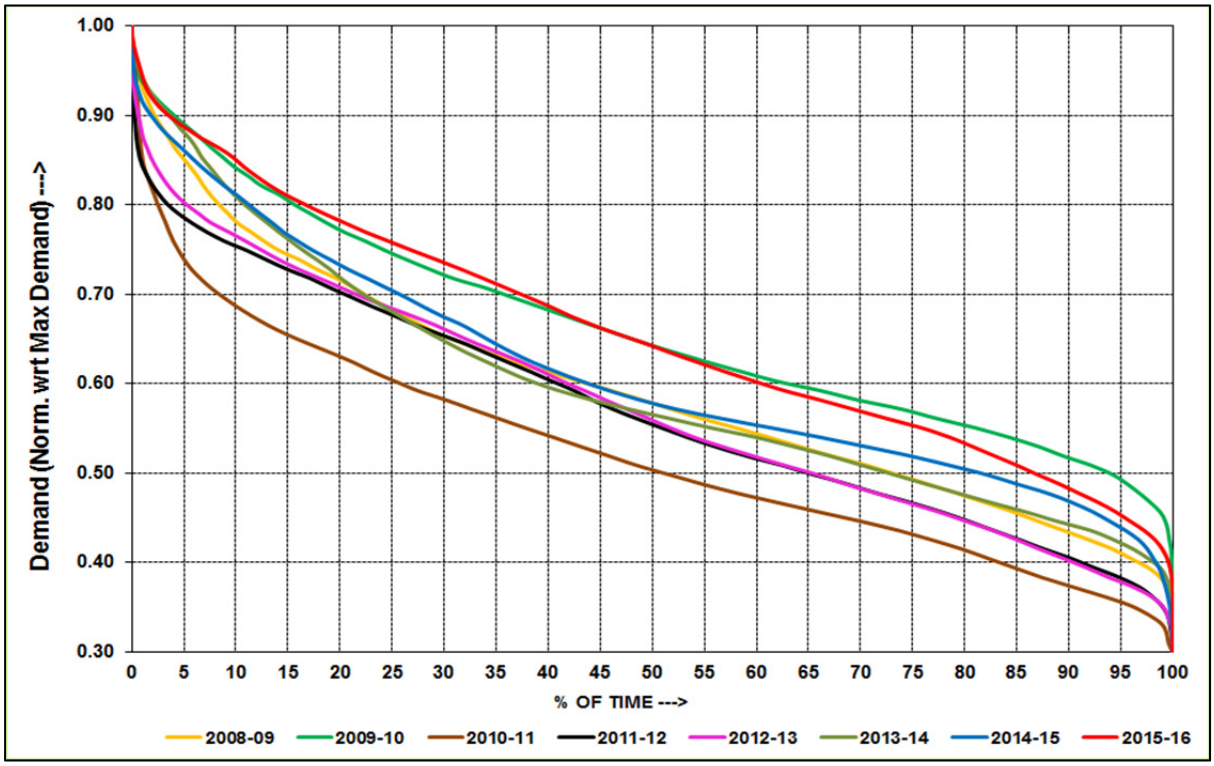
3. Demand-duration curve:

3.1. Annual Demand Duration Curve (considering block-wise samples):

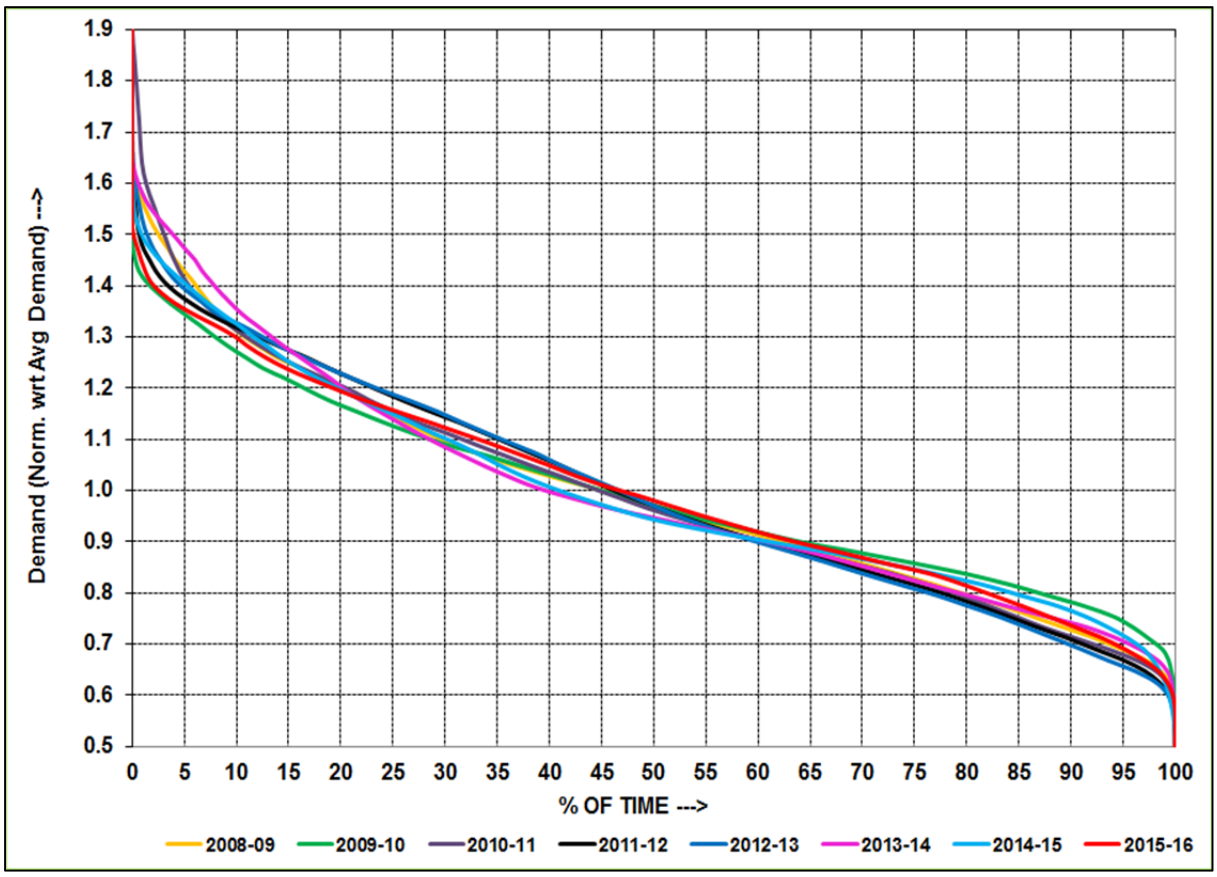


Madhya Pradesh

3.2. Annual Demand Duration Curve: Normalised with respect to Maximum Demand met (occurred during the respective year)

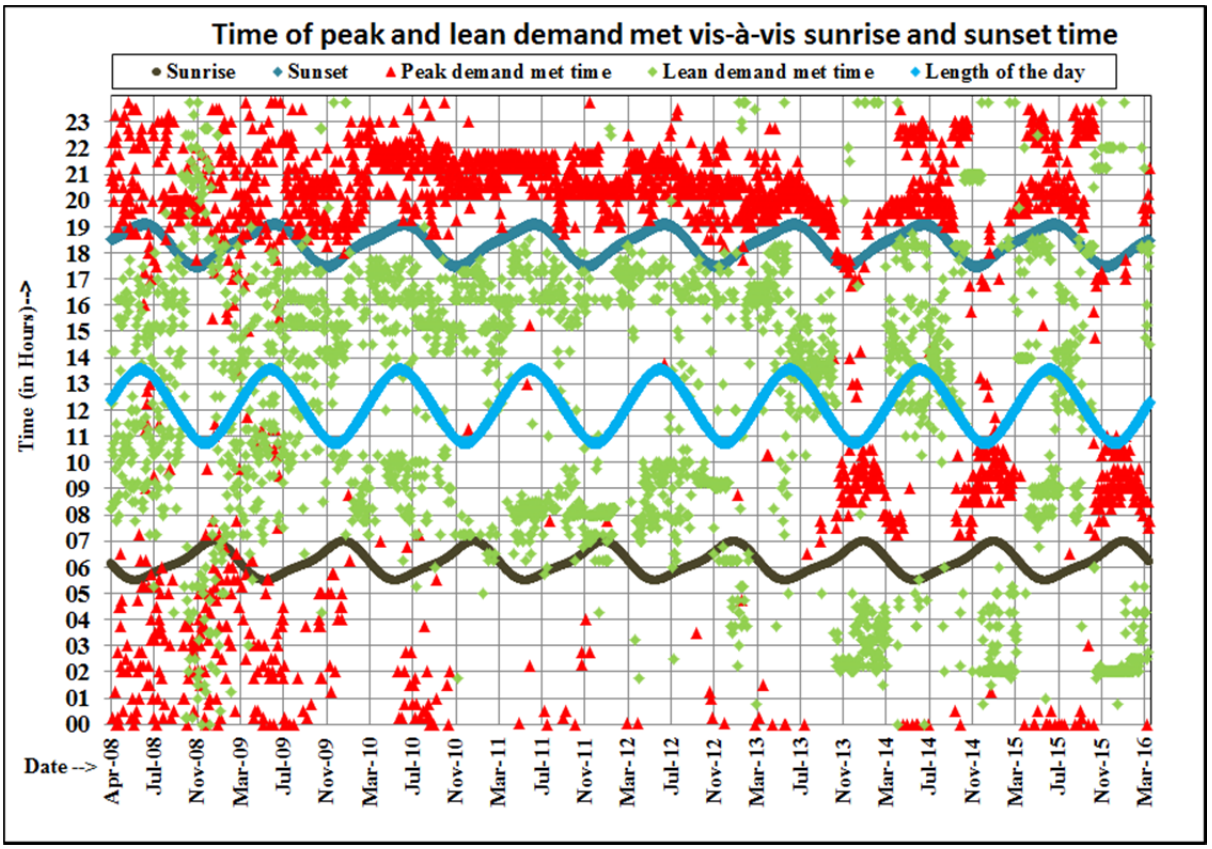


3.3. Annual Demand Duration Curve: Normalised with respect to Average Demand met

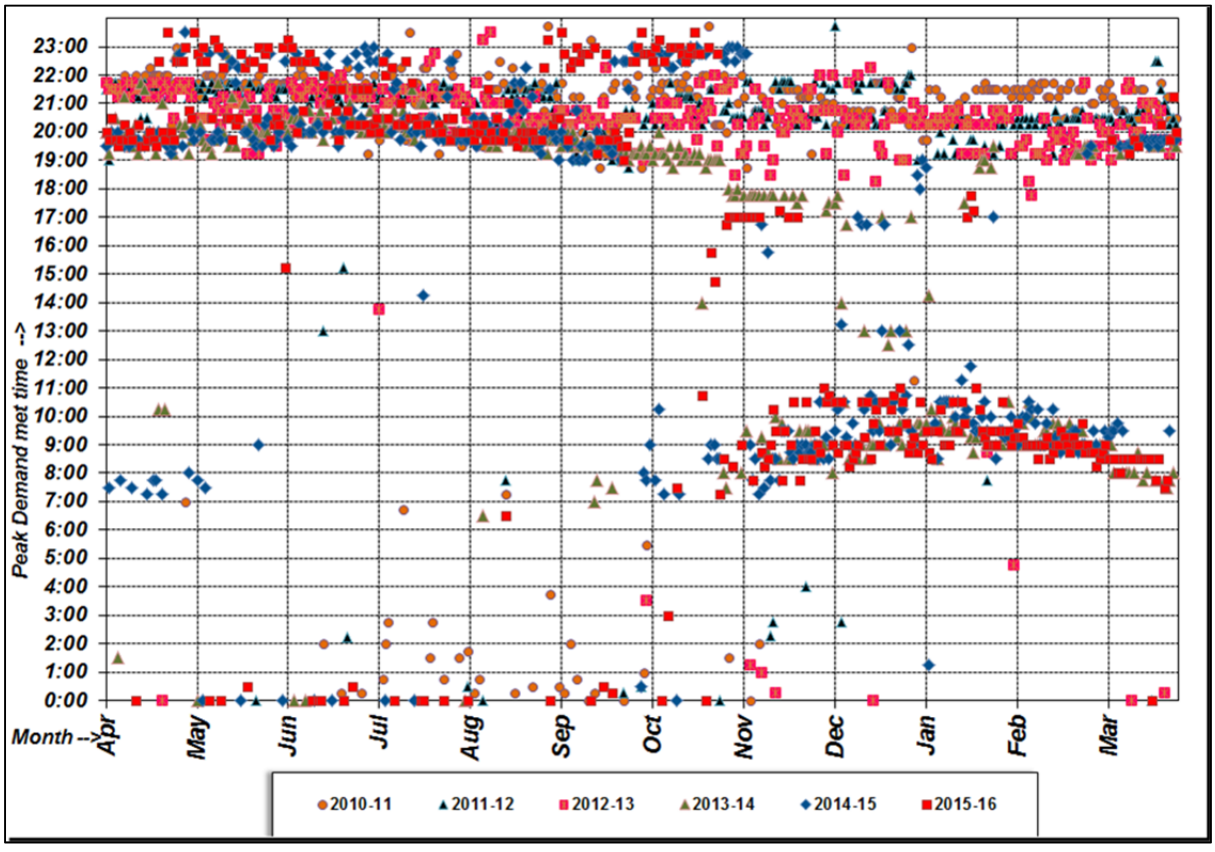


Madhya Pradesh

4. Time of daily sunset, sunrise with occurrences of peak and lean demand met



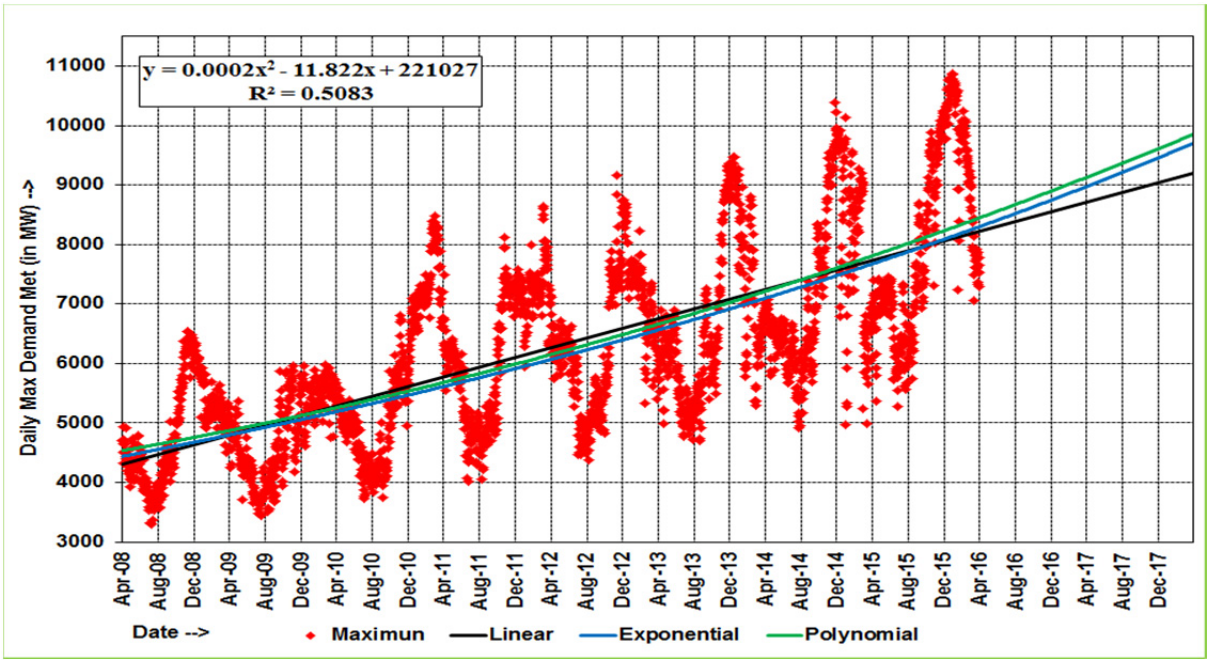
5. Maximum daily Demand Met occurrences: Year-On-Year pattern



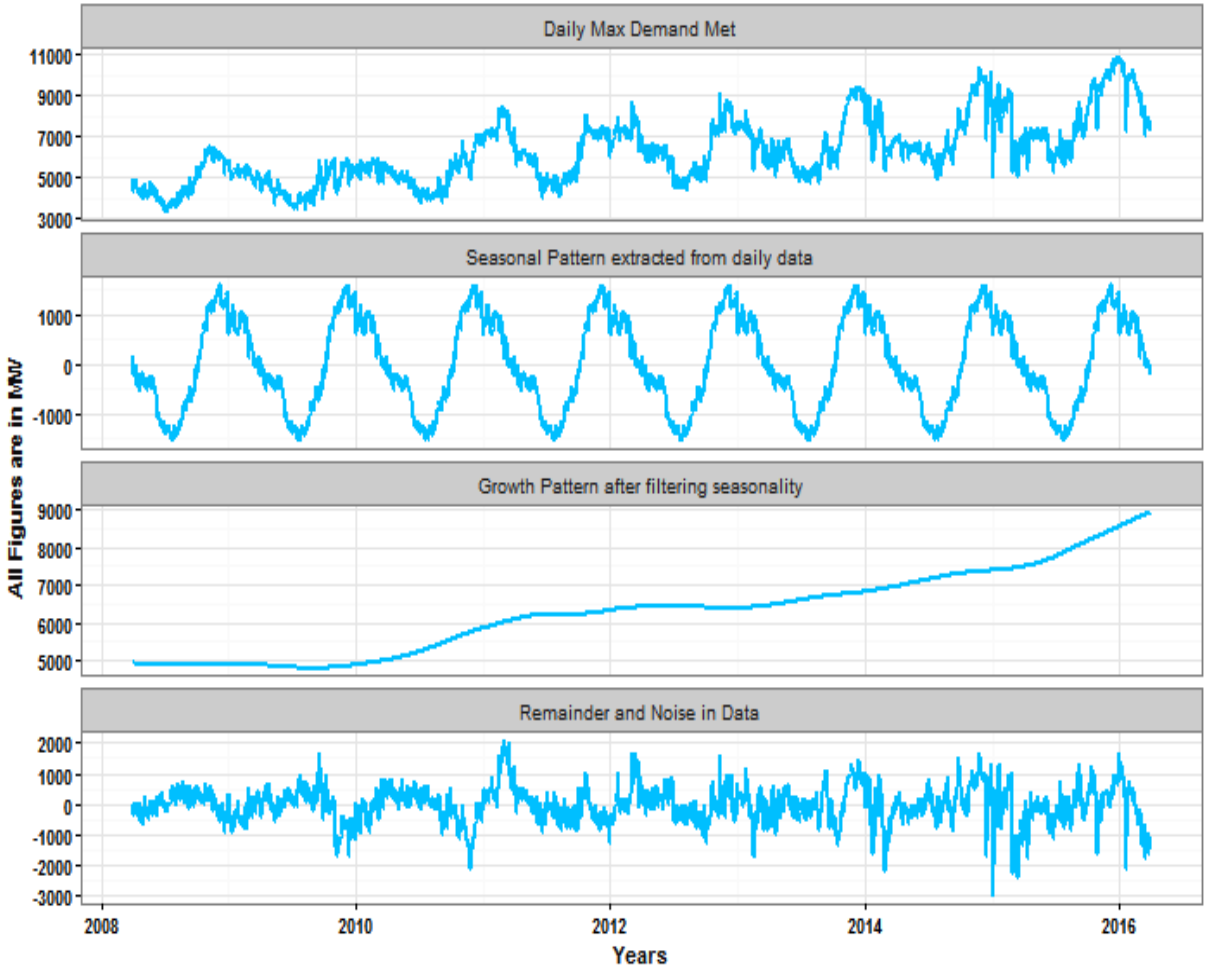
Madhya Pradesh

6. Maximum Demand Met:

6.1. Daily Maximum Demand Met Pattern:



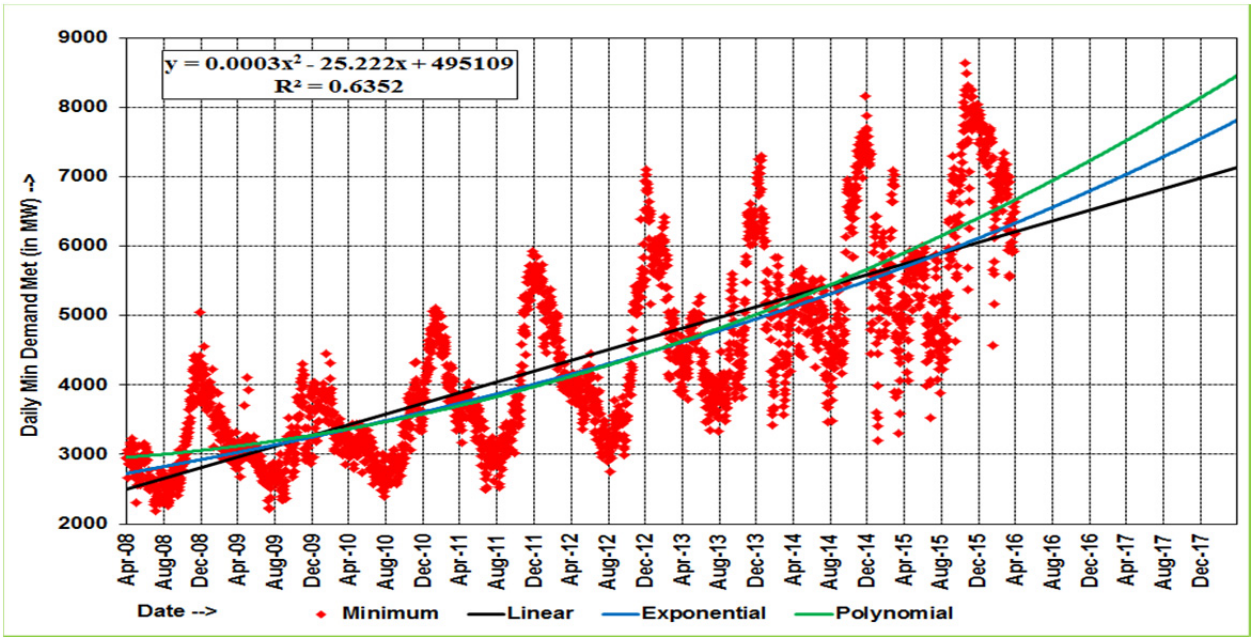
6.2. Decomposition of Daily Maximum Demand Met:



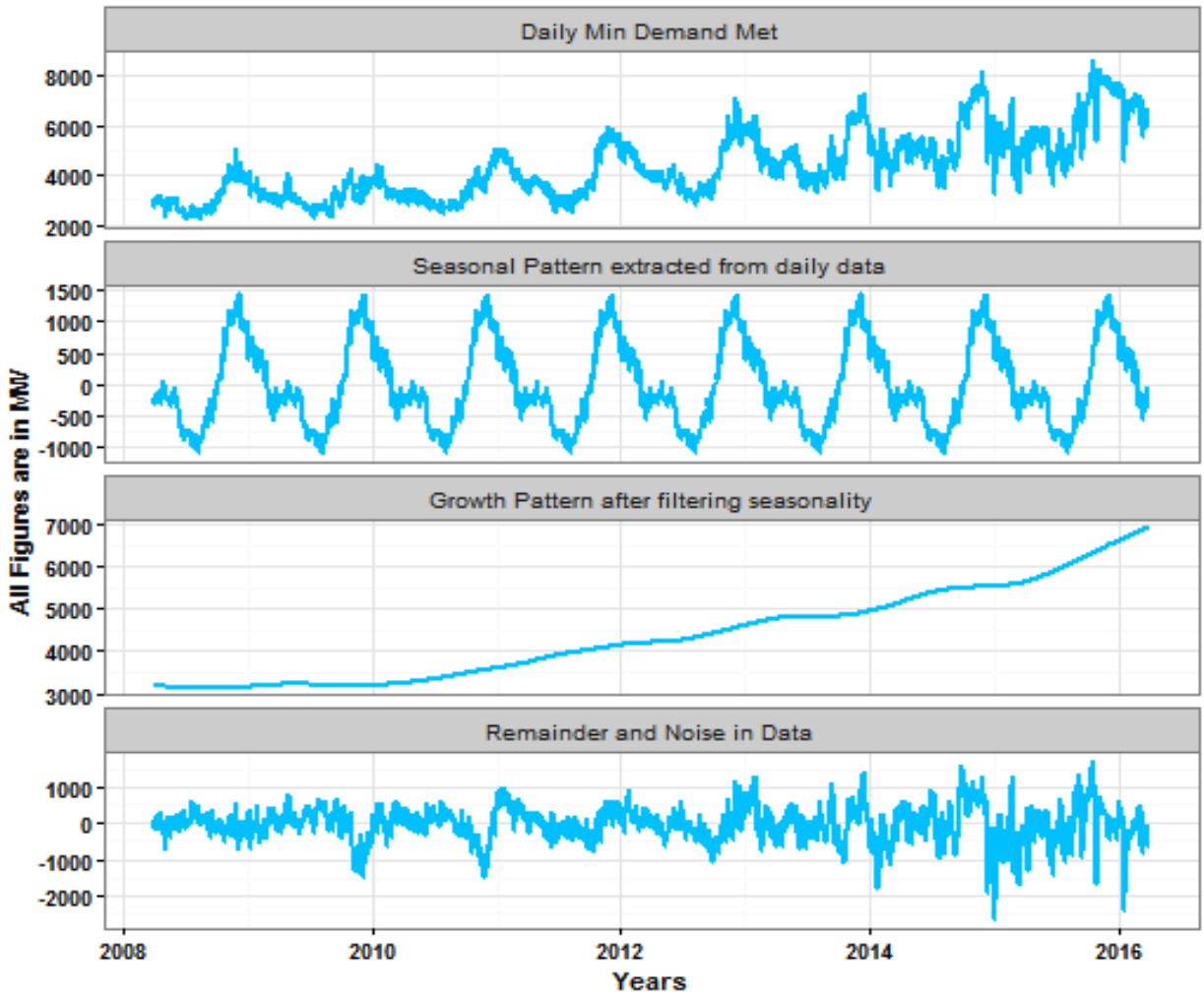
Madhya Pradesh

7. Minimum Demand Met:

7.1. Daily Minimum Demand Met Pattern:



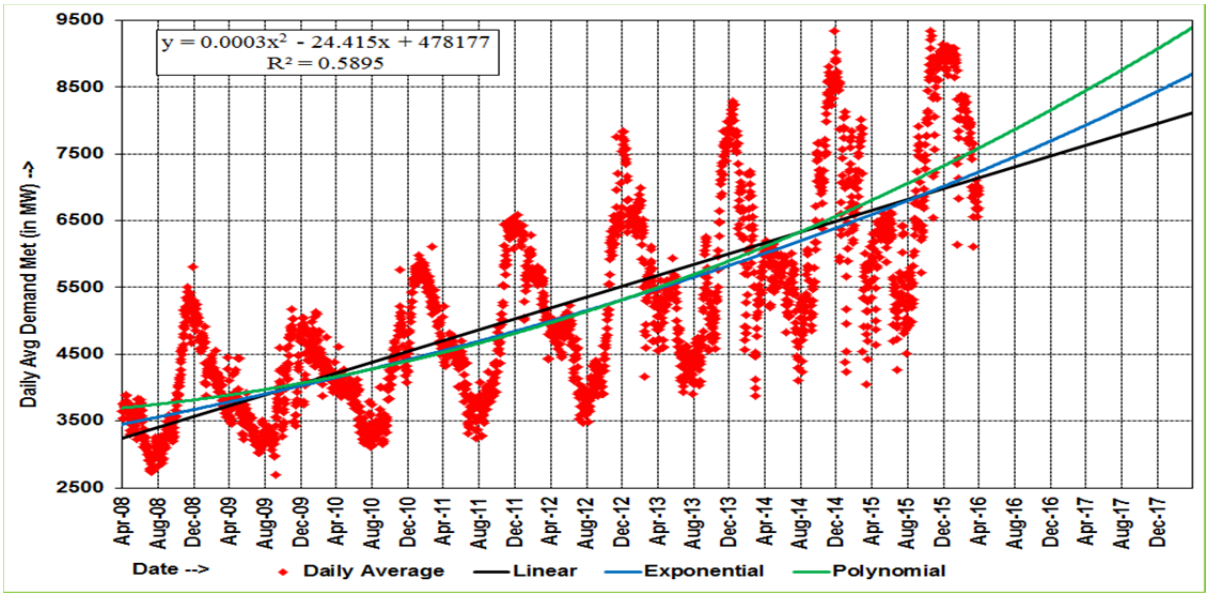
7.2. Decomposition of Daily Minimum Demand Met:



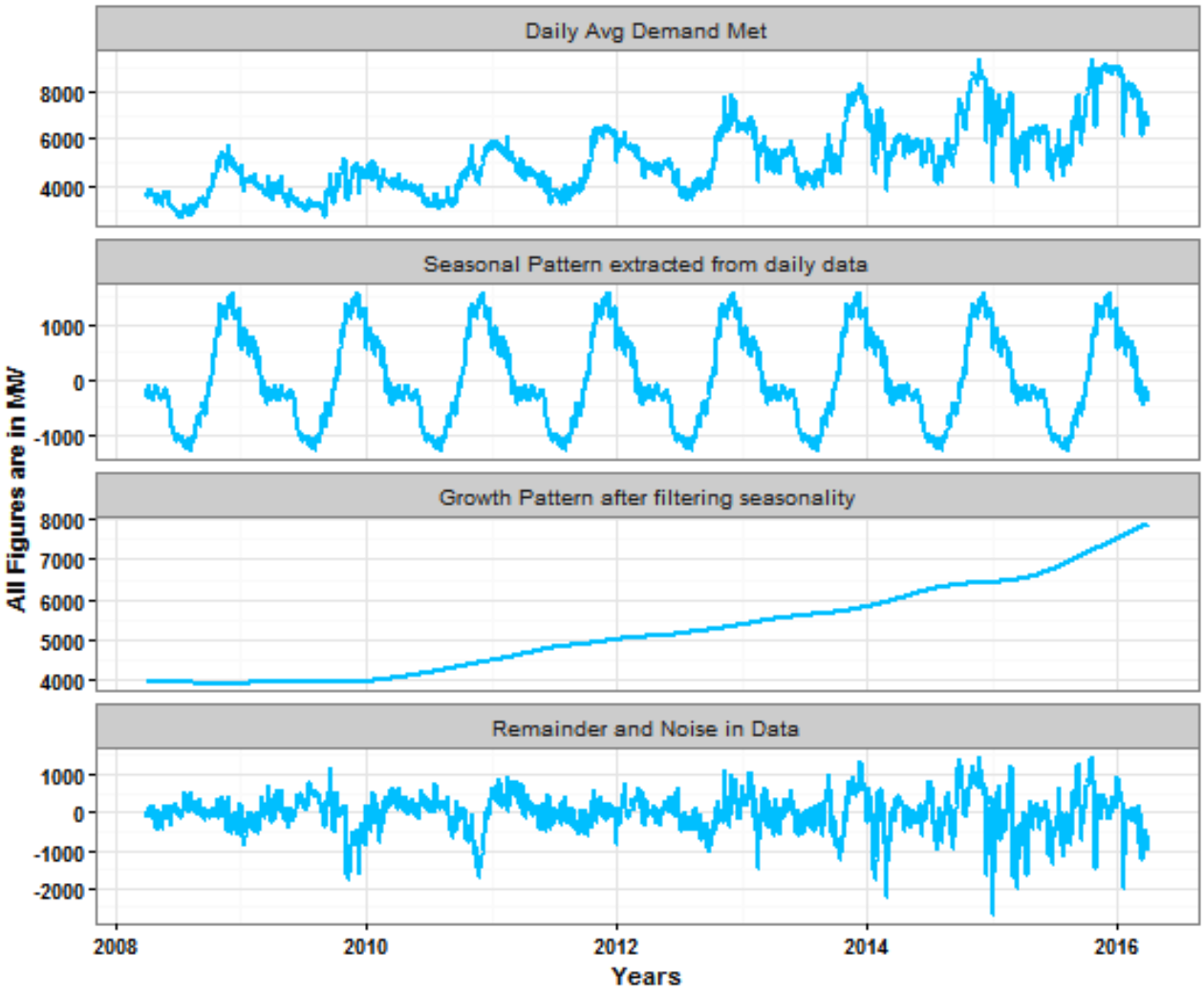
Madhya Pradesh

8. Average Demand Met:

8.1. Daily Average Demand Met Pattern:



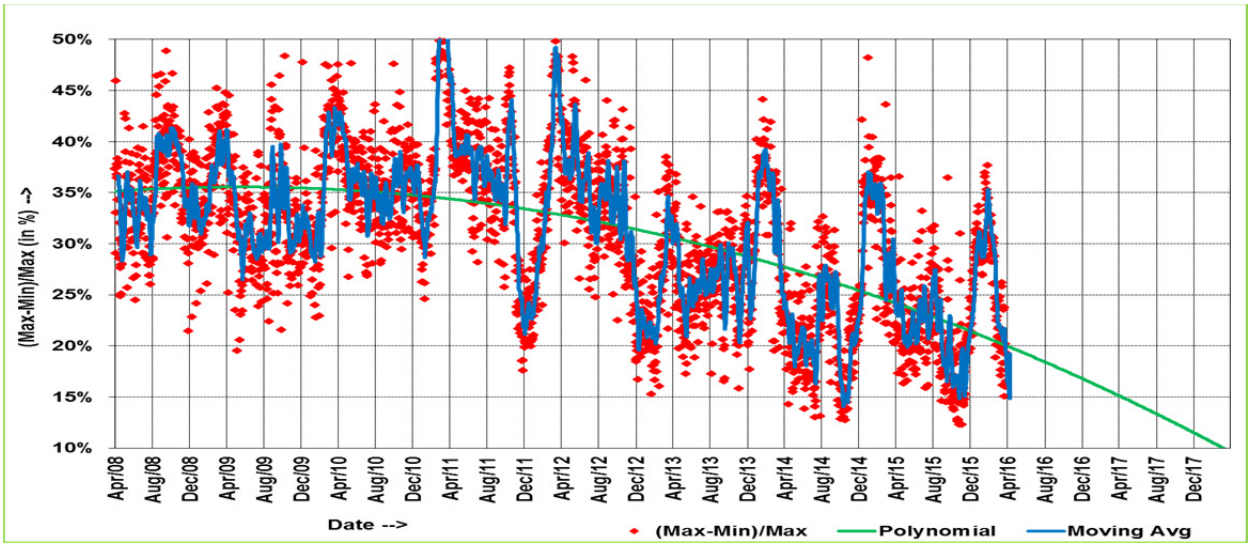
8.2. Decomposition of Daily Average Demand Met:



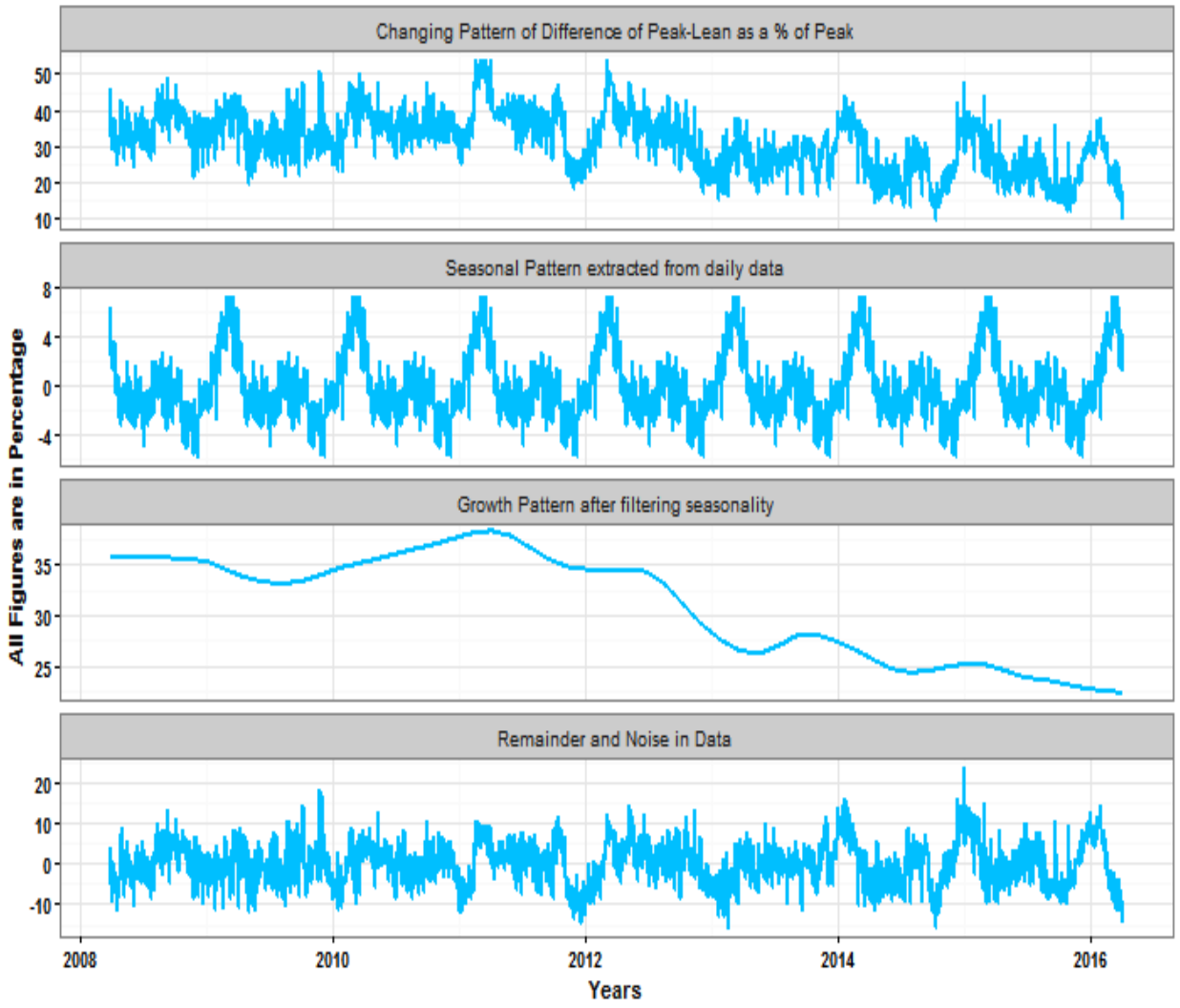
Madhya Pradesh

9. Difference of Peak and Lean demand as a Percentage of Peak demand:

9.1. Daily difference of Peak and Lean as a Percentage of Peak demand met Pattern:



9.2. Decomposition of Daily Peak and Lean demand as Percentage of Peak Demand Met:



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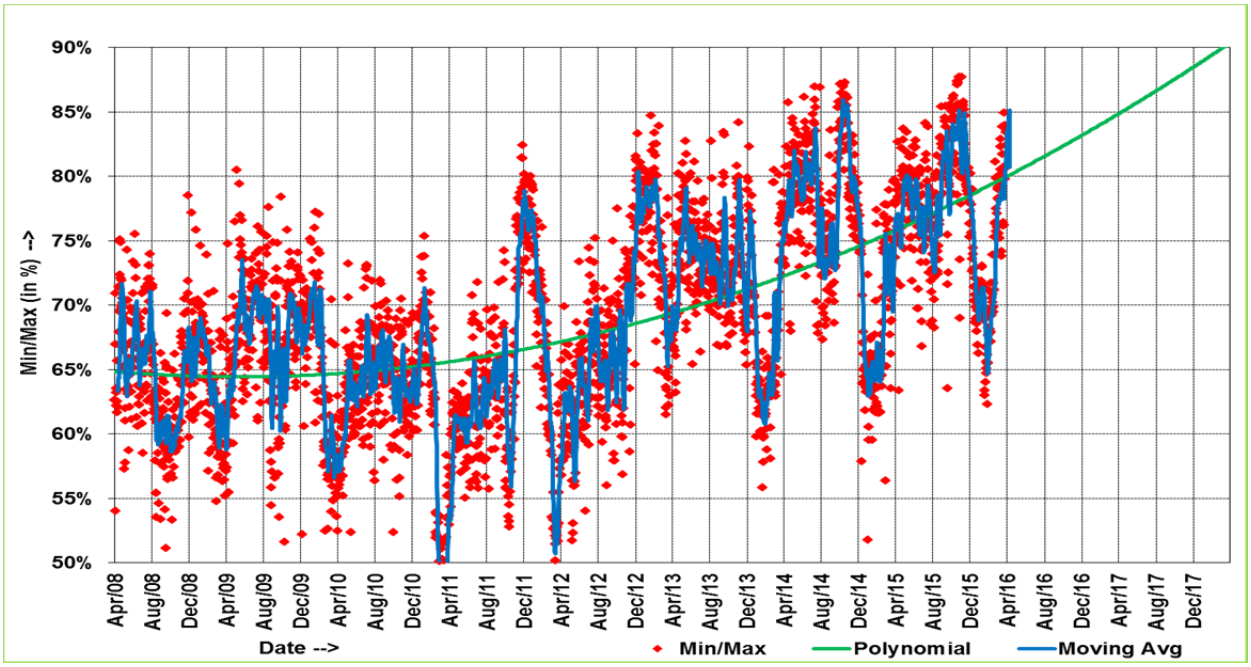
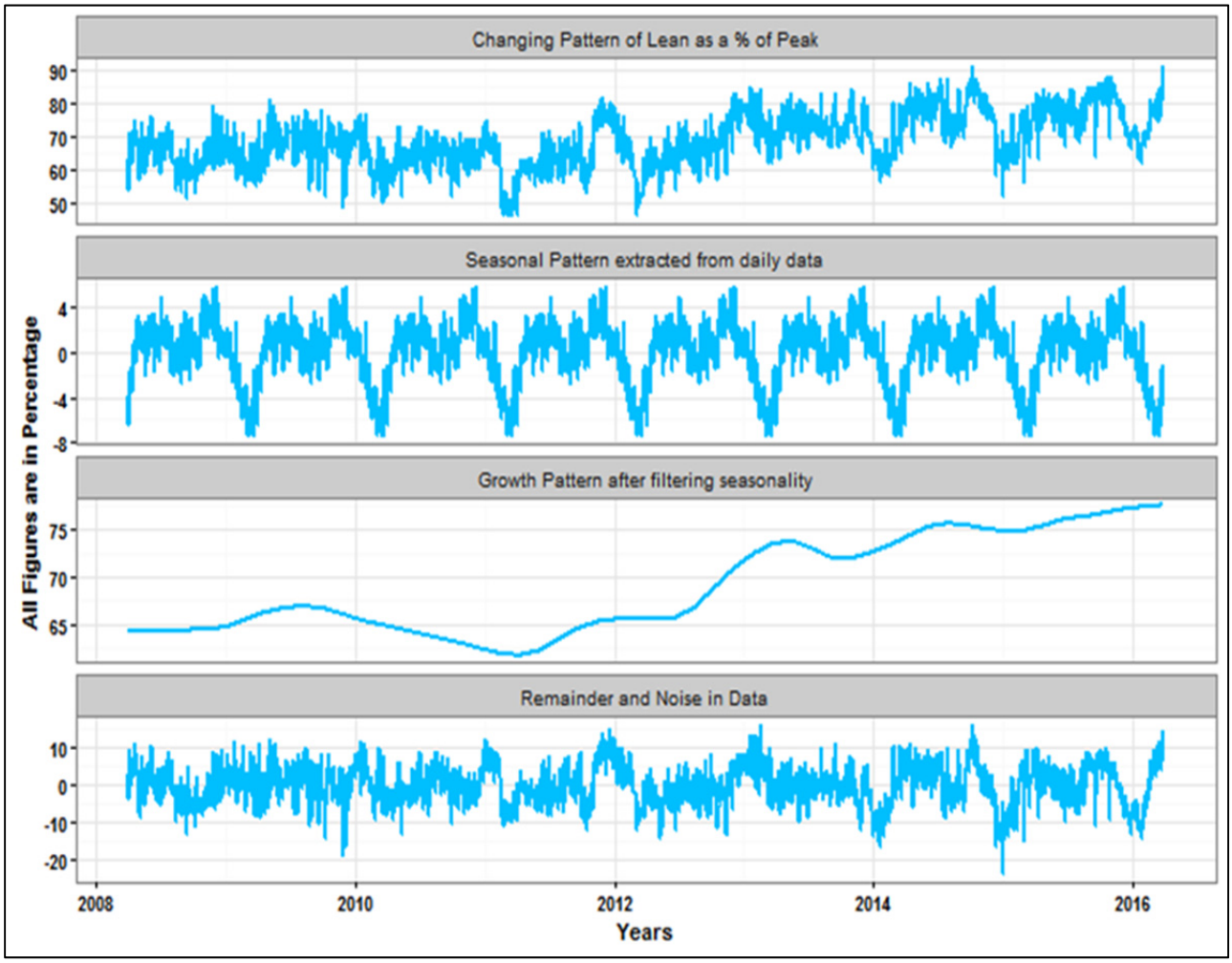
10. Lean as a Percentage of Peak :

10.1. Daily Lean demand as a Percentage of Peak demand met Pattern:

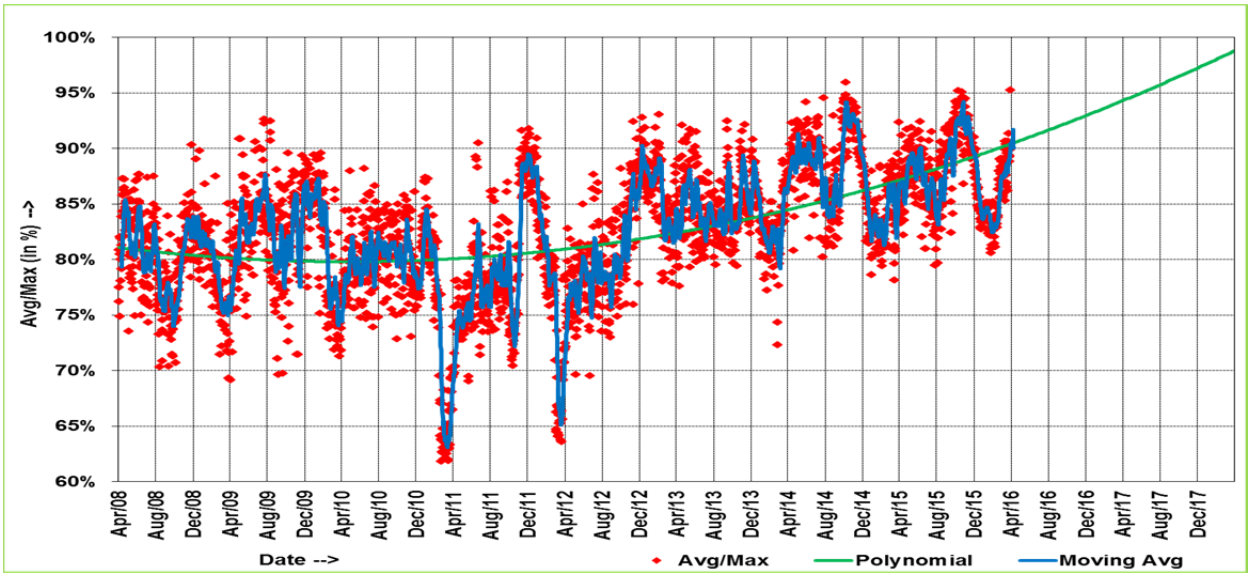


10.2. Decomposition of Daily Lean as a Percentage of Peak Demand Met:

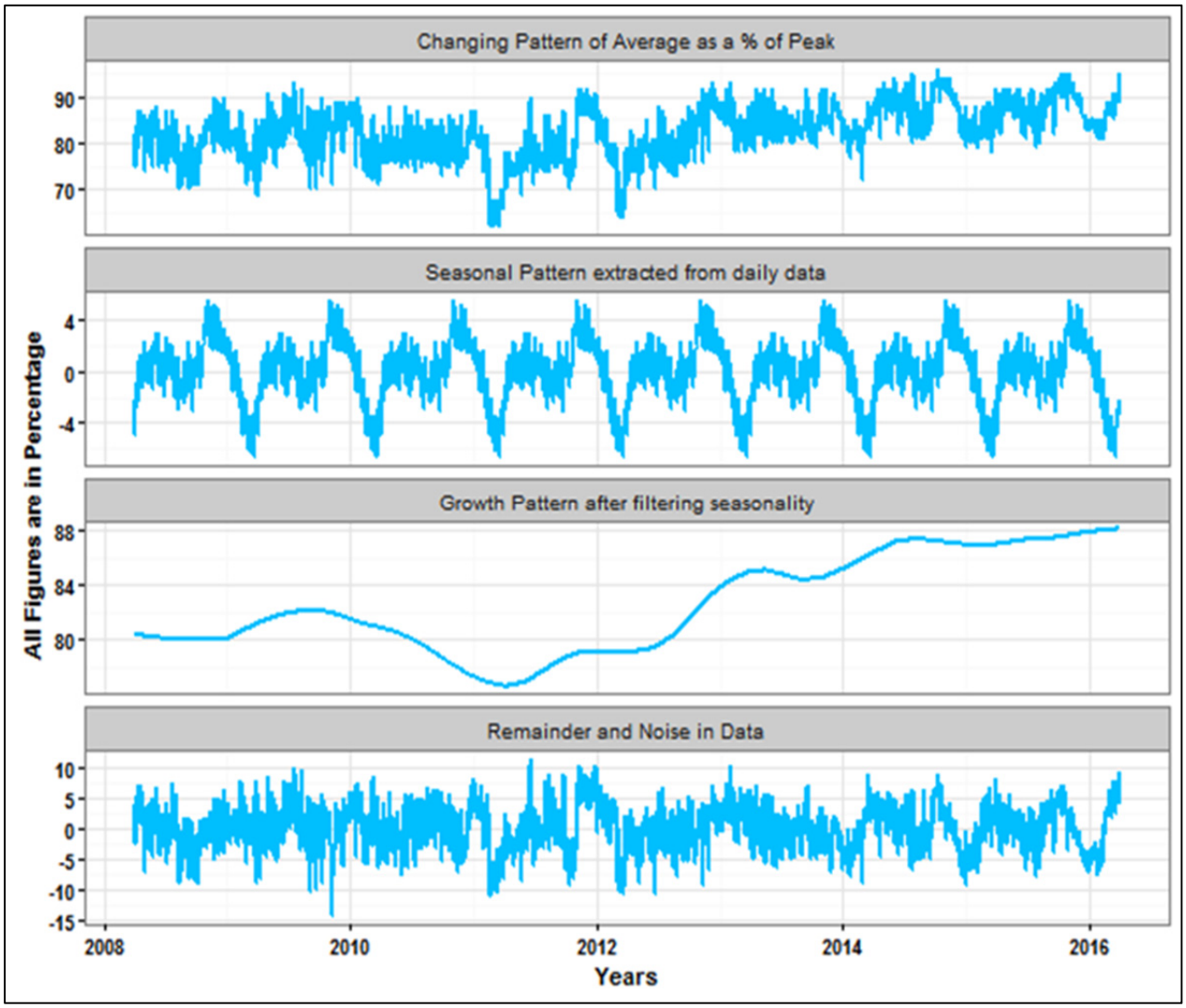


11. Average as a Percentage of Peak (Load Factor):

11.1. Daily Average demand as a Percentage of Peak demand met (Load Factor):



11.2. Decomposition of daily load factor:



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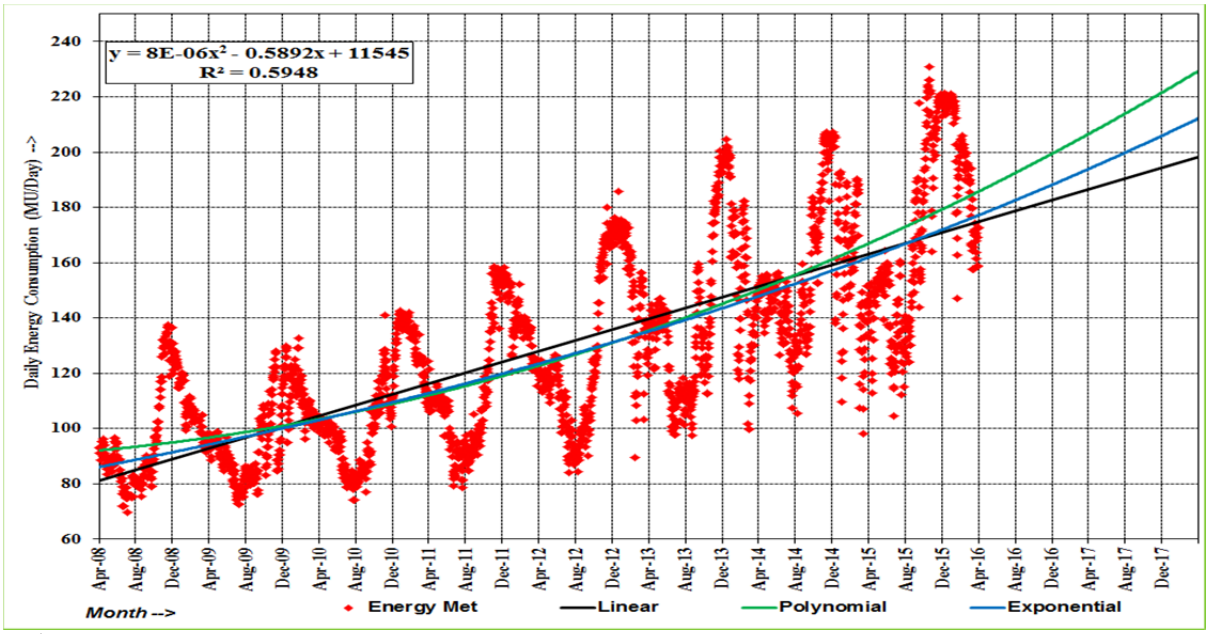
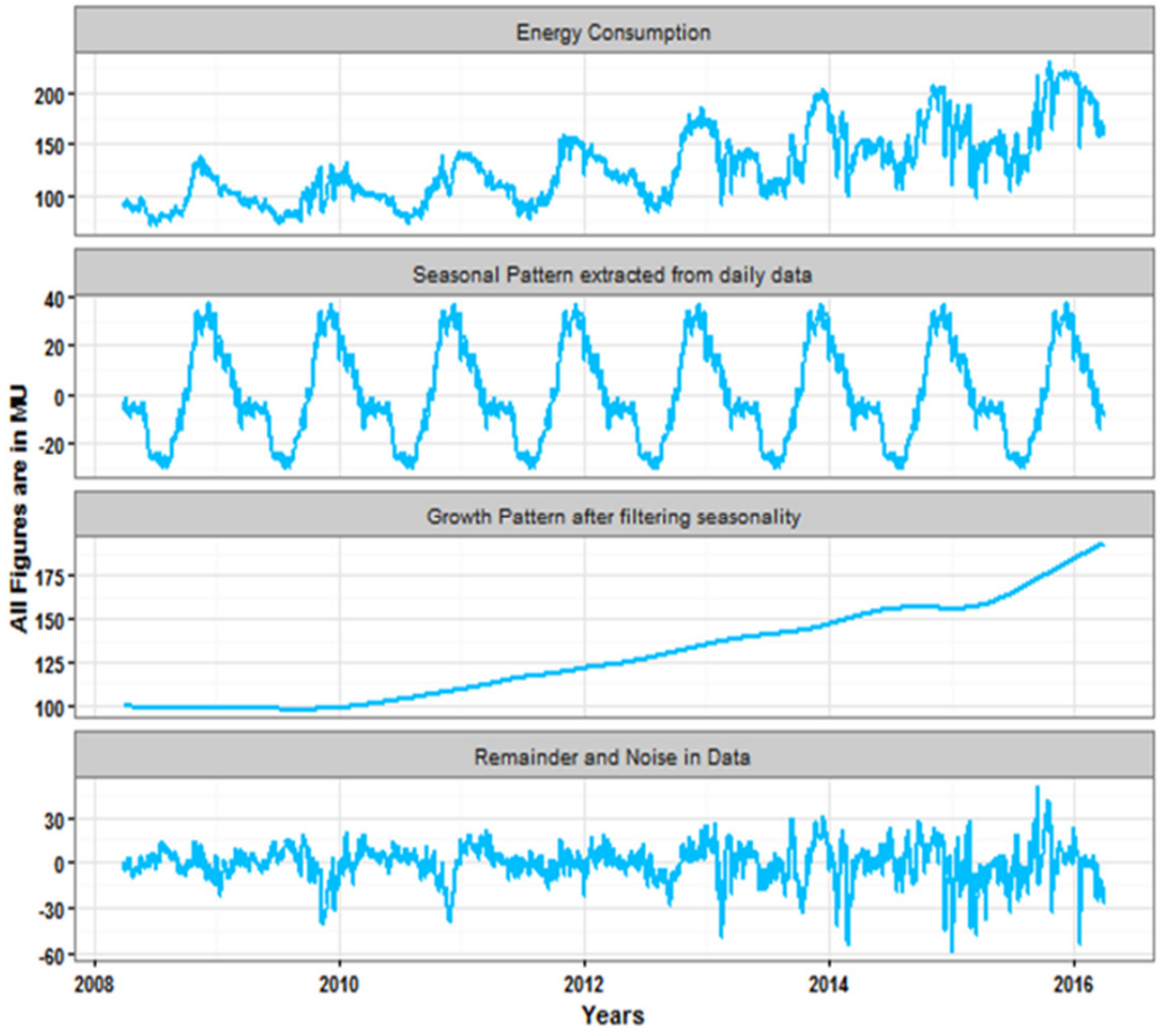
12. Daily energy met:

12.1. Daily energy consumption pattern:



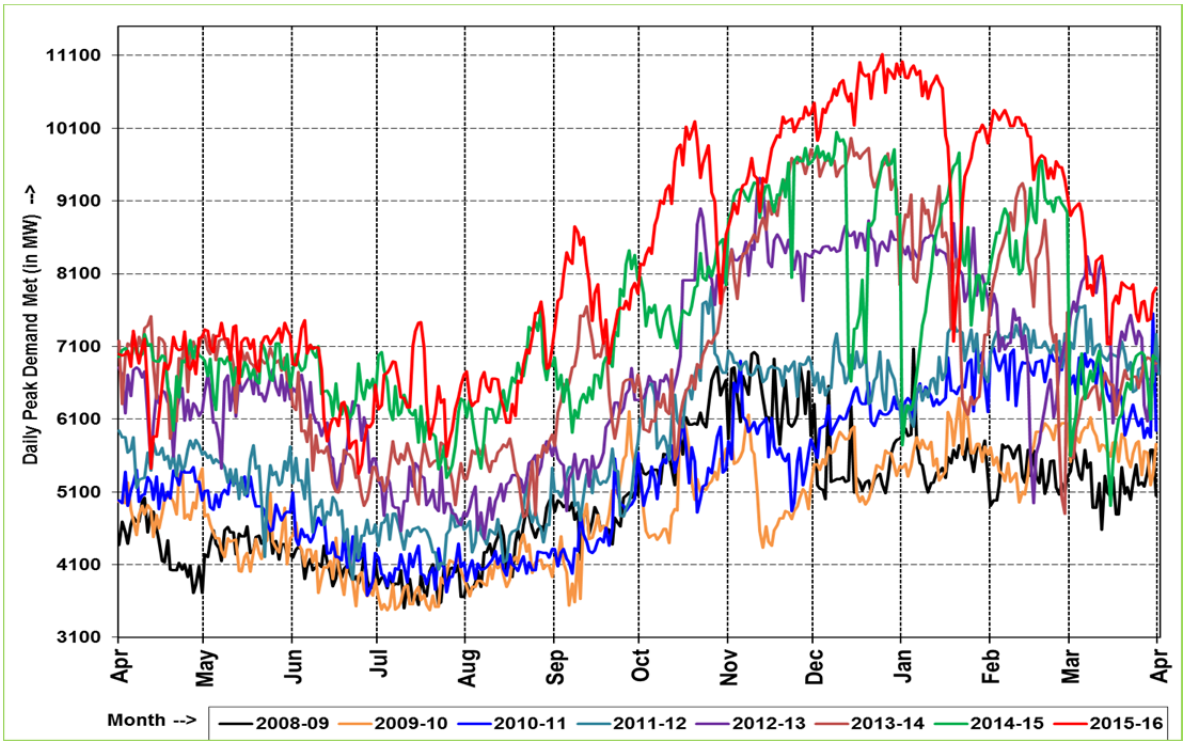
12.2. Decomposition of Daily Energy met:



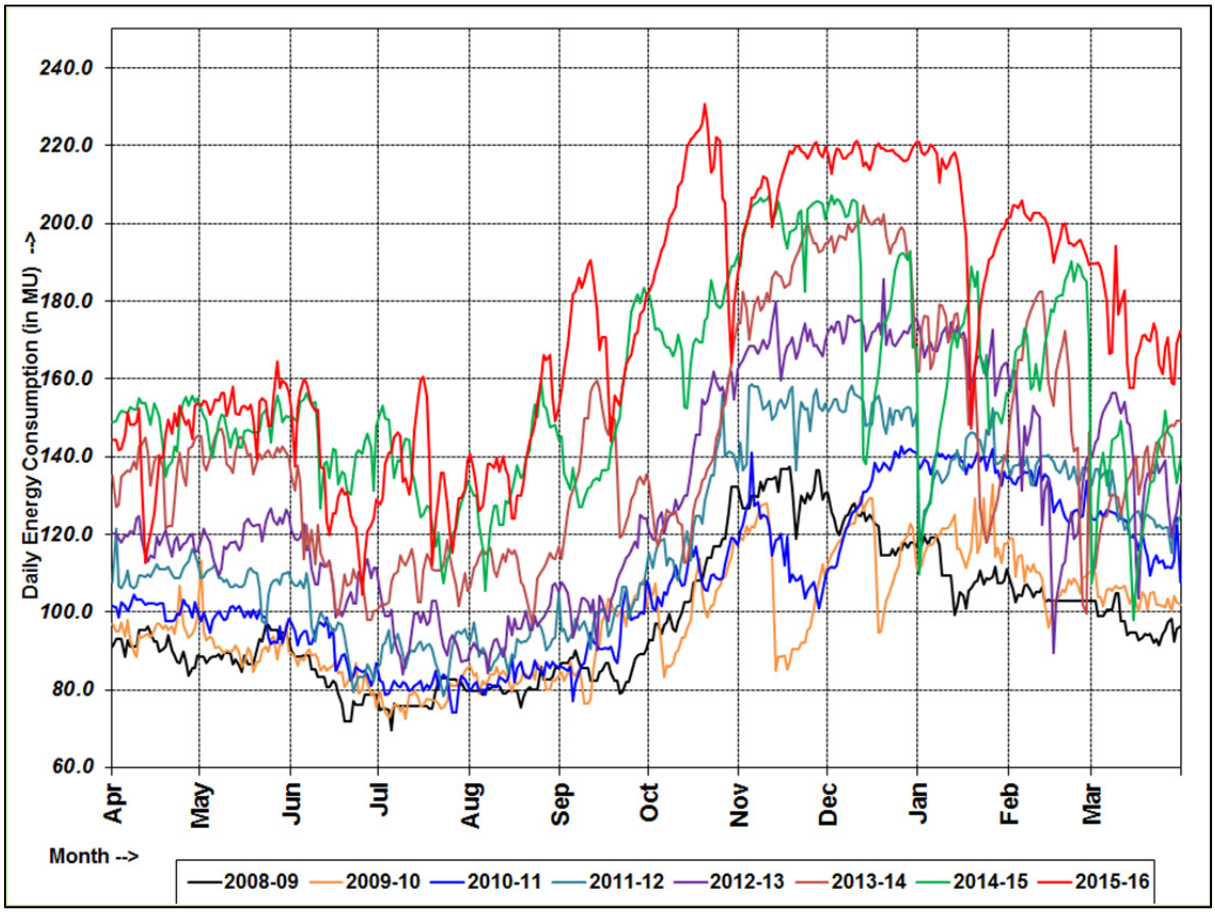
Madhya Pradesh

13. Daily Peak Demand met and Energy Consumption Pattern (Off-line data):

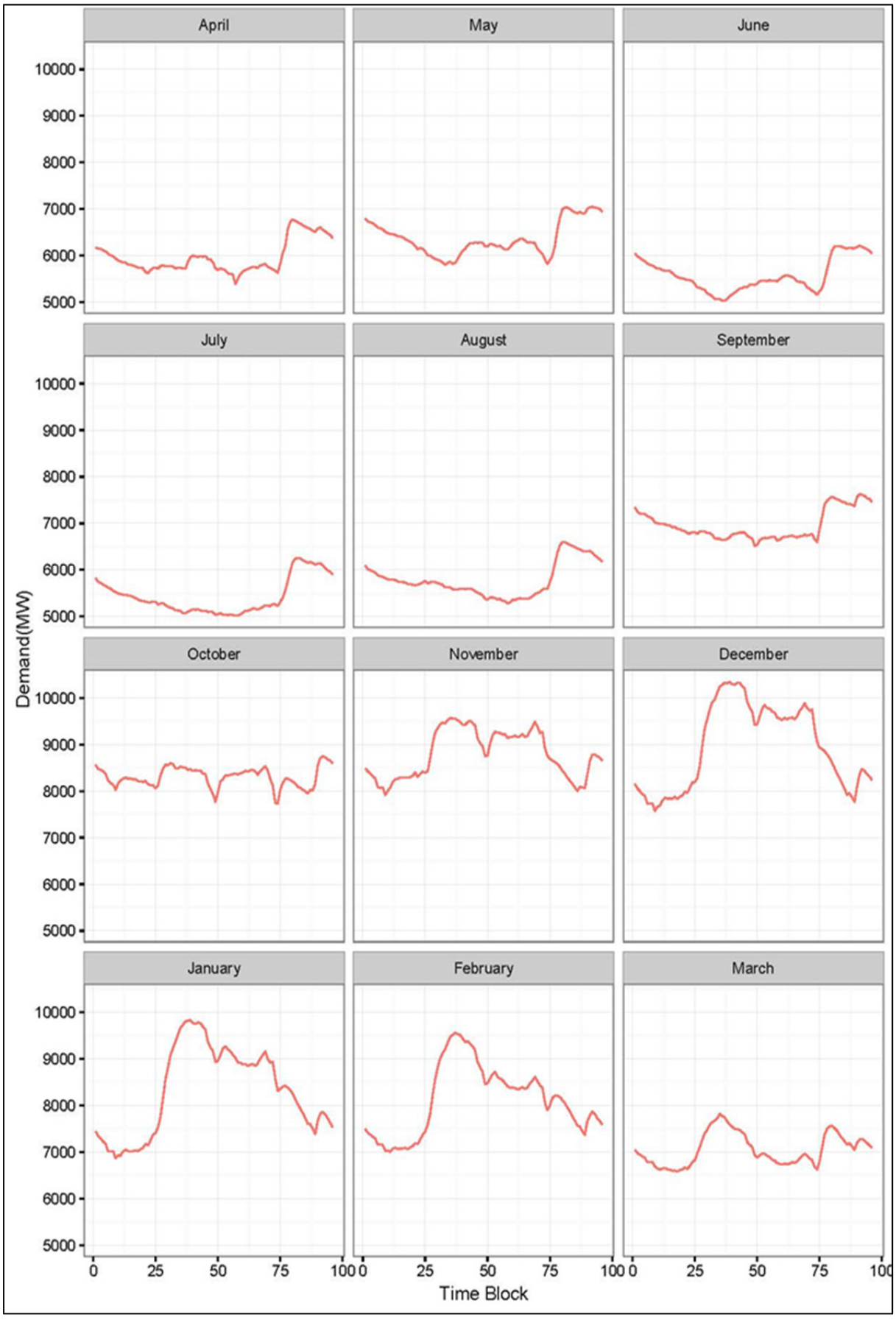
13.1. Daily Peak Demand met pattern:



13.2. Daily energy consumption pattern:



14. Typical monthly demand met pattern:



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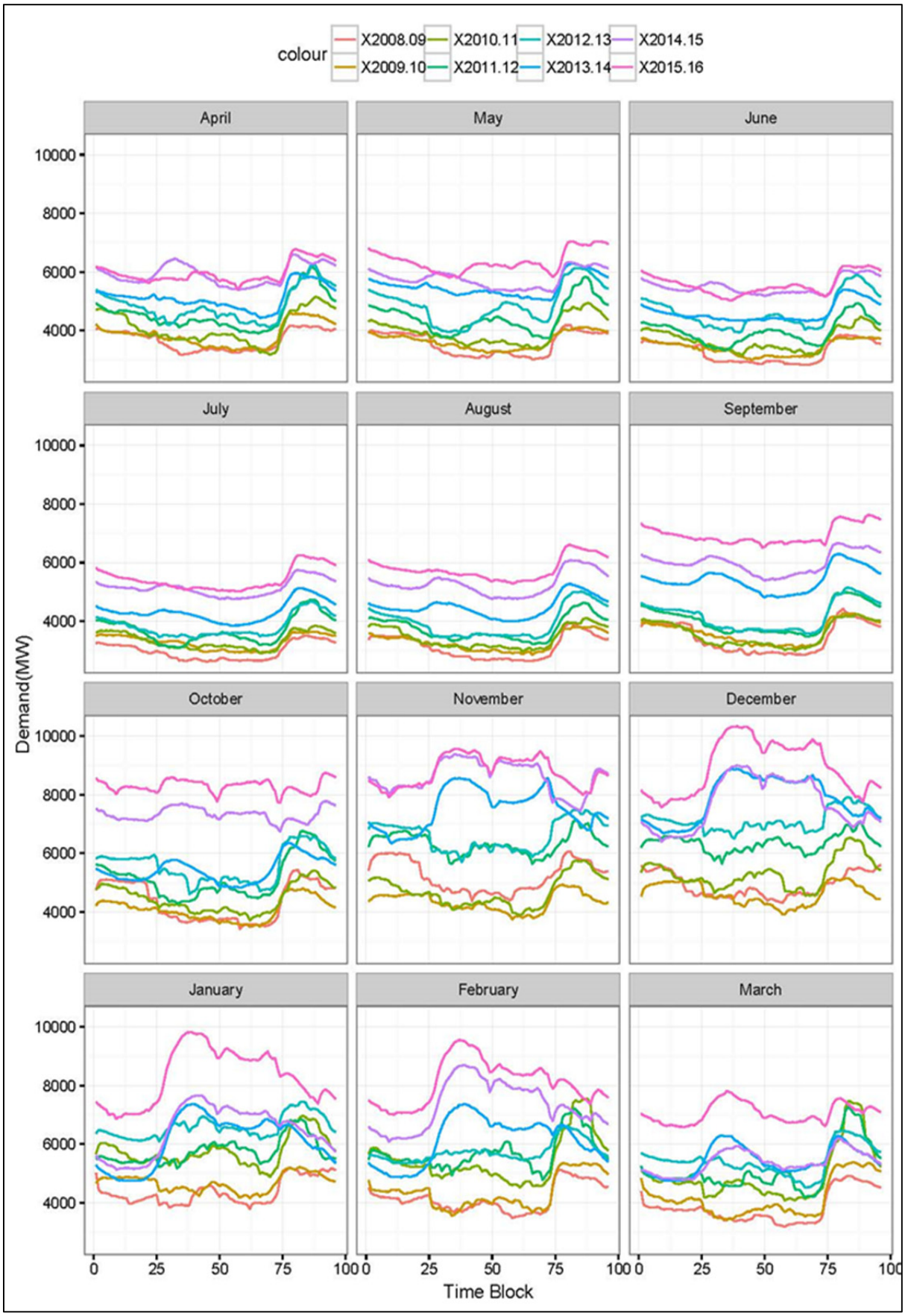
15. Monthly demand met pattern from 2008-2016:



Notes:

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