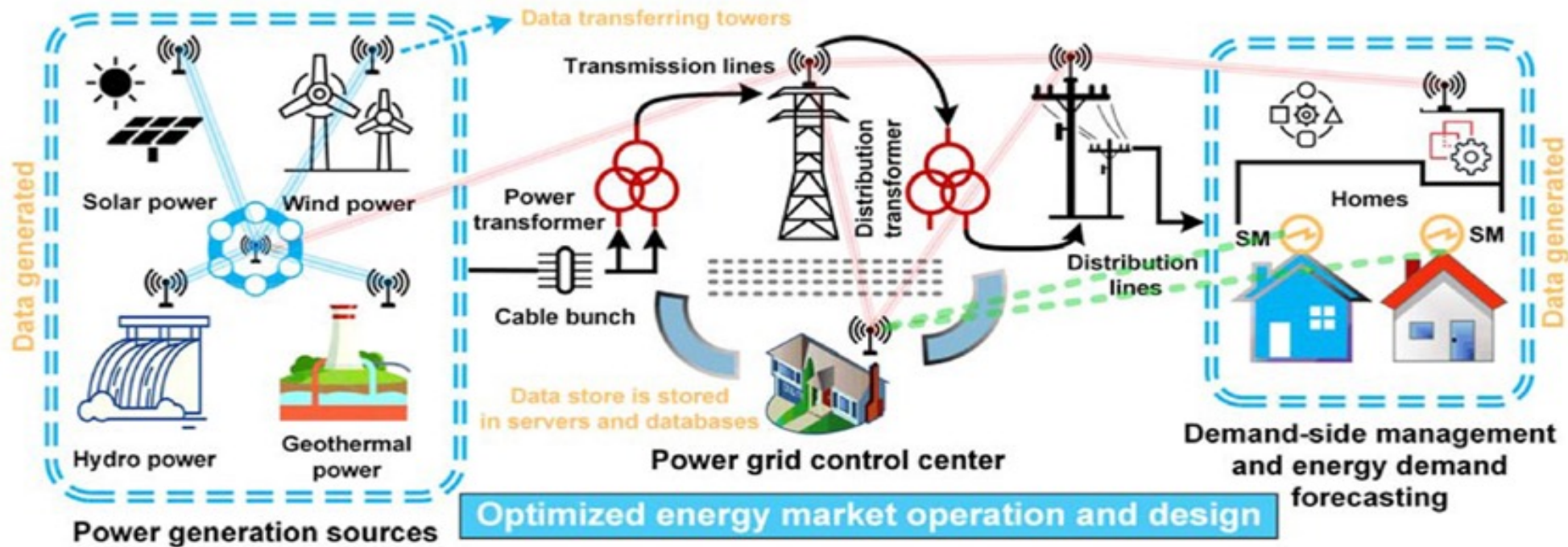


Digital Energy Management and the Use of Artificial Intelligence

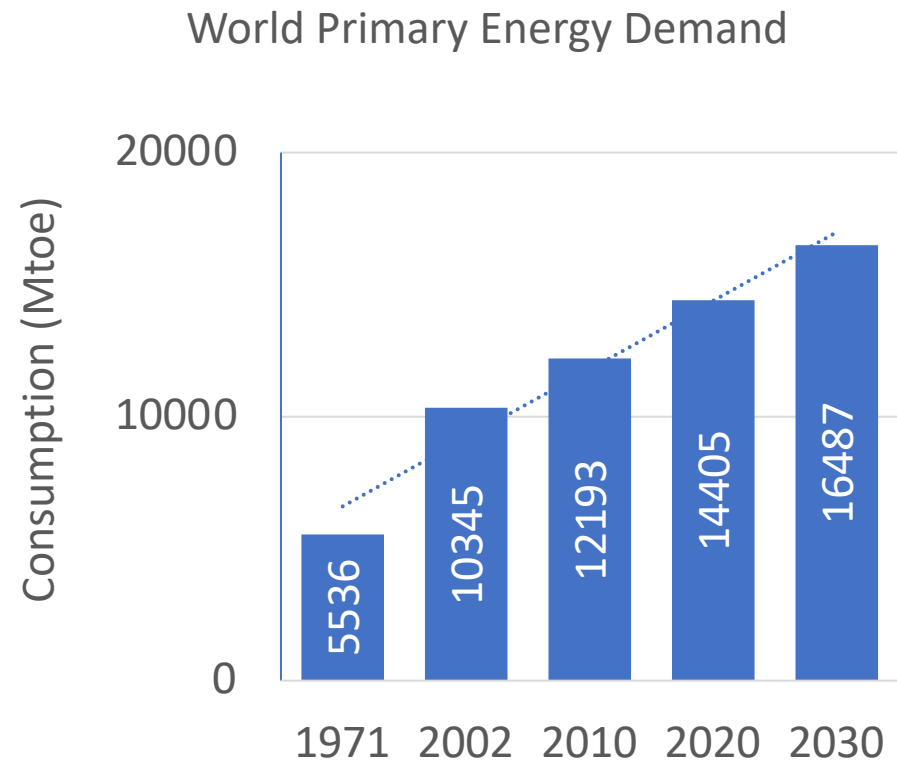
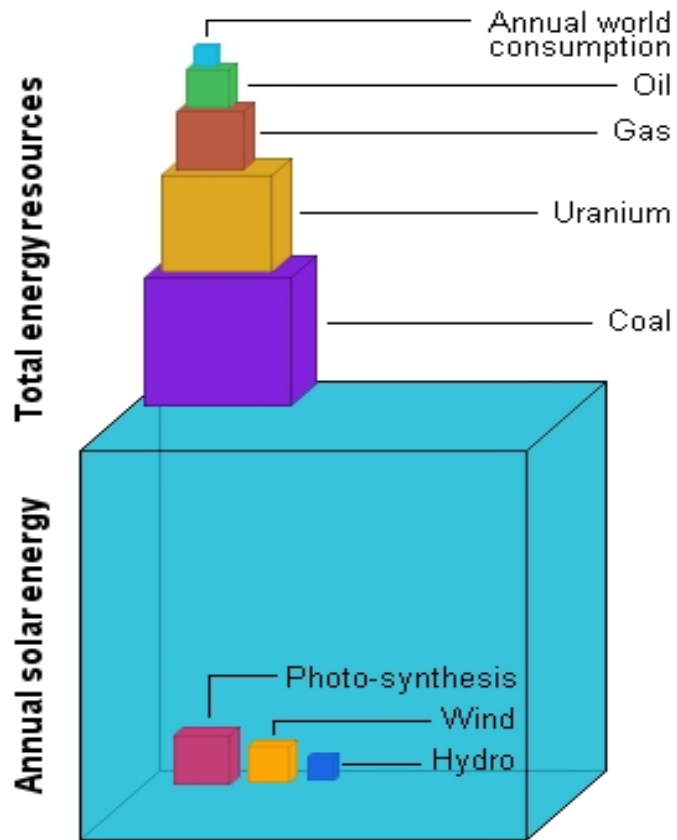


Prof. Dr. Gul Muhammad khan, Director

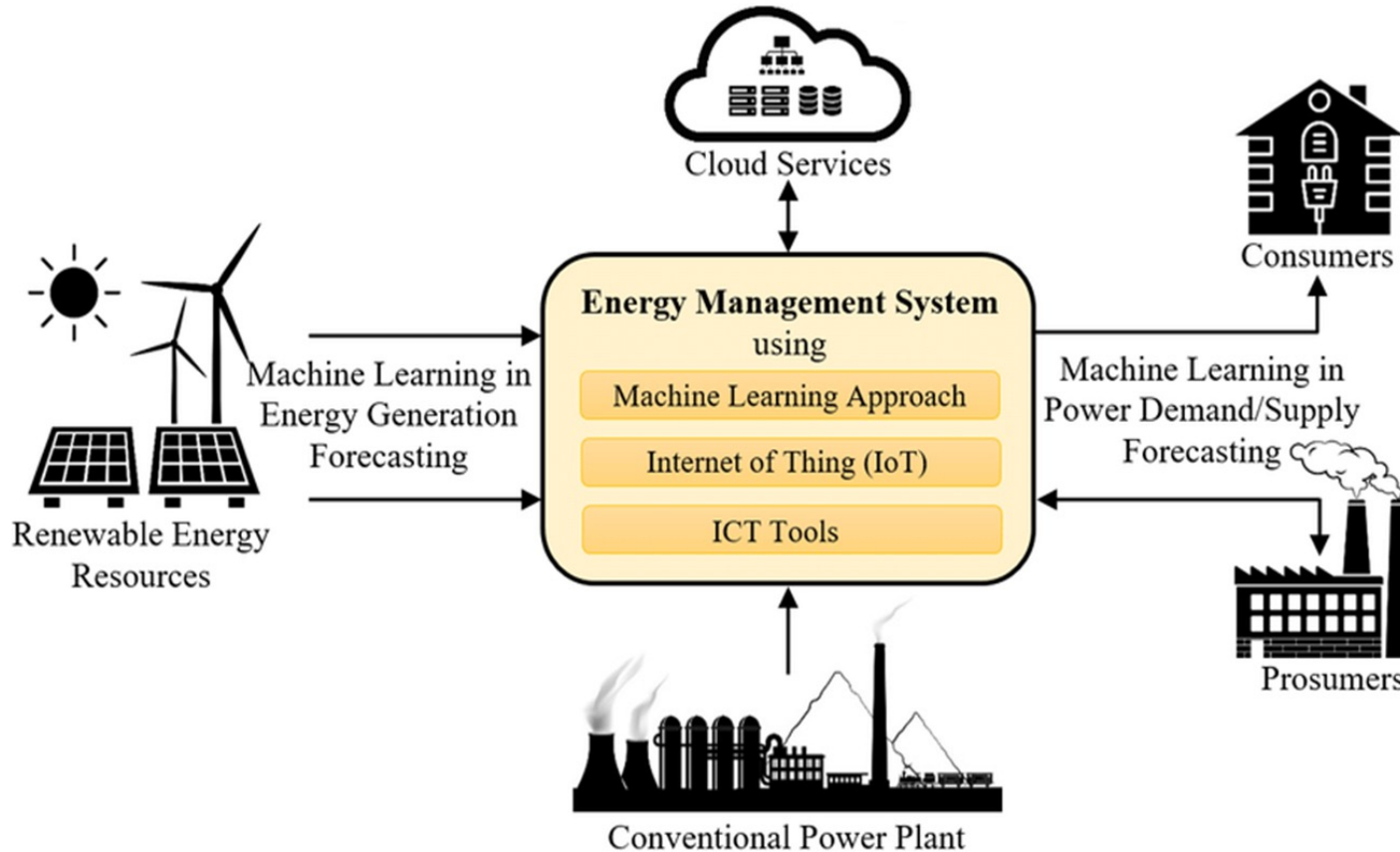
Center of Intelligent Systems and Network Research (CISNR) & National Centre of AI, Intelligent Systems Design, UET Peshawar.

Insatiable Global Energy Demands - Bane or Boon?

- In 2030, the world is expected to be consuming >50 percent more energy than today
- “Business as usual” will not meet world energy, environmental and economic needs



How can AI facilitate Clean Energy Development?

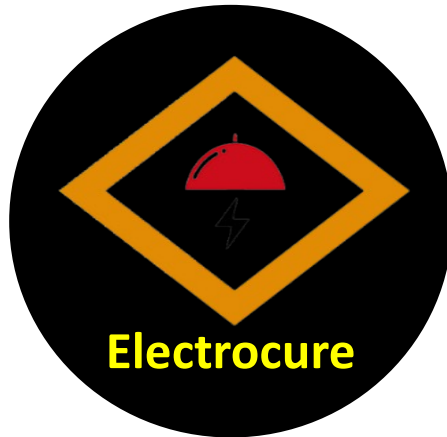


- AI technologies develop **smart** entities that will produce more accurate predictions for complicated problems
- AI in Renewable **Energy Management** is a game changer
- AI can **mitigate** the **unpredictability** of renewable energy sources
- AI-based renewable **energy production forecasting systems** are steadily being perfected, facilitating their integration in power grids
- AI for **Energy Forecasting** to manage **unreliability**

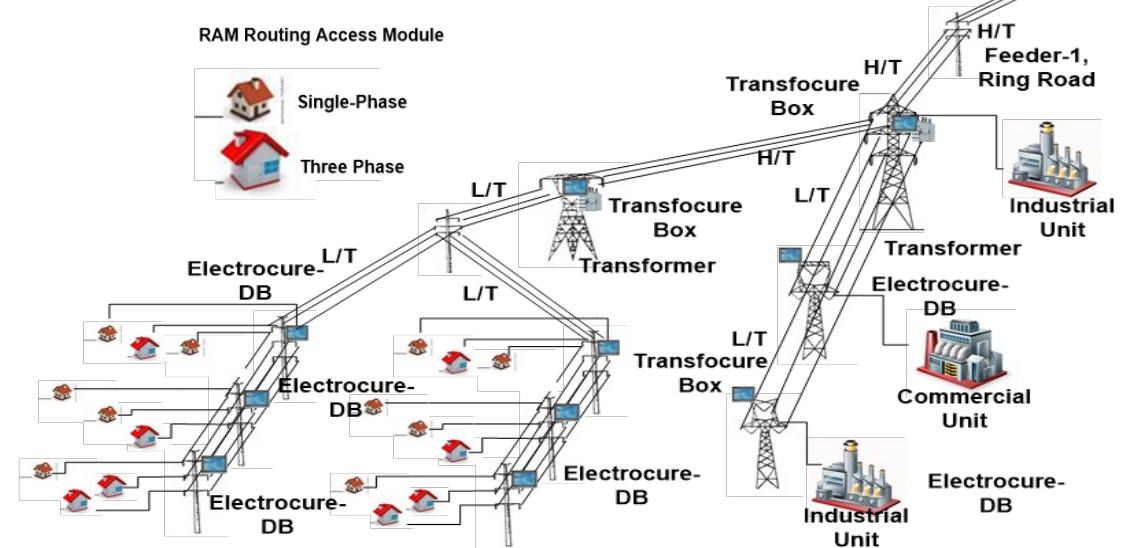
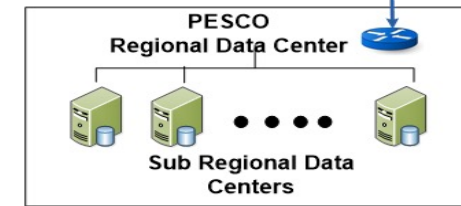
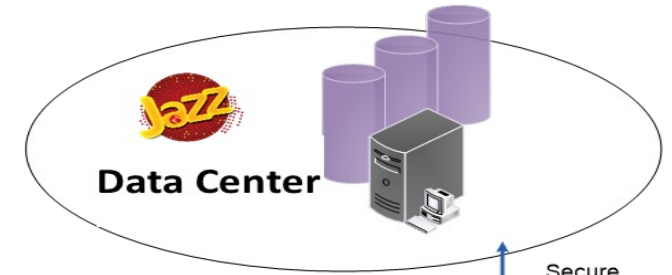
Electricity Management Solutions



- Load balancing on LT
- Automated Meter Data Collection
- Enhanced Equipment Life

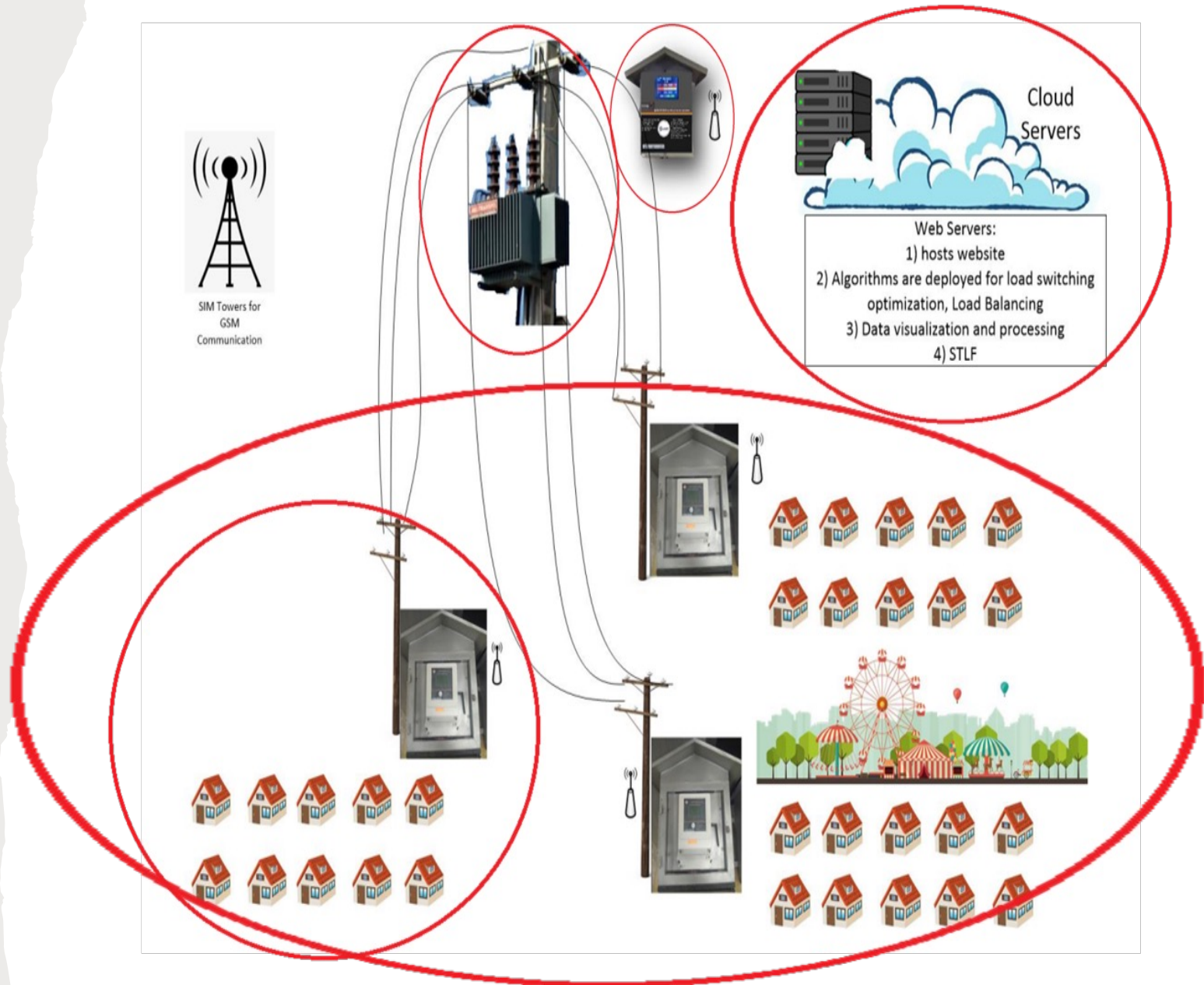


- Meter-less Architecture
- Theft Detection Solution
- Secure & Affordable Set-up



OptimaLoad: Automatic Load Balancing System

- 1 mile of (LT) ANT Conductor = 0.864 ohms Resistance
- Current = 50A
- LOSS = $I^2r = (50)^2 * 0.84 = 2160 \text{ W} = 2.16 \text{ KW}$
- Per Year = $2.16 * 24 * 365 = 18921.6 \text{ KWh}$
= ~ **1,300 USD**
- If the current is twice = 100A
- The loss would be 4 times = **5,200 USD**



Results from Implemented Projects

S.No.	Transformer Type	Un-Balanced Load Condition (Peak Current)	Balanced Load Condition(Peak Current)	%Age Reduction in I_N
		Neutral Loss (KWh-Units)	Neutral Loss (KWh-Units)	
1	100 KVA	8.48	0.13	87.51
2	100KVA	3.70	0.15	80.10
3	100KVA	1.81	0.17	69.48
4	200 KVA	7.34	0.10	88.33
5	200KVA	3.27	0.08	84.79
6	200KVA	2.41	0.05	85.34
Total Lost Units in Neutral per Hour		27.02	Total Lost Units in Neutral Per Hour 0.67	97.5
Total Lost Units in Neutral per Month		19440	Total Lost Units in Neutral per Month 486.18	97.5

S.No.	Transformer Type	Un-Balanced Load Condition (Peak Current)				Balanced Load Condition(Peak Current)				%Age Reduction in I_N
		Phase-1 Loss (KWh-Units)	Phase-2 Loss (KWh-Units)	Phase-3 Loss (KWh-Units)	Neutral Loss (KWh-Units)	Phase-1 Loss (KWh-Units)	Phase-2 Loss (KWh-Units)	Phase-3 Loss (KWh-Units)	Neutral Loss (KWh-Units)	
1	100 KVA	1.479	1.333	0.002	1.289	0.575	0.525	1.021	0.062	78.00
2	100KVA	1.146	4.490	0.014	3.980	1.513	1.248	1.050	0.020	92.87
3	100KVA	0.148	0.941	1.497	0.889	0.785	0.726	1.224	0.013	88.10
4	200 KVA	23.128	8.217	16.866	5.278	21.677	10.227	19.05	0.883	59.09
5	200KVA	30.266	2.188	5.516	18.179	14.482	6.225	8.894	0.738	84.79
6	200KVA	8.387	15.416	29.932	11.251	15.011	26.115	11.84	2.250	55.28
Total Lost Units in Neutral per Hour					40.866	Total Lost Units in Neutral Per Hour			3.966	
Total Lost Units in Neutral per Month					29423.5	Total Lost Units in Neutral per Month			2855.5	90%

Particulars	Values
Units lost on 250 Transformers during Month-1	43,665.77
Units lost on 250 Transformers during Month-2	49,157.18
Units lost on 250 Transformers during Month-3	47,167.29
Quarterly units lost	1,39,990.2
Yearly units lost	5,59,961
Yearly Revenue lost (PKR)	83,99,414
Units recoverable via 250 TransfoCures per month	46,663.41

Electrocure – Administrative(Theft) Losses (10 Transformers) Recovery

S/No.	Transformer #	Units lost in 10 days	Per month units lost	Quarterly units (KWh) lost	Amount lost (PKR)
1	TR 05	455	1365	5460	81900
2	TR 139	3167	9501	38004	570060
3	TR 31	512	1536	6144	92160
4	TR 160	7040	21120	84480	12,67,200
5	TR 16	3085	9255	37020	555300
6	TR 89	2	6	24	360
7	TR 136	1098	3294	13176	197640
8	TR 83	3010	9030	36120	541800
9	TR 145	10	30	120	1800
10	TR 122	284	852	3408	51120
Total		18,663	55,989	2,23,956	33,59,340

METERO-CURE

Simple Solutions To Complex Problems



House with Meter



Meter Reader Taking Meter Picture



Logged on as [User] Log out Print this page Print all pages **Advanced search** Export results

Customer & Connections > Readings > All Readings Division Cont. 2 > Connection Settings > Tools > RO Reports > Final Reports > View Data > Connections

1 All Readings Details found: 41617 Page 1 of 20

Criteria: all any

Add field Show options

Reference No:

Year:

Month:

Meter Reader:

Verifier:

DEO:

Search

Reference No	Month	Date Time	Off-Peak MR Readings	Off-Peak Readings	Peak MR Readings	Peak Readings	Meter Reader	Off-Peak Image
02262140024705	August	2014-08-05 10:06:16	25895	25895			rustam	
02262140024694	August	2014-08-05 10:06:57	35256	35256			rustam	
02262140024725	August	2014-08-05	00	00			rustam	
02262140024742	August	2014-08-05	00	00			rustam	

PESHAWAR ELECTRIC SUPPLY COMPANY - ELECTRICITY CONSUMER BILL

G.S.T # 21-00-2716-031-48

REAR: 03-AUG-14 DUE: 04-AUG-14

16 JAN 12

MONTHS	UNITS	BILL	PAID
AUG 13	543	6015	6015
AUG 14	454	4970	4970
SEP 14	968	10975	10975
OCT 14	541	6111	6111
NOV 14	311	10173	10173
DEC 14	252	3330	3330
JAN 14	308	4516	0
FEB 14	252	6298	6298
MAR 14	154	2109	2109
APR 14	423	5758	5758
MAY 14	393	5970	0
JUN 14	1385	27452	27452

For Other Complaints
SDO : 00009217356 / 0315-8610296
XEN : 00009017369 / 0315-8610258
S.E. : 00009017356 / 0315-830672

For May 2014 @ -0.8199 and One
Pending FPA as per court decision is also incorporated.
Net FPA = 322.25 GST FPA = 54.00
Total Free No. 0800-843338

13296 14444

182 01138140

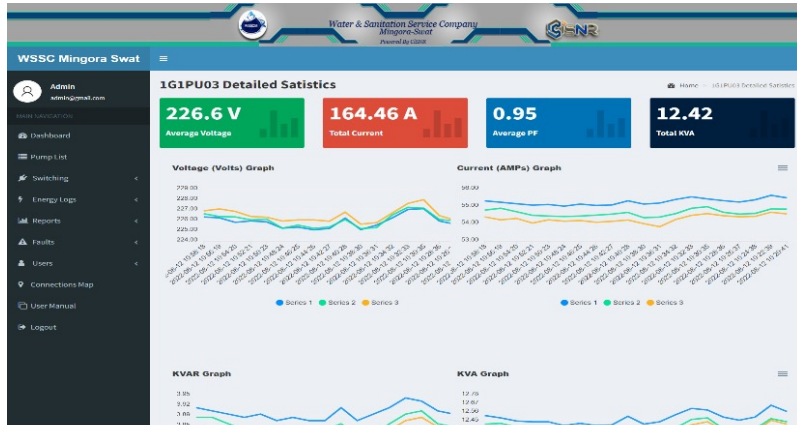
00250698

PESHAWAR ELECTRIC SUPPLY COMPANY - ELECTRICITY CONSUMER BILL

Bank Stamp

BILL MONTH: Jul 11 DUE DATE: 13 AUG 14 REFERENCE No: 026214-0501164 PAYABLE WITHIN DUE DATE: 13296 PAYABLE AFTER DUE DATE: 14444

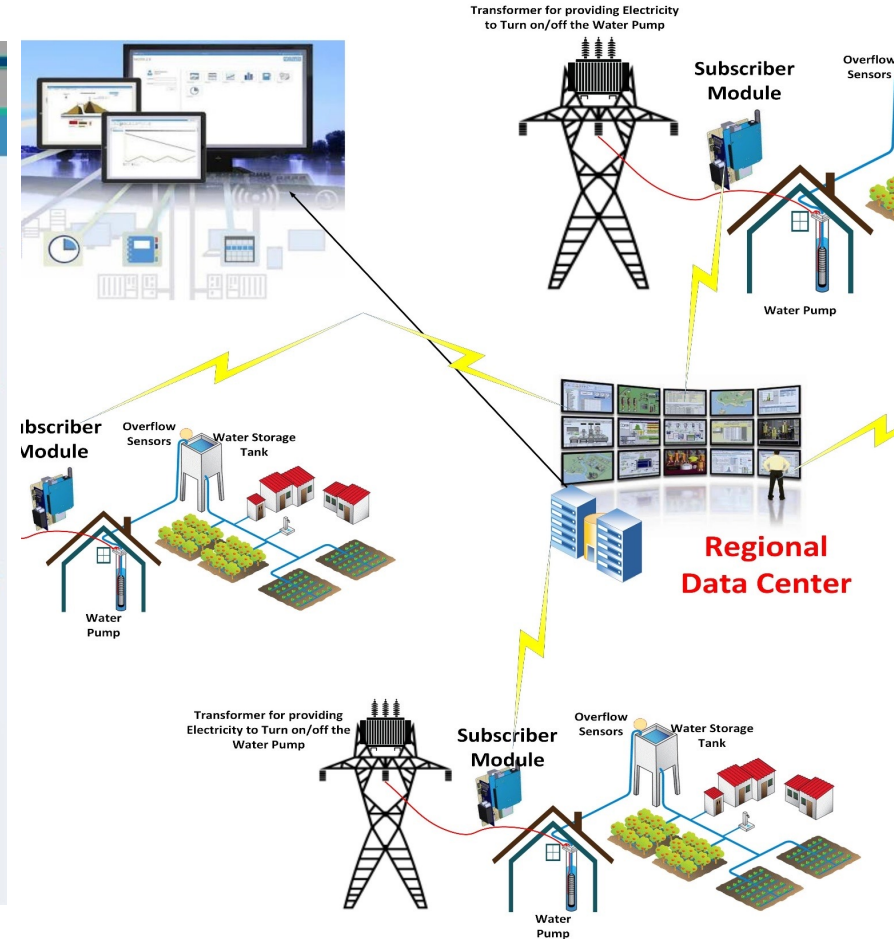
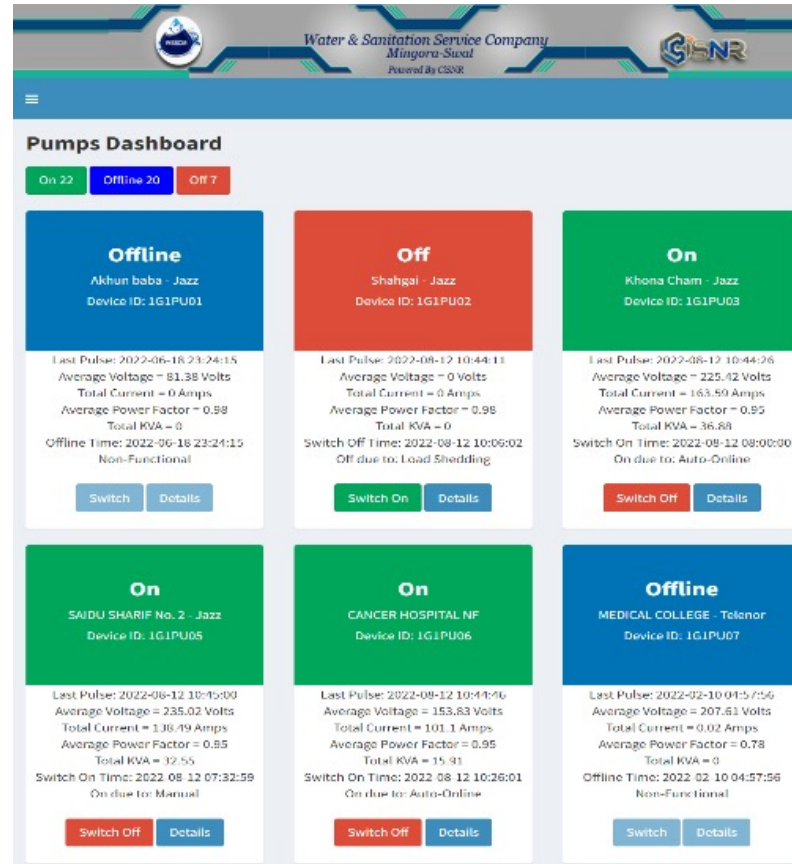
Real-Time Municipal Energy Management with GIZ Pakistan



WSSC Mingora Swat

Auto Switching

Pump ID	Pump	Start Time	Off Time	Repeat	Enable/Disable	Auto Status	Auto Time Adjustment	Job Creation Date & Time	Actions
1G1PU01	Akhun Baba - Jazz	05:00:00 pm	12:00:00 pm	Daily	Off	Offline	Enable	2022-08-10 12:00:56	Edit Delete
1G1PU02	Shahgai - Jazz	05:00:00 am	05:00:00 am	Daily	Off	On	Enable	2022-08-11 12:00:32	Edit Delete
1G1PU03	Khona Cham - Jazz	05:00:00 am	12:30:00 pm	Daily	On	On	Disable	2021-08-01 12:04:09	Edit Delete
1G1PU04	SAIDU SHARIF NO.2 - Jazz	05:00:00 am	13:15:00 pm	Daily	On	On	Enable	2022-02-04 14:22:13	Edit Delete
1G1PU05	SAIDU SHARIF NO.2 - Jazz	07:00:00 am	06:00:00 pm	Daily	Off	On	Enable	2022-02-10 09:13:22	Edit Delete
1G1PU06	CANCER HOSPITAL NF	05:00:00 am	12:30:00 pm	Daily	Off	On	Enable	2022-04-12 11:21:20	Edit Delete
1G1PU07	MEDICAL COLLEGE - Telenor	02:00:00 pm	07:00:00 pm	Daily	Off	Offline	Disable	2021-08-12 13:14:00	Edit Delete
1G1PU08	Shahzee Abad Tubo well no 5 Telenor	01:30:00 pm	03:30:00 pm	Daily	Offline	Offline	Enable	2022-01-14 18:02:52	Edit Delete
1G1PU09	AFSAR ABAD Telenor	07:00:00 am	12:00:00 pm	Daily	Off	On	Enable	2021-08-12 14:40:46	Edit Delete



Increasing Energy Efficiency through Digitization

Demonstrate the advantage of **digitization and governance** tools in energy management.

Demonstrate the **improvement in quality of the utility service** through digitization.

Demonstrate the advantage of **real time energy audit in short, medium, and long-term** energy management planning.

Demonstrate the role of digitization in **local government planning**, operations, and monitoring & evaluation.

Demonstrate the advantage of Digitization and real-time monitoring in **Asset managements** of Municipalities.

Demonstrate the **reduction in Maintenance cost** through real-time Monitoring and autonomous management of tube well pumping stations.

Increasing Energy Efficiency through Digitization

Demonstrate the advantage of new technologies such as **VFDs in auto energy management and energy consumption** reduction and its feasibility in terms of ROI.

Demonstrate the efficiency in **fuel consumption through real-time monitoring and rout profiling** of Water supply and waste collection trucks using GPS.

Demonstrate the impact of digitization and real-time monitoring & control on **energy efficiency of Streetlights**.

Demonstrate the **impact** of introducing **technological governance** tools on the **policy making implementation** and revisiting.

Voltage Unbalance in pumping motors

- Three-phase distribution systems often serve single-phase loads. An imbalance in impedance or load distribution can contribute to imbalance across all three of the phases.
- Potential faults may be in the cabling to the motor, the terminations at the motor, and potentially the windings themselves.
- This imbalance can lead to stresses in each of the phase circuits in a three-phase power system. At the simplest level, all three phases of voltage should always have the same magnitude.

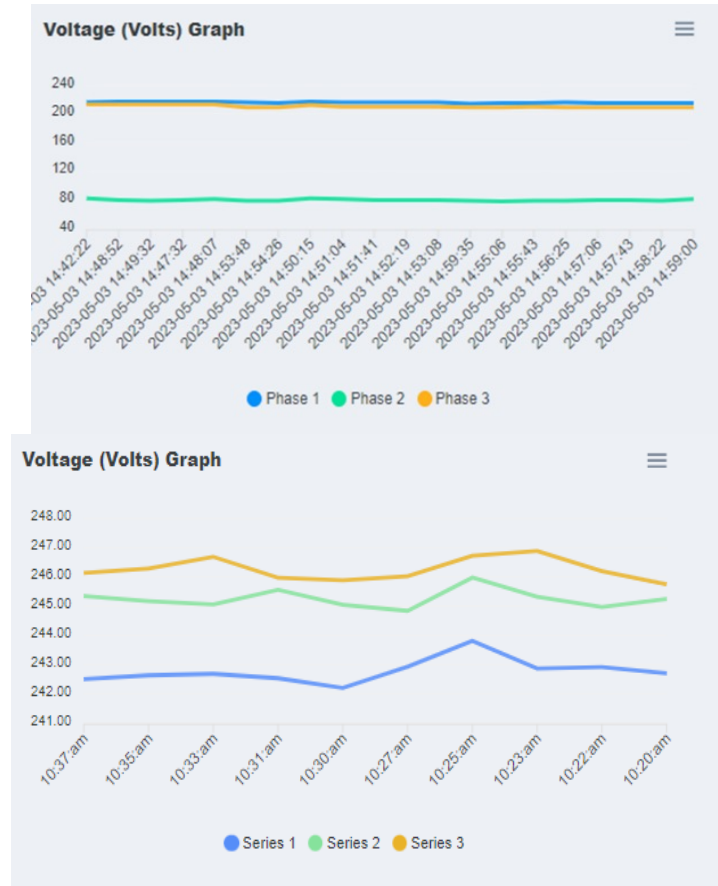
Impact: Imbalance creates excessive current flow in one or more phases that then increases operating temperatures—leading to insulation breakdown

- NEMA standard MG-1, states that polyphase motors shall operate successfully under running conditions at rated load when the voltage unbalance at the motor terminals does not exceed **1%**.

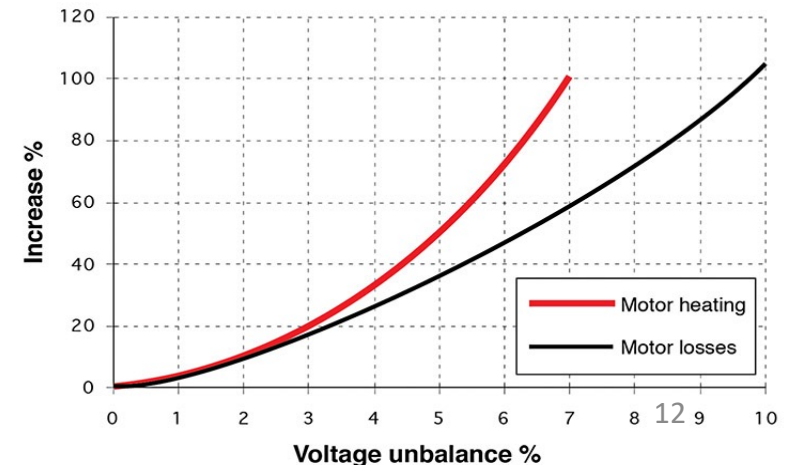
Characteristic	Performance		
Average voltage	230	230	230
Percent unbalanced voltage	0.3	2.3	5.4
Percent unbalanced current	2.4	17.7	40
Increased temperature rise (°C)	<1	11	60

Figure 1: Effects of voltage unbalance on a 5 hp motor.

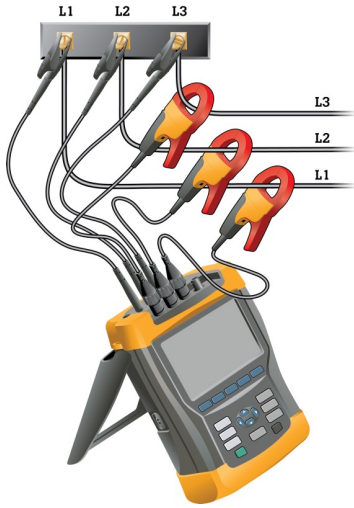
Mitigation strategy: The mitigation strategies for unbalance voltage in pumping motors are; balanced supply of voltage from distribution side and installation of voltage regulators.



Increase in motor heating and losses vs. voltage unbalance



Current Unbalance in pumping motors

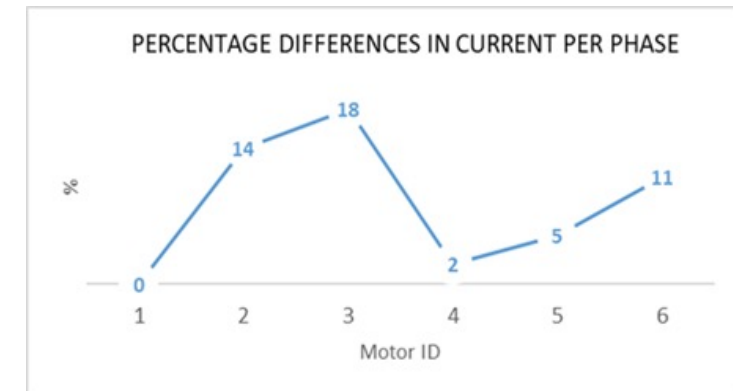
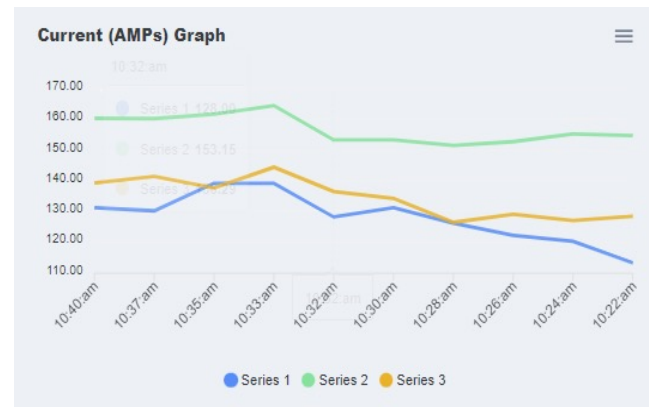


Voltage unbalance and winding issues are two common causes for current unbalance in pumping motors. Current variation in pumping motors led to motor inefficiency and reduced their lifespan.

When there is a voltage unbalance, the variation in phase currents exceeds the normal range of 5-7%. This imbalance leads to increased copper losses, resulting in reduced motor efficiency.

Furthermore, the prolonged exposure to unbalanced voltages can significantly decrease the motor's lifespan. As evident from the graph, Current unbalance must be minimized below 5% to enhance energy efficiency in Motor ID "2,3,6". Voltage was balanced in this case, so the current variation is due to winding problem.

Mitigation Strategy: Possible solution to mitigate current variation is to consider rewinding of motor, which involves replacing the faulty winding with a new one. Alternatively, if the motor is severely affected, it may be necessary to replace it entirely with a new motor that can handle the required load and operates efficiently. By taking appropriate action to rectify voltage unbalance and winding issues, motor efficiency can be improved, ensuring optimal performance and extending its lifespan.



Data was recorded from WaterScada devices installed at 6 tube wells at CDA Islamabad (22-28 March 2023)

AI

Learning

Optimization

Control

BEMS



Three level energy saving for equipment, facility and the whole building management

HVAC



Predict future conditions and adjust equipment output in advance

LS



Personnel interactive lighting control

ICT



Self-configuration, optimization & healing to optimize the service

RES + Power grid



Forecast the future weather to keep stable output with the largest amount of renewable energy

Industry



Trial & error for high energy efficiency

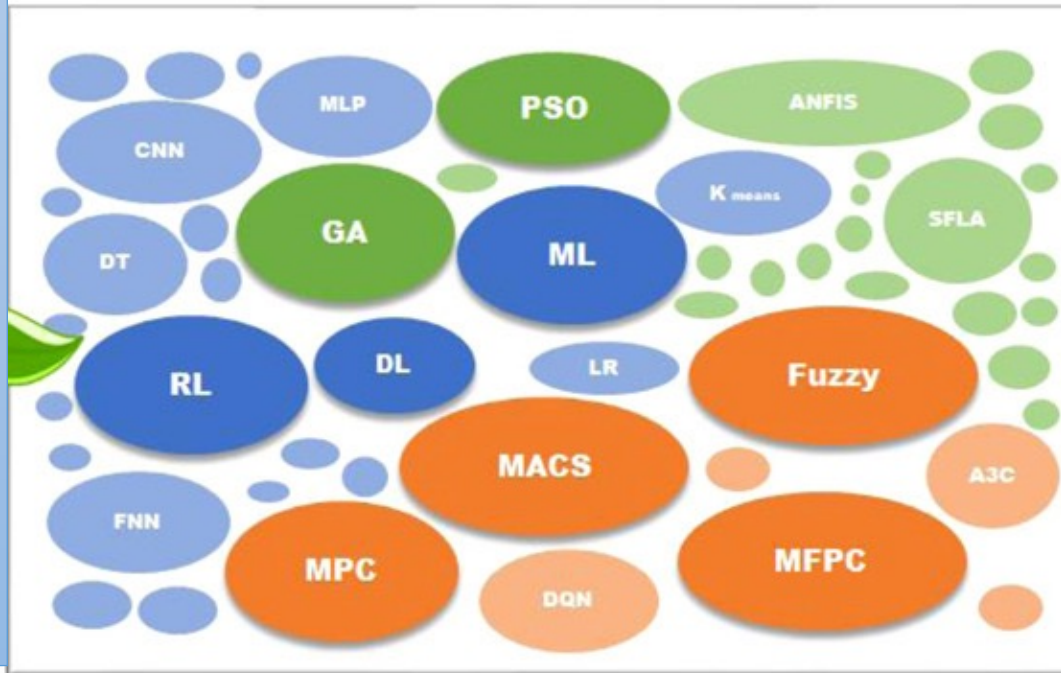
Universal workflow of artificial intelligence for energy saving (Energy Reports-2022)

Da-sheng Lee ^{a,*}, Yan-Tang Chen ^a, Shih-Lung Chao ^b

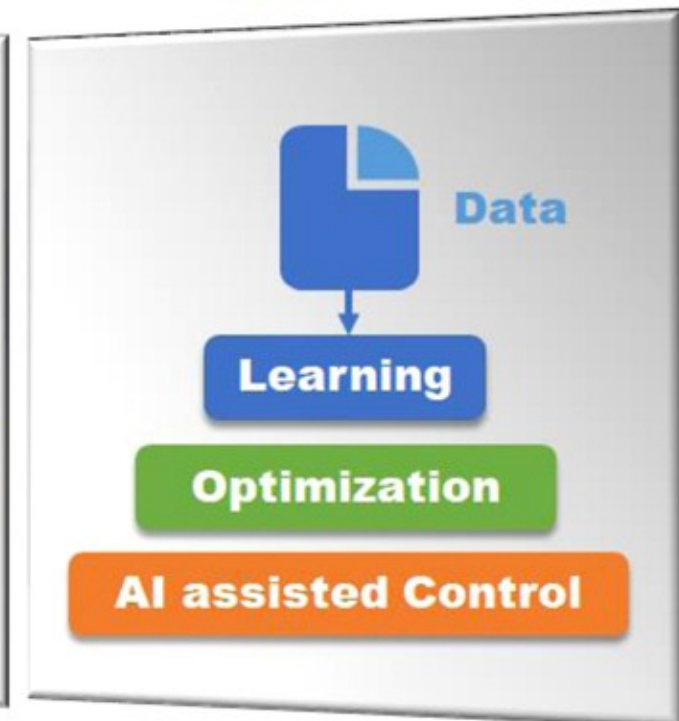
This study analyzed **164 academic papers**, with a total of **113 AI methods** applied in **six different fields** of application

Funded by: **Ministry of Science and Technology, Taiwan**

Survey of **113** technologies



Results



Workable method to assist the use of AI in **6** fields

35%
Building
energy cost
saving



6/19/23

25% HVAC
energy
saving



50%
artificial
lighting
energy
saving



Up to 70%
communication
power saving



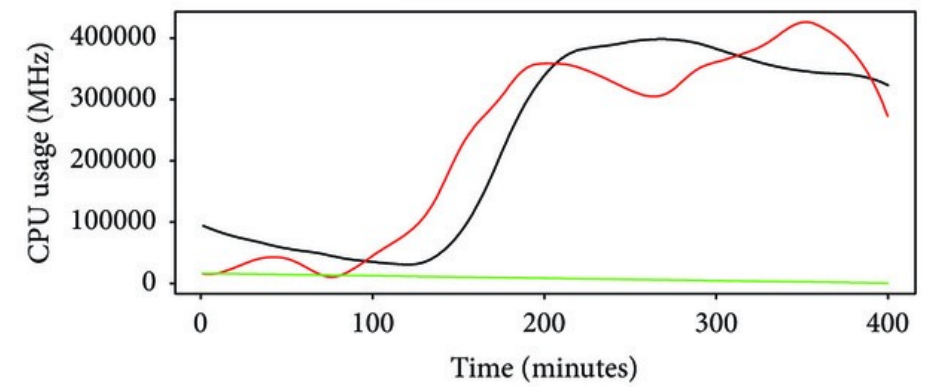
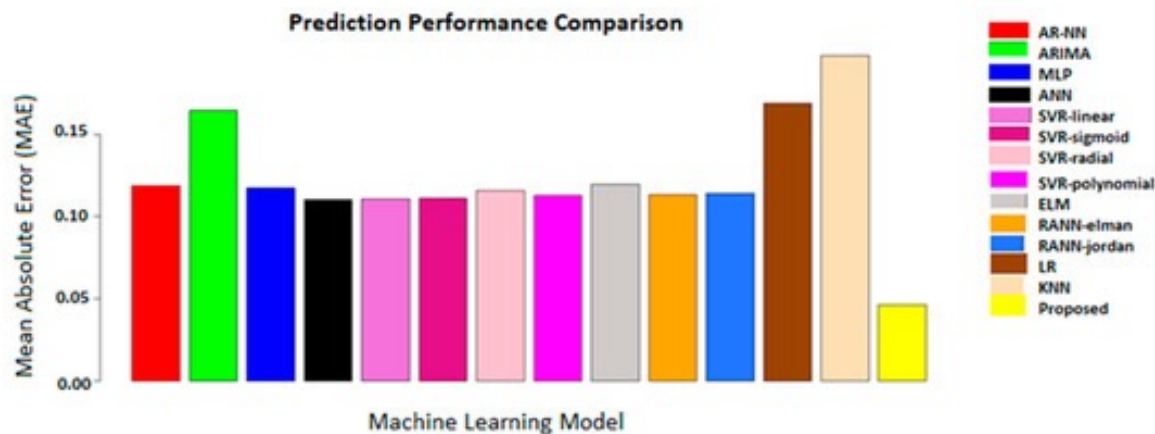
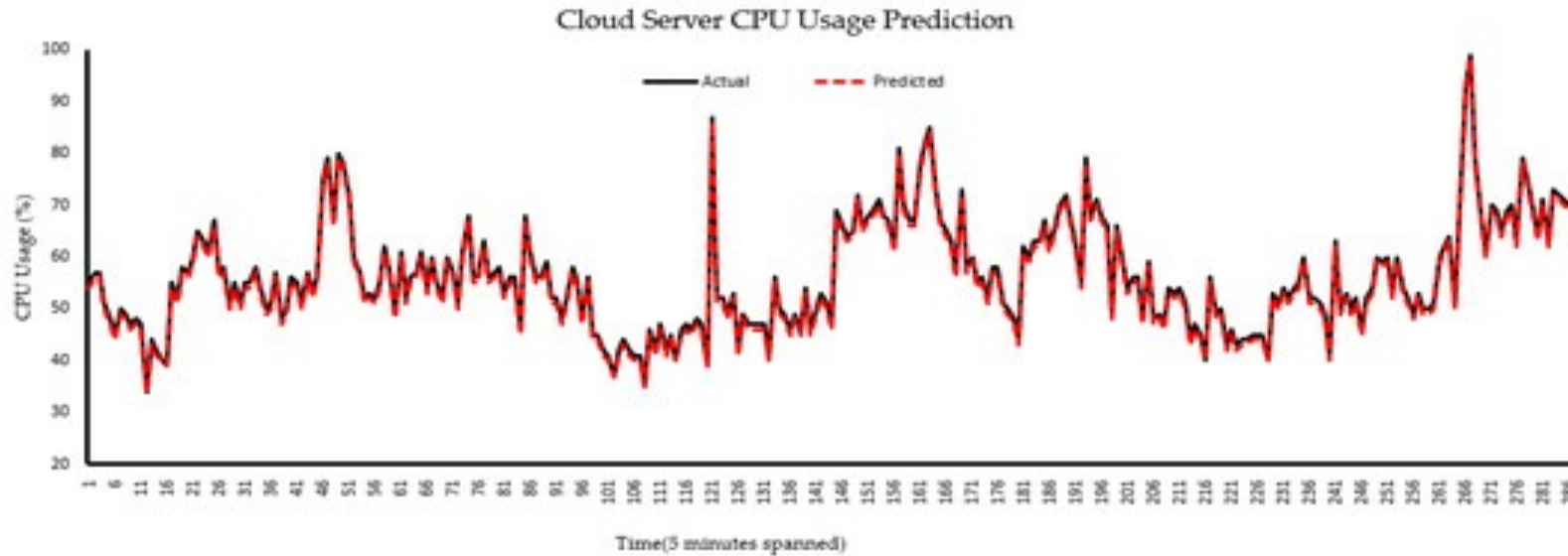
Grid energy
supplied with
the largest
renewable
energy up to
30% peak
power



30%
factory peak
power
reduction

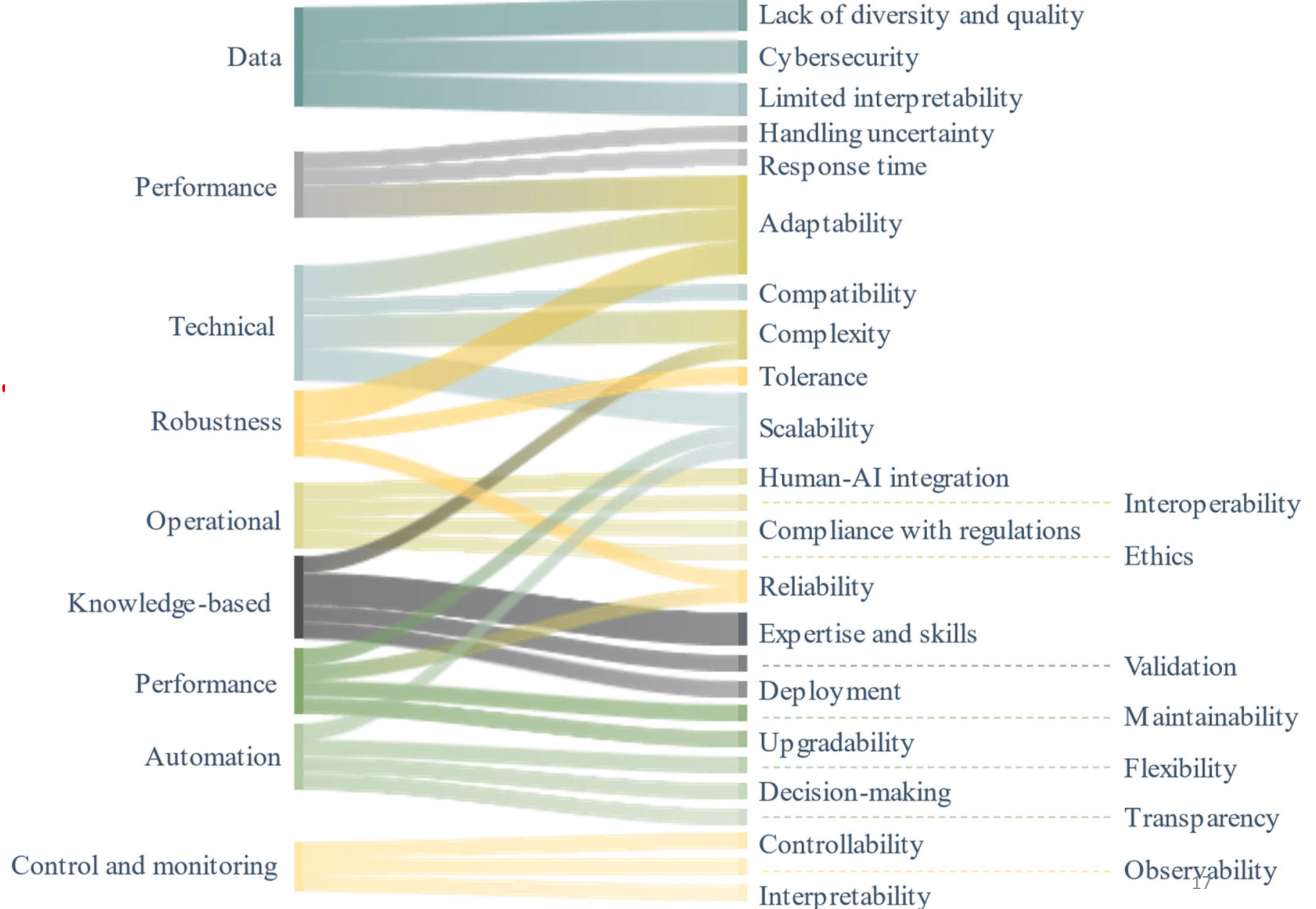


Energy Efficiency on Individual PC/Cell-Phone, Network and Cloud Utilization AI based Prediction System



— Original CPU usage
 — AR-NN predicted
 — ARIMA predicted

Why? and Why Not'



What are Other Dimensions?

Developing an energy management policy

- Oversee the development and implementation of the Municipal Energy Management Policy
- Oversee the development, implementation and review of the Municipal Energy Management Action Plan (MEMAP), which need to incorporate budgets/resources, timelines and responsibilities
- Review the action plan at the end of each year based on the results generated through the monitoring system and amend the plan based on the experiences of the previous year
- Develop a clear methodology and system for Monitoring and Verification

Establishing appropriate organisational structures

- Oversee appropriate allocation of energy management within the municipal organisational structure
- Ensure relevant representatives from line departments participate in the committee meeting and engagements

What are Other Dimensions?

Ensuring appropriate skills and knowledge

- Oversee energy management and energy awareness capacity building within the municipality

Establishing energy information systems

Marketing and communicating energy-related information

Investing in energy conservation

- Facilitate the establishment of an energy intervention finance competency within the municipality

Implementing energy conservation interventions

- Oversee the audit of the effectiveness of the various energy interventions carried out by the municipal units
- Outline corrective or preventive actions based on the audit of the energy interventions carried out by the municipal units



What is Blocking the Application of and Investments in Energy Efficiency in the World?

- Energy-efficiency potentials are not being realised, even when they are economically cost-effective. Numerous barriers impede their adoption and rapid market diffusion
 - Lack of information on **energy efficiency among consumers** and the financial sector, leading to cost-effective energy-efficiency measures opportunities being missed
 - Limited know how of **policy makers**
 - **Lack of technical capacity** to develop and implement energy efficiency projects
 - Organizational and institutional **gaps** and **overlaps**
 - **Limited access to capital** may prevent energy-efficiency measures from being implemented
 - **Inertia**: individuals who are opponents to change within an organisation may result in overlooking energy-efficiency measures that are cost-effective
- **Policy interventions are required to overcome such barriers**