ENERGY Audit - Industry

By

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Senergy

Synergy

between

Our expertise on conservation of energy

&

Your experience & knowledge of

process, operations, plant engineering, etc.

To

Save Energy

Senergy

- Leading Energy Conservation Consultants in India
- Conducting Energy Conservation Studies for past 25 years.
- Team of experts headed by a technocrat from IIT
- Customer driven company with many repeat orders & orders form group companies
- Among of the first to receive ISO 9001-2000 certification.
- Lead Auditor ISO 50001, Energy Management System

Senergy

- Empanelled with Maharashtra & Gujarat Governments (MEDA & GEDA)
- BEE Certified & Accredited Auditors
- Over 1,000 clients in diversified fields including Power Plants, Ferrous & non-ferrous, Chemical, Pharmaceutical, Textile, Pulp & Paper, Engineering, Automobiles, Hotels, Hospitals & Commercial Premises
- Instrumental towards energy saving of Rs 75 crores/year

Senergy

- Interactive studies.
- Practical & Realistic Suggestions.
- Turnkey Consultancy during Implementation.
- Long term services for Sustainable Savings & Continuous Improvements.
- Basic & Advanced Training Programs.

Few of our clients

- Hindustan Zinc Ltd
- Sterlite Industries Ltd
- Grasim Industries Ltd
- Excel Industries Ltd
- Century Enka Ltd
- Century Rayon
- Asian Heart Hospital
- Essel World
- EBG India Pvt Ltd
- Sandoz Ltd
- Wartsila Industries Ltd
- PepsiCo India Ltd
- USV Ltd
- Jindal Saw Ltd
- United Nations Industrial Development Organization – UNIDO Allana Industries Ltd
- Tata Chemicals Ltd
- Schenectady Herdillia ltd
- Hindustan Lever Ltd
- Nicolas Piramal India Ltd
- NOCIL Ltd
- DGP Hinoday Ltd
- Tata Metalliks Ltd
- Ultratech Ltd
- Whirlpool of India Ltd
- Pidilite Industries Ltd
- Sachivalay – Gujarat
- Wockhardt Ltd
- Clarient Chemicals (India) Ltd

Instruments

- Ultrasonic non-contact type flow meters for liquid
- Ultrasonic non-contact type Energy (kCal/hr, TR) flow meter for liquid
- Power & Harmonic analyzers
- Clamp-on type power / energy meters
- Thermal Imager
- Anemometers – to measure velocity of gases
- Digital Manometers & Pressure Gauges
- Digital thermometers for liquid / surface temperature
- Environment Meter for Lux, Temperature, RH, Sound & CO_2
- Combustion Gas Analyzer
- Pressure Gauges
- Digital Hygro-temp Meter (for Temp & RH measurement)

Energy Audit – Coverage

- Analysis of specific energy consumption
  - overall
- Analysis of energy bill – electricity & fuel
- Energy & Mass Balance for
  - Furnaces (RTHF, API & Cold draw plant)
  - Coal Gas Plant
- Power Quality & Harmonic Analysis
- Thermal Imaging of Electrical System
- Performance of
  - Pumps
  - Fans & Blowers
  - Compressors
  - Cooling Tower
  - refrigeration Compressors

Energy Audit – Coverage

- Motor Load Study
- Study of distribution system
  - Cable Losses
  - Water
- Brain storming & joint analysis of proposals
- Energy Awareness & Training (Duration - 3 to 4 hours)
- Identification of potential saving areas
- Suggestions & Recommendation
- Report & Final Presentation

Specific Energy Consumption

Specific Energy: Energy consumed per unit output.

It is the Key performance assessment tool for every energy consumer.

Collect the following data on monthly basis & for last 12 month

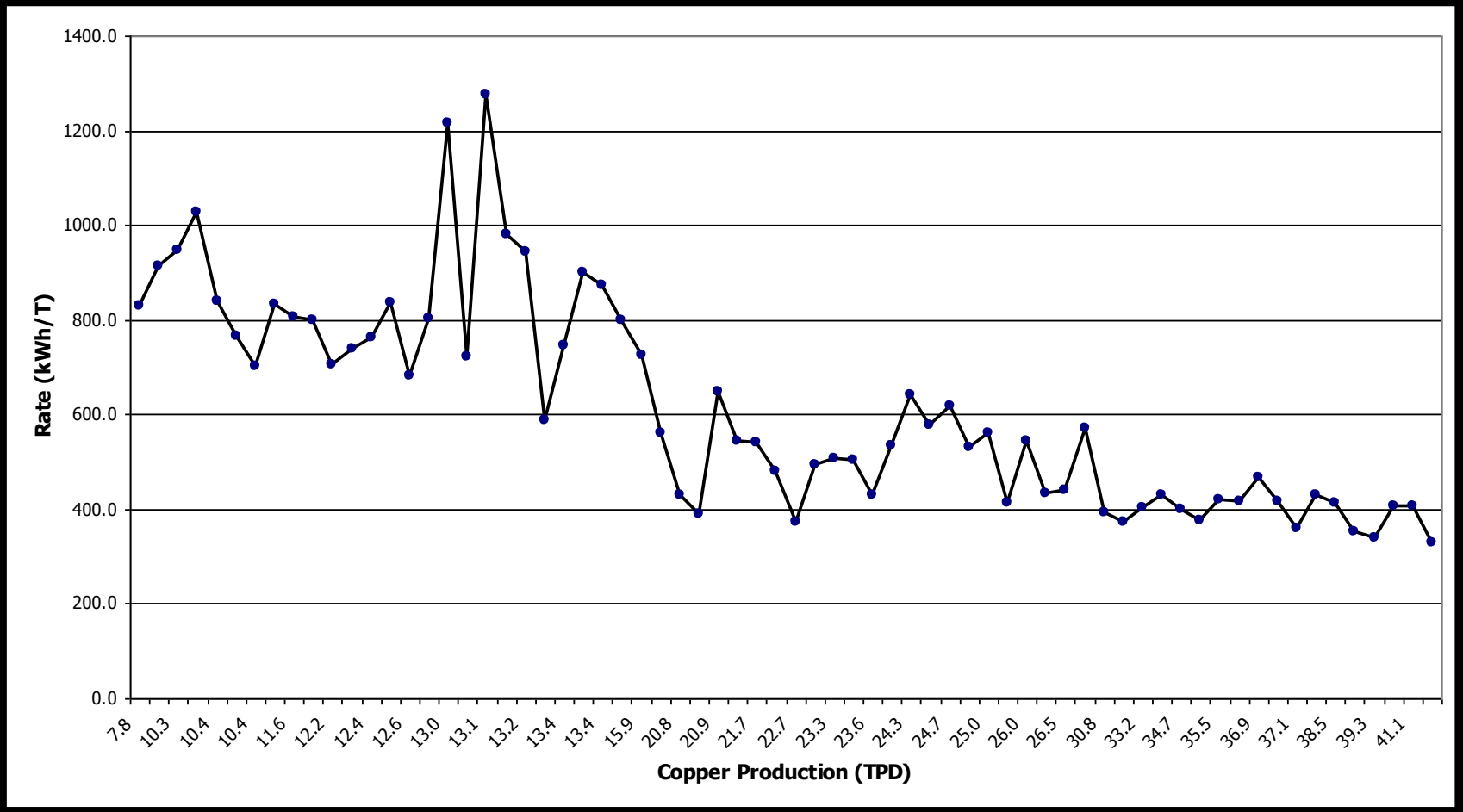
- Total production
- Power consumption – SEB & Captive
- Consumption of each type of fuel
- Cost of each type of fuel

Specific Energy Consumption

Outcome savings / gains through

- Operational improvements
- Effective monitoring
- Streamlining production / Operations

Specific Energy Consumption



Energy & Mass Balance

Mass Balance

- Mass can neither be created nor destroyed, but for fusion or fission reactions.
- Input Material = Output Material

Energy Balance

- Energy can neither be created nor destroyed, but for fusion or fission reactions.
- Input Energy = Output Energy

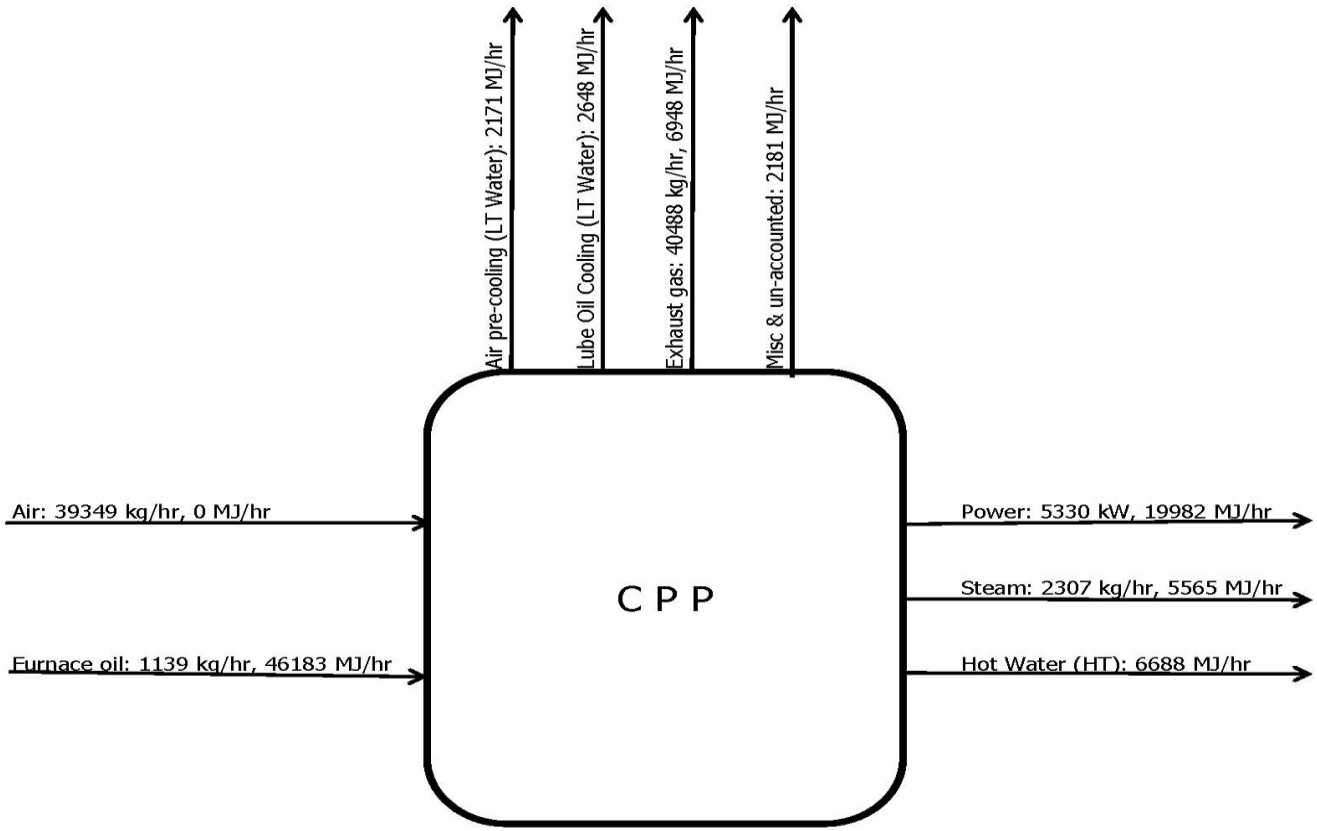
Outcome

- Clear idea about potential saving / gain areas

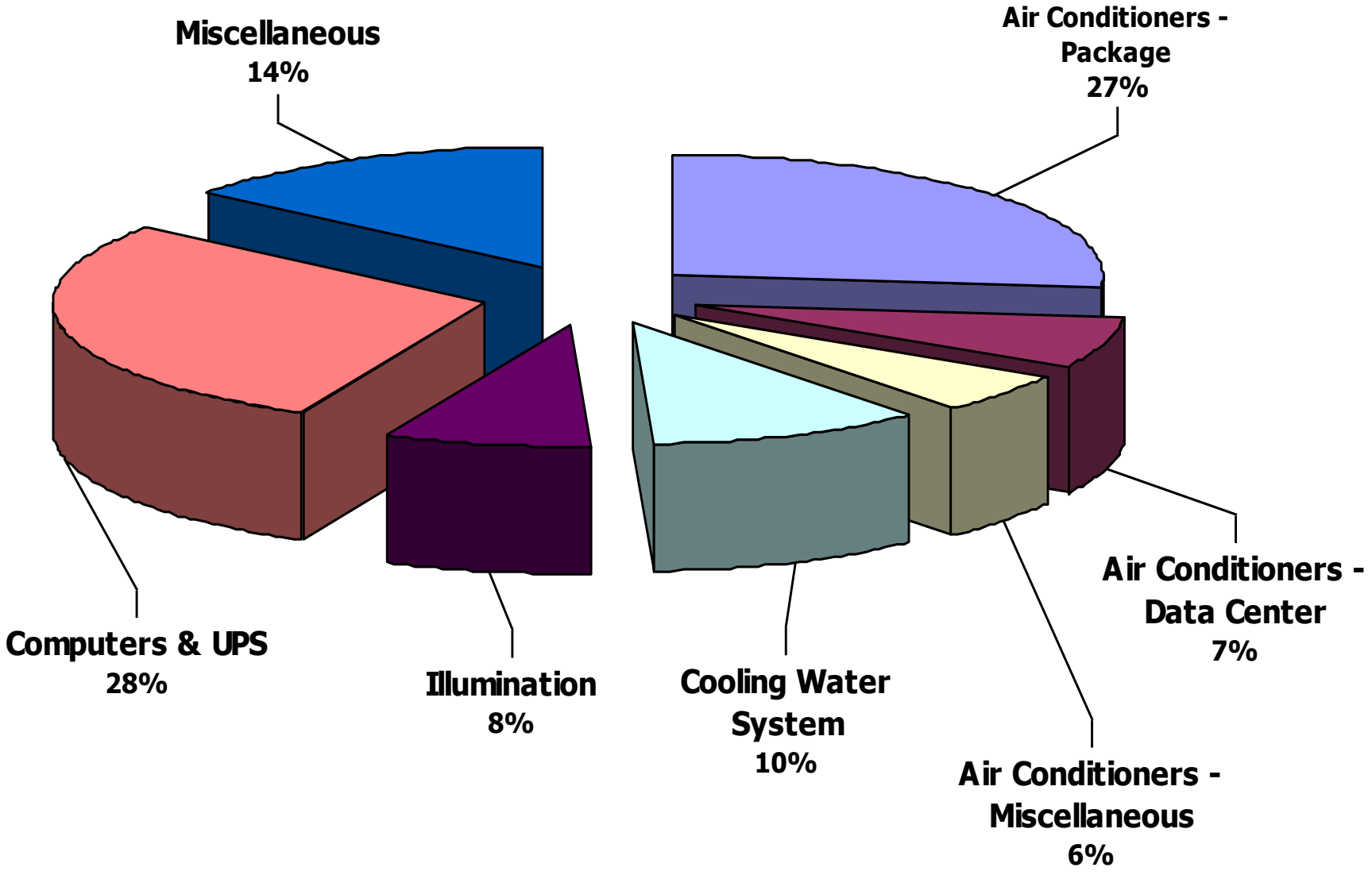
Energy & Mass Balance
Engine - Furnace Oil Fired

Description	Consumption	
	MJ/hr	%
Input Energy - FO	46183	100.0%
Power	19982	43.3%
Steam	5565	12.0%
Hot Water - VAM	6688	14.5%
Flue Gas	6948	15.0%
Hot Water - Atmosphere	4820	10.4%
Miscellaneous	2181	4.7%

Energy & Mass Balance



Energy Accounting / Balancing



Analysis of Energy Bills

Electricity Bill

- Power Factor
- Load Factor
- Time of Day
- Demand Management

Fuel Bill

- Possibility of replacing cheaper source of energy
- Combined Heat & Power (Cogeneration) Systems

Outcome

- Optimizing purchase cost of energy

Power Quality & Harmonic Analysis

Logging of electrical parameters of individual phases

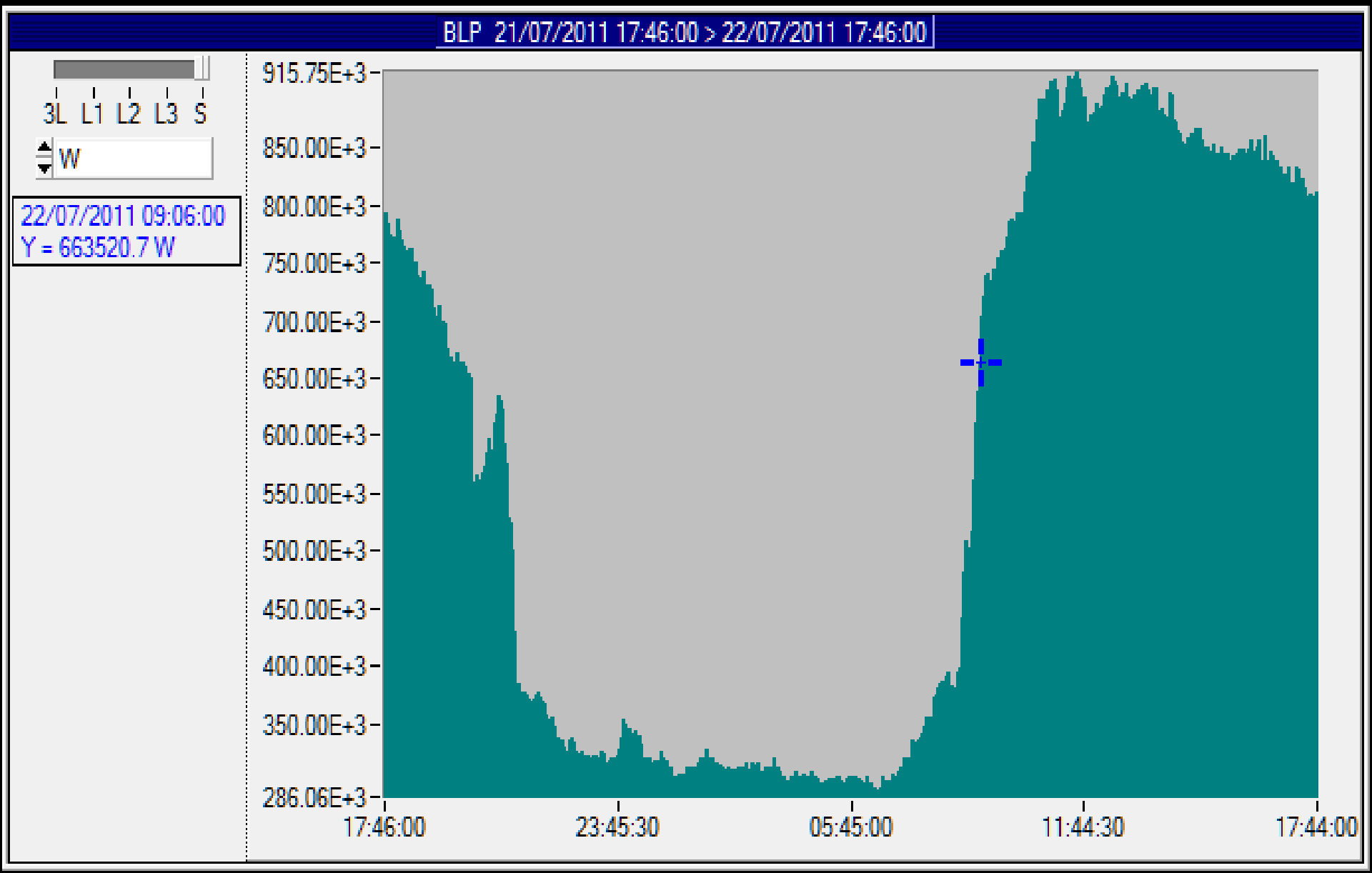
- Voltage, Current, Power Factor and Power – real, active and reactive
- Current harmonics – Total (THD) as well as 3^{rd} , 5^{th}, up to 23^{rd}
- Voltage harmonics – Total (THD) as well as 3^{rd} , 5^{th}, up to 23^{rd}

Outcome

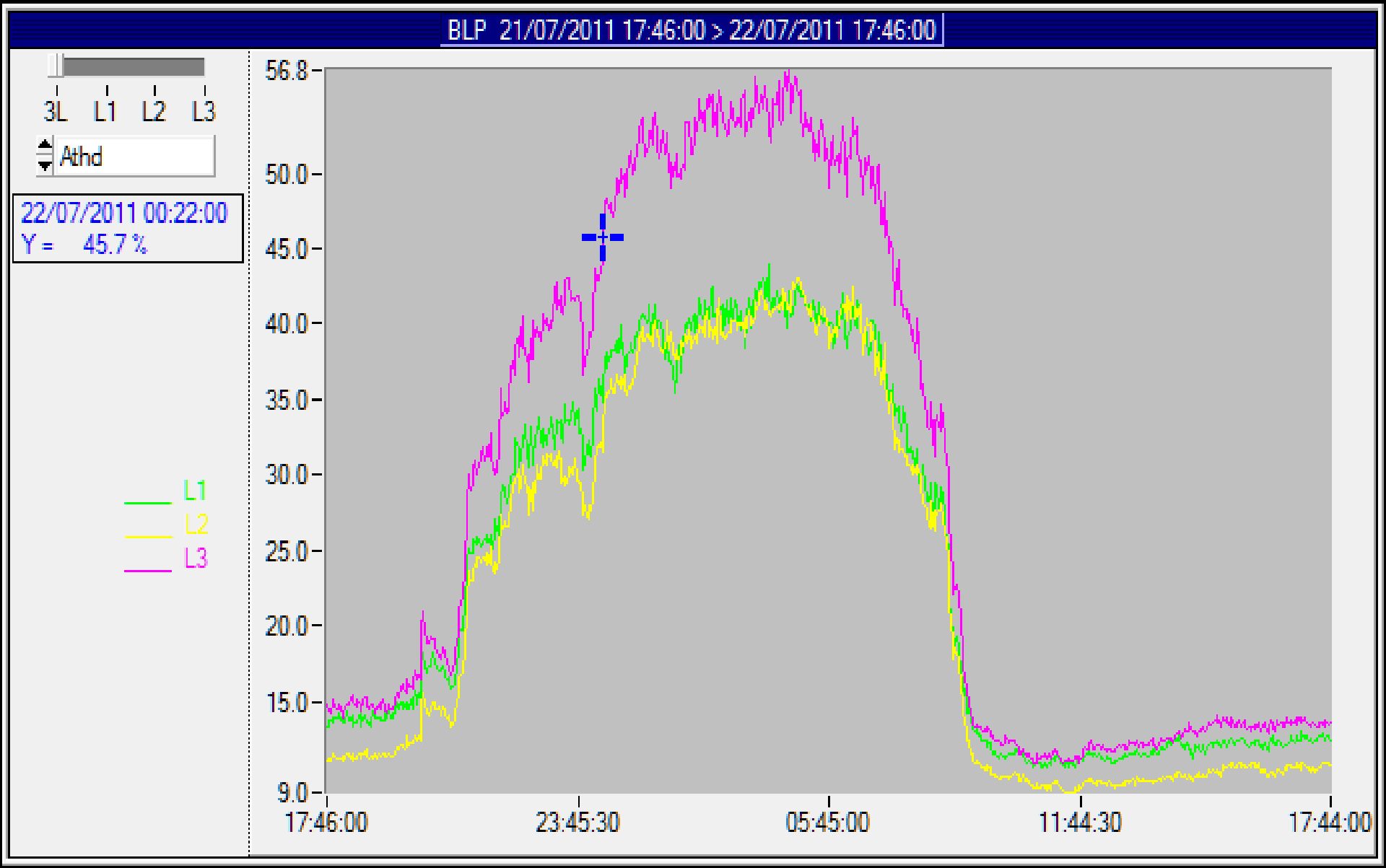
- Phase Imbalance in electrical parameters including current, voltage
- Harmonic distortion in current as well as voltage wave forms
- Loading profile over a period of time

The purpose is to identify power quality and harmonic issues; the correct actions would improve power quality but may not necessarily result in energy saving.

Consumption Profile – 24 hr



Current Harmonics - Total



Thermal Imaging of Electrical System

Measure

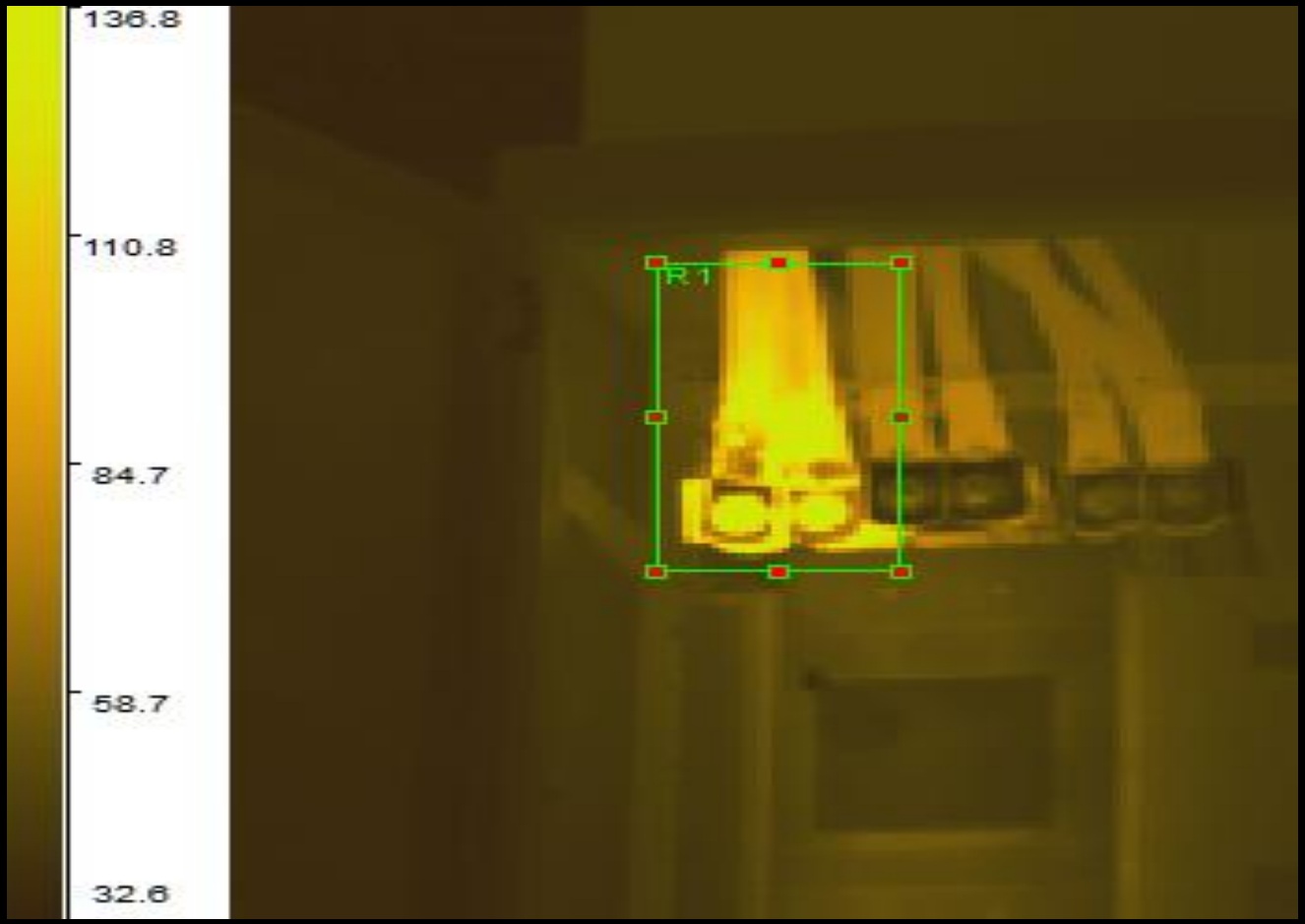
- Temperature profile of electrical panels / connections with Thermal Imager Camera

Outcome

- Identification of Hot Spots

The purpose is to identify hot spot due to localized heating; which could lead to failure / accidents. The correct actions would ensure safe operation but may not necessarily result in energy saving.

Thermal Imaging of Electrical System



Label	Max Value	Min Value	Average Value
R1	210.2°C	44.3°C	91.8°C

Motors

Measure

- Operating parameters like Voltage, Current, Power Factor and Power
- Note down Motor Rating, Efficiency, type of Application and Operating Period

Outcome

- Load / Loading Pattern of the motors
- Expected drop in Efficiency at operating load
- Steps to optimize motor performance
- Potential saving with cost benefit analysis

Motors

Equipment	Rating	Power	Voltage	Current	P F	Load
	kW	kW	V	A		%
Compressor - Air	1020	911	10970	53	0.91	89%
Blower – RAB	1200	717	10970	43	0.87	60%
Blower - SO2	2800	1954	10890	117	0.88	70%
Pump - Boiler Circulation	220	196	3390	40	0.82	89%
Pump - Boiler Feed Water	200	153	3390	29	0.89	77%
Compressor - Zinc Dust L	500	434	3390	94.7	0.78	87%
Blower - Zinc Dust	150	51	425	133	0.52	36%
Pump - Filter Water Supply	125	85	425	137	0.87	68%
Compressor - JK 01 – 5	200	171	417	268	0.87	86%
Blower - Hot Air	200	68	417	157	0.6	34%
Fan - Cooling Air	132	69	408	120	0.8	52%
Ball Mill	180	150	421	260	0.8	83%

Pumps

Measure

- Velocity of liquid to determine flow rate
- Differential Pressure
- Power drawn by motor
- Note down Motor Efficiency and Specific gravity of Liquid

Outcome

- Present pump efficiency
- Operating parameters – Flow, differential head and power.
- Recommended Efficiency at Operating parameters
- Steps to achieve the recommended parameters
- Potential saving with cost benefit analysis

Pumps

Description	Units	WC-1 - M-1	WC-1 - M-2	WC-1 - M-3	WC-1 - M-4
Actual Parameters					
Cost of Power	Rs/kWh	2.56	2.56	2.56	2.56
Operation	Hr/day	24	24	24	24
	Day/Year	360	360	360	360
Flow rate	M3/hr	878	917	865	898
Differential Head	M	33	33	34	33
Motor Power	kW	140	124	155	145
Pump Efficiency	%	63%	74%	57%	62%
Recommended Parameters					
Head	M	34	34	34	34
Flow rate	M3/hr	900	900	900	900
Pump Efficiency	%	85%	85%	85%	85%
Shaft Power	Bkw	98.1	98.1	98.1	98.1
Motor Power	kW	109.0	109.0	109.0	109.0
Economics					
Loss	kW	31.0	15.0	46.0	36.0
	kWh/year	267911	129671	397511	311111
	Rs/year	685851	331957	1017627	796443

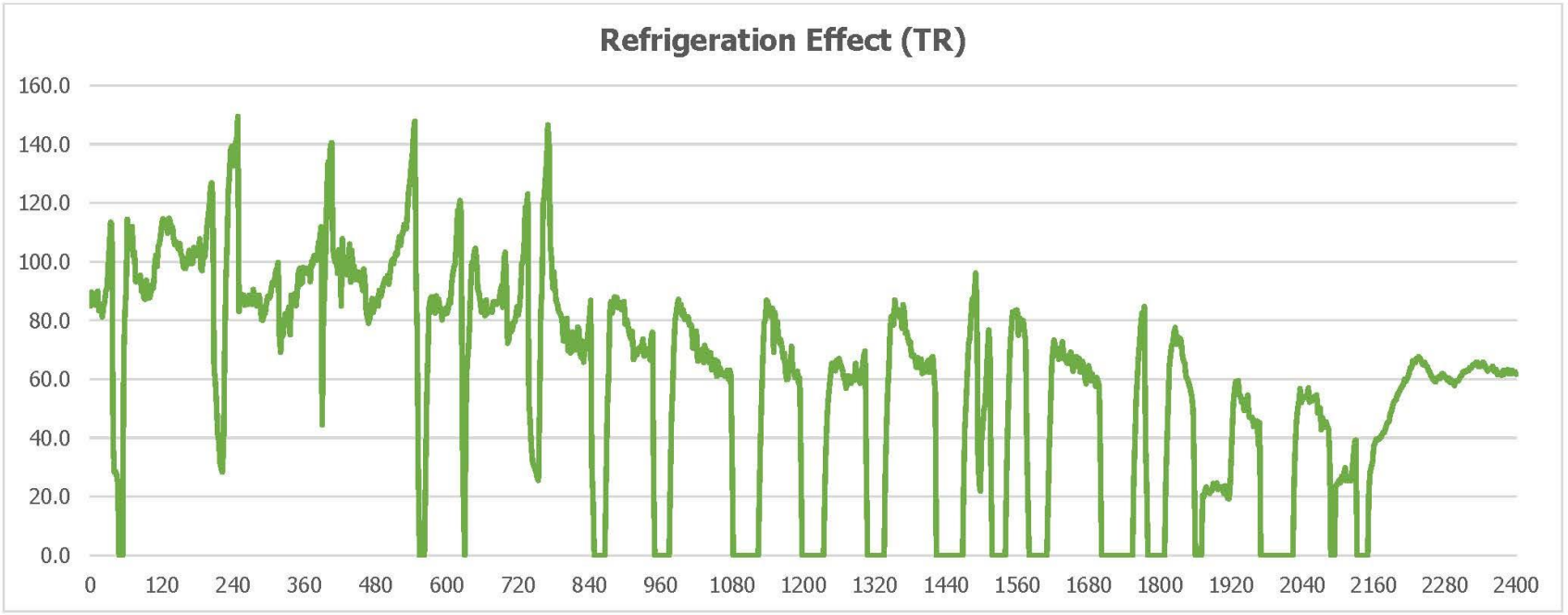
Refrigeration Compressors

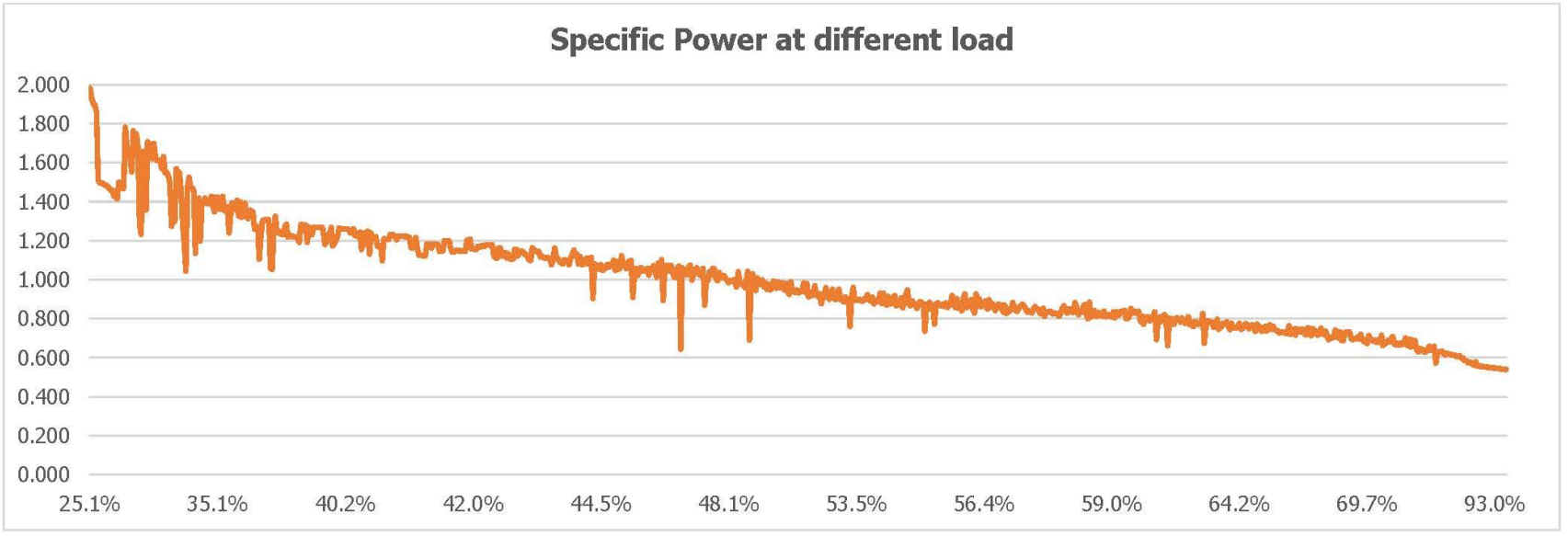
Measure

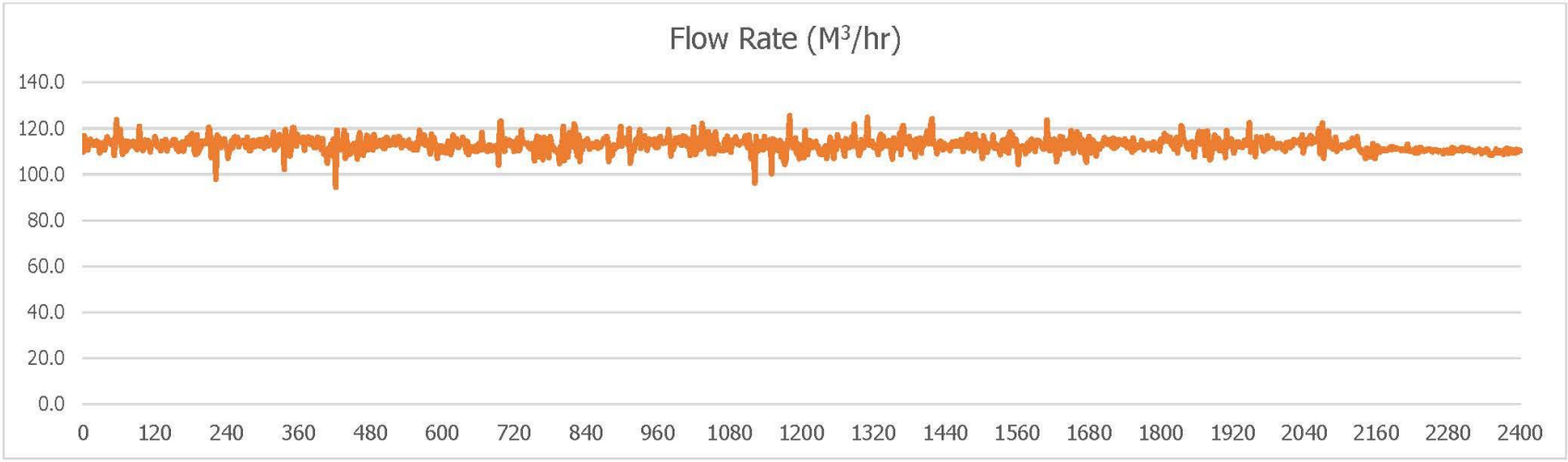
- Velocity of liquid to determine flow rate through chiller
- Differential Temperature across chiller
- Power drawn by compressor motor
- Note down Motor Efficiency, Specific gravity and Specific heat of Liquid, Speed of Compressor

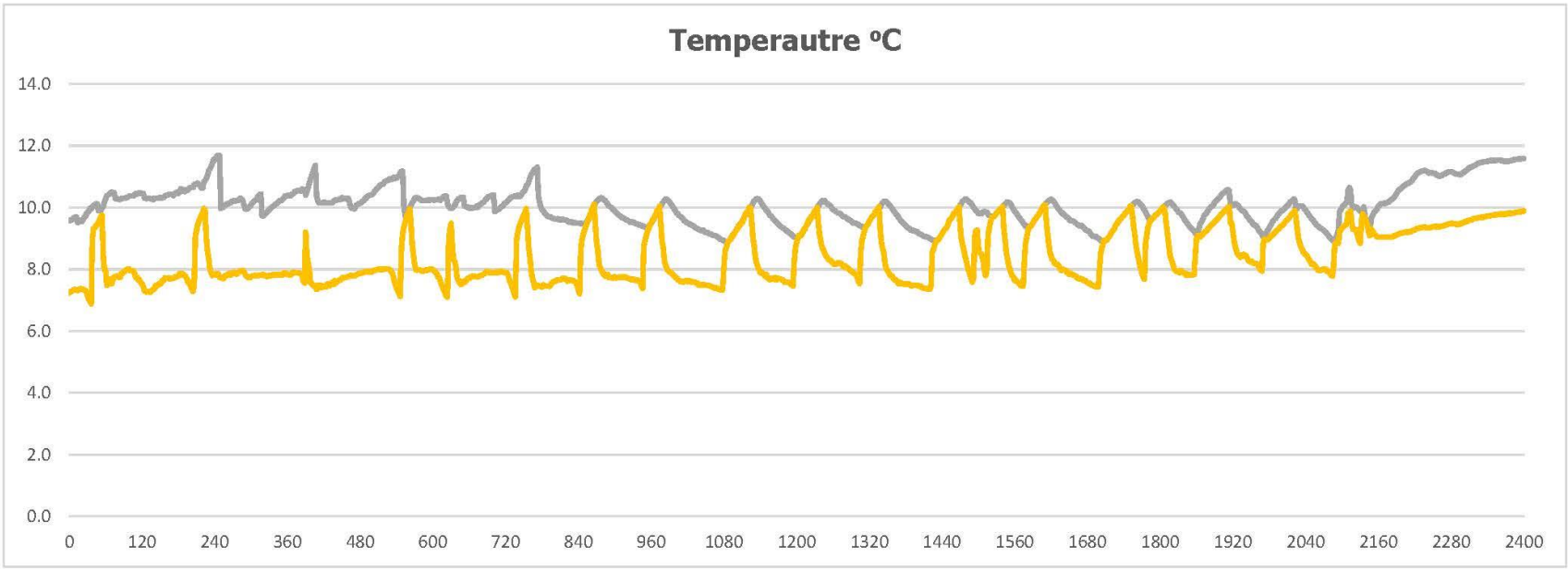
Outcome

- Operating capacity & Specific Power Consumption
- Recommended Specific Power at operating / design parameters
- Steps to achieve the recommended / design parameters
- Potential saving with cost benefit analysis


Refrigeration Effect (TR)
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
0
120
240
360
480
600
720
840
960
1080
1200
1320
1440
1560
1680
1800
1920
2040
2160
2280
2400


Specific Power at different load
2.000
1.800
1.600
1.400
1.200
1.000
0.800
0.600
0.400
0.200
0.000
25.1%
35.1%
40.2%
42.0%
44.5%
48.1%
53.5%
56.4%
59.0%
64.2%
69.7%
93.0%


Flow Rate (M3/hr)
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
0
120
240
360
480
600
720
840
960
1080
1200
1320
1440
1560
1680
1800
1920
2040
2160
2280
2400


Temperautre ºC
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
0
120
240
360
480
600
720
840
960
1080
1200
1320
1440
1560
1680
1800
1920
2040
2160
2280
2400

Refrigeration Compressors

Sr No	Description	ChWC – 11 100 TR
1	Start Time	January 1st, at 20:00 Hr
2	End Time	January 2nd, at 20:00 Hr
3	Duration	24 Hours
4	Inlet Temperature	13.0 ^{o}C
5	Outlet Temperature	12.2 ^{o}C
6	Flow Rate	80.4 M^3/hr
7	Refrigeration Load - Maximum	83.6 TR 83.6% of Rated
8	Refrigeration Load - Average	33.8 TR 33.8% of Rated
9	Power Consumption – Average	19.4 kW
10	Specific Power Consumption – Average	0.943 kWh/TR
11	Refrigeration Compressor – On duration	60.4%
12	Average output of Refrigeration Compressor	20.46 TR 20.5% of Rated

Fans & Blowers

Measure

- Velocity of gas to determine flow rate
- Differential Pressure
- Power drawn by motor
- Note down Motor Efficiency, Temperature and Specific gravity of gas

Outcome

- Operating efficiency (Static pressure) of fan
- Operating parameters – Flow, Diff Pressure & Power
- Recommended Efficiency at Operating parameters
- Steps to achieve the recommended parameters
- Potential saving with cost benefit analysis

Fans & Blowers

Description	Unit	Blower-1	Blower-2
Actual Parameters			
Flow Rate	NM^3/hr	6700	9000
Differential Pressure	Mm WG	1800	4650
Motor Power	kW	675.0	1954.0
Fan Efficiency	%	63%	69%
Damper Position	% Open	40%	60%
Desired Parameters			
Flow Rate	NM^3/hr	6700	9000
Differential Pressure	Mm WG	1800	4650
Fan Efficiency	%	70%	80%
Motor Power	kW	50.4	152.9
Potential Savings			
Loss	kW	1711	4214
	kW/Month	12329	30556
	Rs/Month	3,13,00	77600

Air Compressors

Capacity Test

- Isolate compressor & receiver from the system.
- Close the outlet valve of the receiver.
- Switch off the compressor.
- Vent the air to bring down the pressure to atmospheric.
- Start the compressor.
- Note down the final pressure and the time required to reach the final pressure.
- Measure power consumption of the compressor at the final pressure.
- Measure volume of the receiver and the piping till the receiver.

Indicative Method:

Measure suction flow rate with anemometer & note down area of air flow.

Air Compressors

Leak Test / Operating Load Test

Operating Load:

- Note down overall load time and operating time of the compressors during the specified period.

Leak Test:

- Switch off all the consumers of compressed air.
- Operate optimum number of compressors.
- Note down the total time of the test and the loading time of the individual air compressors.
- Note down power consumption loading and un-loading of the individual compressors.

Air Compressors

Outcome

- Operating capacity
- Specific Power Consumption
- Recommended Specific Power at operating / design parameters
- Leakages in the system
- Loading pattern on the compressor
- Steps to achieve the recommended / design parameters
- Potential saving with cost benefit analysis

Air Compressors

capacity Test

Description	Unit	Auxiliary Module	Shot Blasting	Gear Box	Recron
Model		E-37-7.5	E-18-7.5	E-22-7.5	E-18-7.5
Make		Elgi	Elgi	Elgi	Elgi
Capacity	M^3/hr	382.5	178.5	212.5	178.5
	CFM	225	105	125	105
Rated Pressure	Kg/cm^2	7	7	7	7
Actual Pressure	Kg/cm^2	6	6.2	6.4	6
Receiver & Piping Volume	M^3	1.05	1.05	1.05	1.05
Power - Load	kW	36.3	18.7	24.9	17.4
Power - Un-load	kW	9.2	4.6	7.21	4.9
Capacity test - Time to fill Receiver	Sec	64	132	168	136
Operating Capacity	M^3/hr	354.4	177.5	144.4	166.8
Specific Power	kW/M^3	0.102	0.105	0.172	0.104

Air Compressors

Operating Load

Description	Unit	Compressed Air	
		LP	HP
Loading Period	Hr/day	56.0	16.0
Loading Period	Hr/day	16.0	8.0
Utilization	% total	78%	67%
Load Power	kW	170.8	157.5
Unload Power	kW	33.5	34.5
Consumption	kWh/day	10100	2800
Useful Power	kWh/day	9564	2525
Unload Losses	kWh/day	536	275
Total Air	M^3/day	106272	22956
	M^3/hr	4428	956
	CFM	2605	563

Air Compressors

Leak Test

Description	Unit	Low Pressure System (7.0 kg/cm^2_g)	
		CP-1	CP-3
Design Flow Rate	CFM	1100	1100
	M^3/Hr	1870	1870
Design Pressure	Kg/Cm^2_g	7.0	7.0
Operating Pressure	Kg/Cm^2_g	7.0	7.0
Motor Input Power	kW	162	180
Loading Time	Sec	100	64.05
Unloading Time	Sec	0	349
Losses due to leakages	M^3/Hr	1870	290
	kW	162.0	27.9
	% Total	100%	16%

Cooling Towers

Measure (during a specified period of time)

- Air velocity to determine air flow rate for each cell
- Ambient Conditions - DBT, WBT
- Inlet and outlet temperature of water
- Range and Approach
- Power drawn by Fan

Outcome

- Operating parameters - Output, Effectiveness , L/G Ratio
- Recommended Operating parameters
- Steps to achieve the recommended parameters
- Potential saving with cost benefit analysis

Cooling Towers

Description	Unit	CT - 1 - 1	CT - 1 - 2	CT - 1 - 3
Actual Parameters				
Dry bulb Temperature - Top	^{o}C	31.0	31.0	31.0
Wet bulb Temperature - Top	^{o}C	29.0	29.0	29.0
Dry bulb Temperature - Bottom	^{o}C	30.0	30.0	30.0
Wet bulb Temperature - Bottom	^{o}C	25.0	25.0	25.0
Air velocity	m/s	7.74	6.3	6.64
Fan Diameter	M	6.40	6.40	6.40
Air Flow Rate	kg/hr	1075113	869536	922320
Cooling Water Temperature - Top	^{o}C	37.1	37.1	37.1
Cooling Water Temperature – Sump	^{o}C	30.8	30.8	30.8
Power Consumption	kW	27.00	28.0	27

Cooling Towers

Description	Unit	CT - 1 - 1	CT - 1 - 2	CT - 1 - 3
Overall Parameters				
Cooling Water Flow Rate	M^3/hr	1186.0	1186.0	1186.0
Cooling Tower Performance	TR	2471	2471	2471
L/G ratio		1.10	1.36	1.29
Actual Range	^oC	6.3	6.3	6.3
Actual Approach	^oC	5.8	5.8	5.8
Cooling tower Effectiveness	%	52%	52%	52%
Evaporation Losses	M^3/hr	11.43	11.43	11.43
Drift loss	M^3/hr	2.97	2.97	2.97
Water consumption	M^3/hr	14.40	14.40	14.40
Specific Power	kW/TR	0.011	0.011	0.011

Furnaces

Specific Energy / Efficiency (Direct / Indirect)

Measure (during the specified period of time)

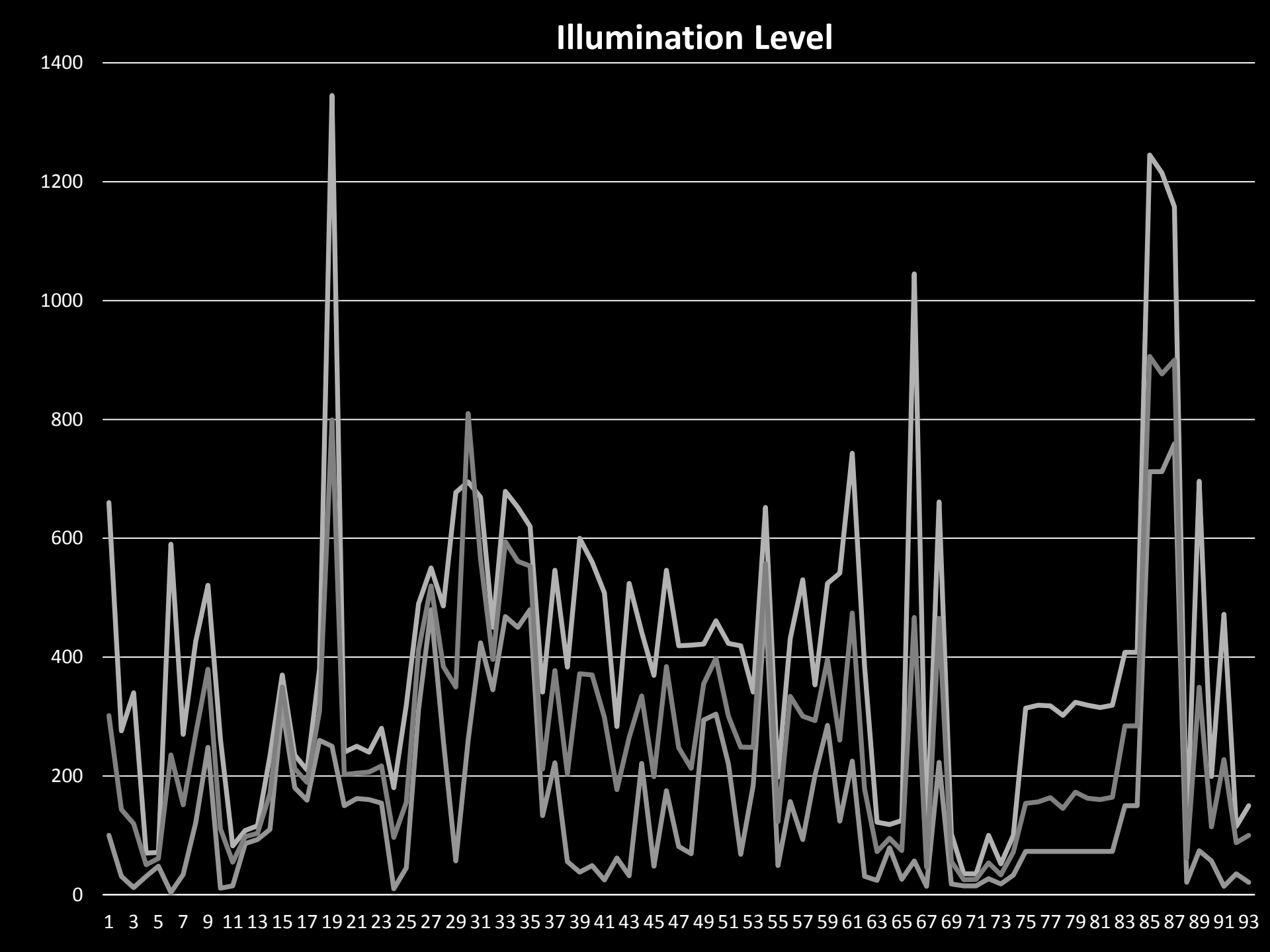
- Useful Heat energy for heating the product
- Total Energy supplied
- Combustion gas analysis – CO_2, O_2 & Stack temp
- Surface area and wall temperature
- Furnace temperature & Opening
- Any other sources of losses

Outcome

- Operating efficiency by direct & indirect method
- Losses with quantification from individual avenue
- Recommended parameters & steps to achieve them
- Potential saving with cost benefit analysis

Illumination & Indoor Air Quality

- Illumination Level
- Temperature
- Relative Humidity (RH)
- Carbon dioxide (CO_2) contents


Illumination Level
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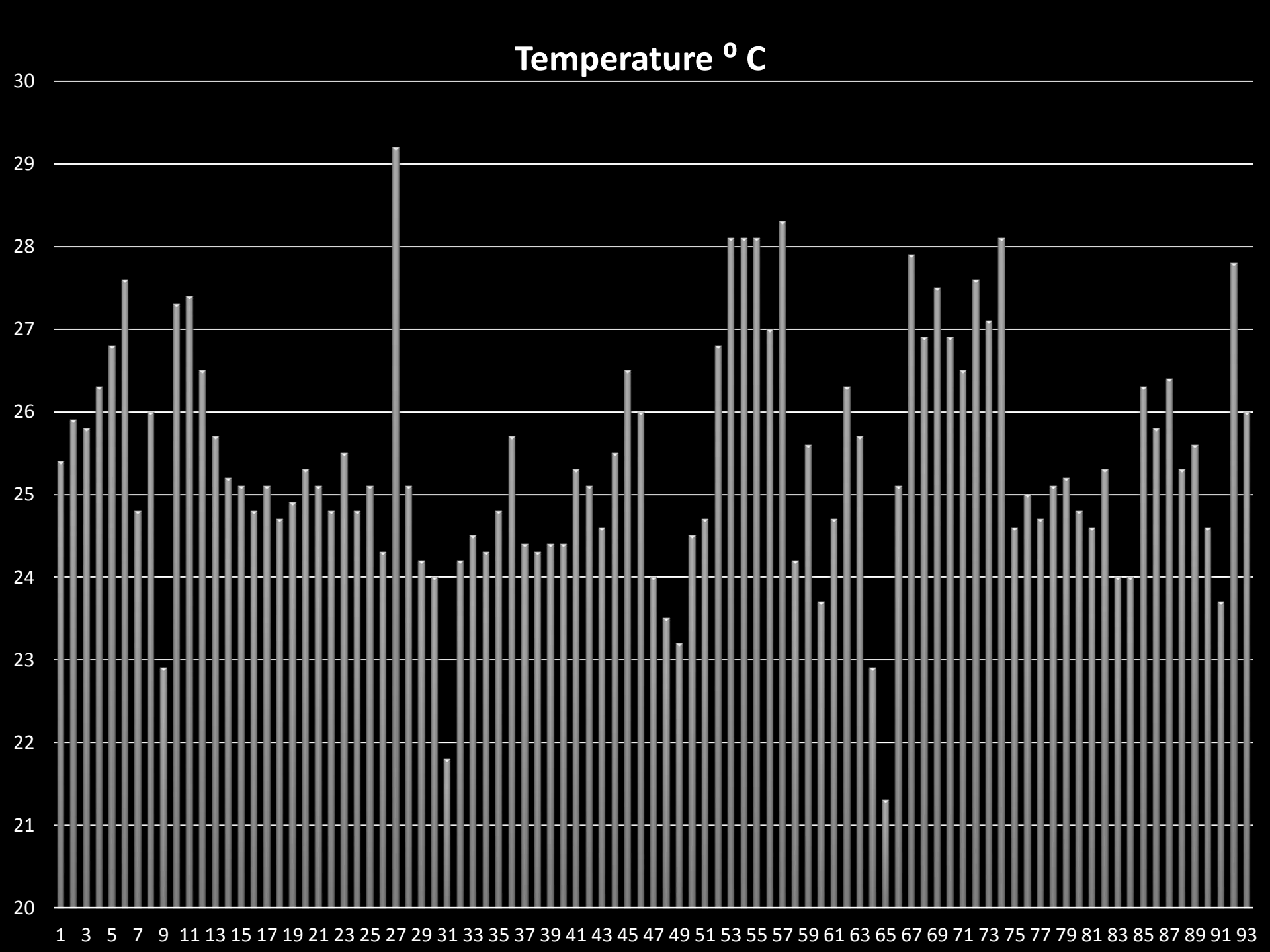
Temperature ° C
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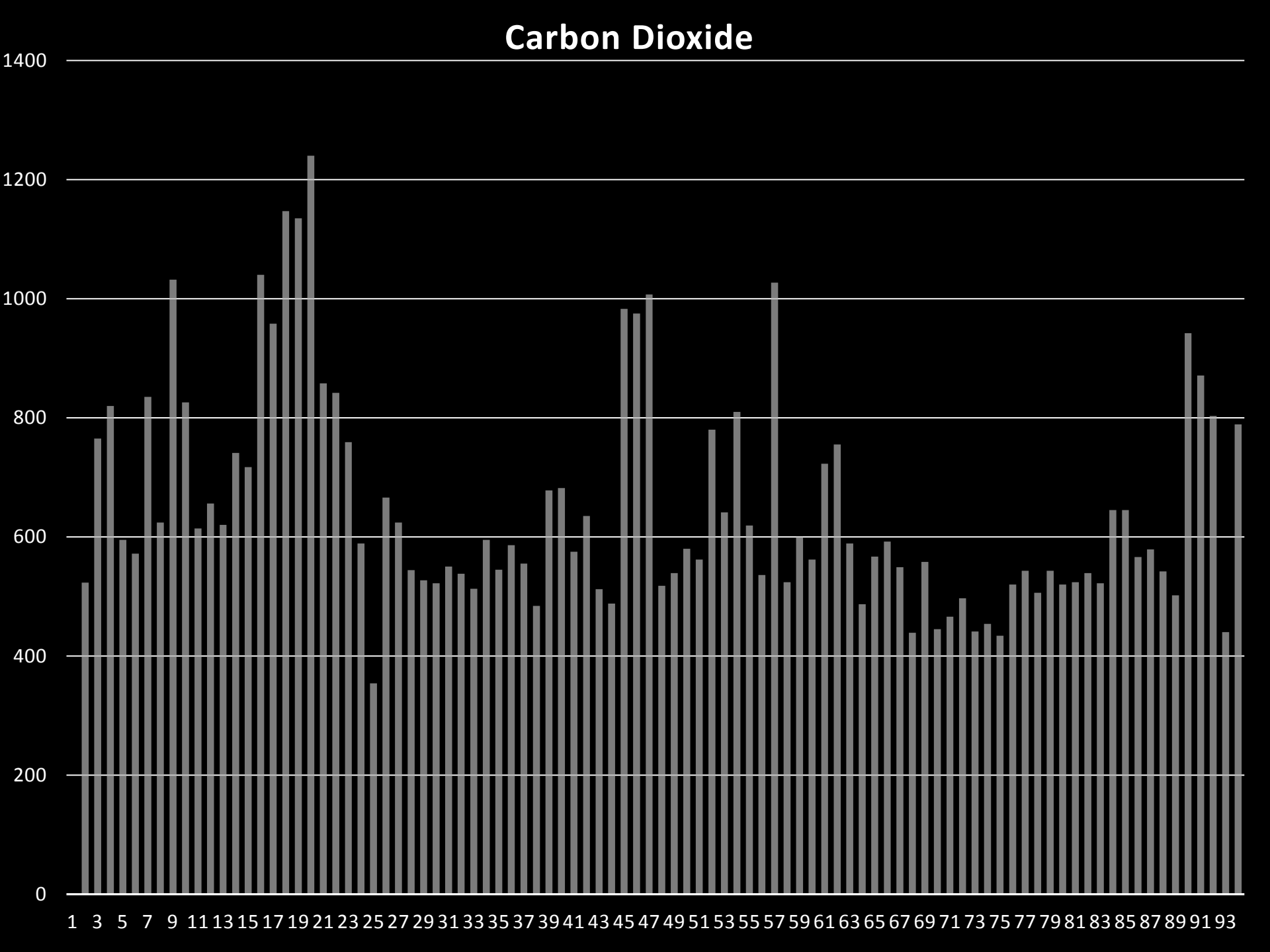
Carbon Dioxide
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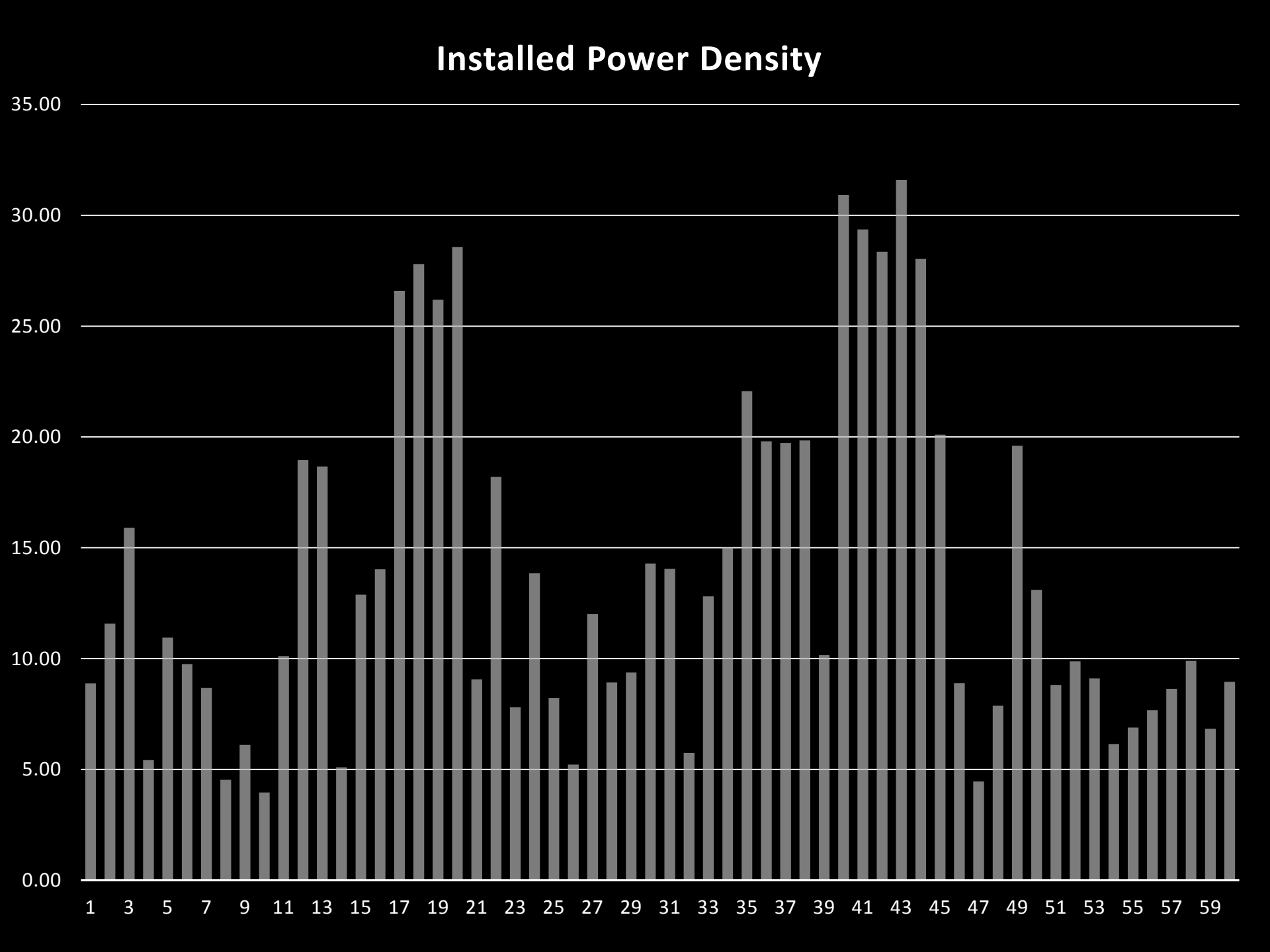
Installed Power Density
35.00
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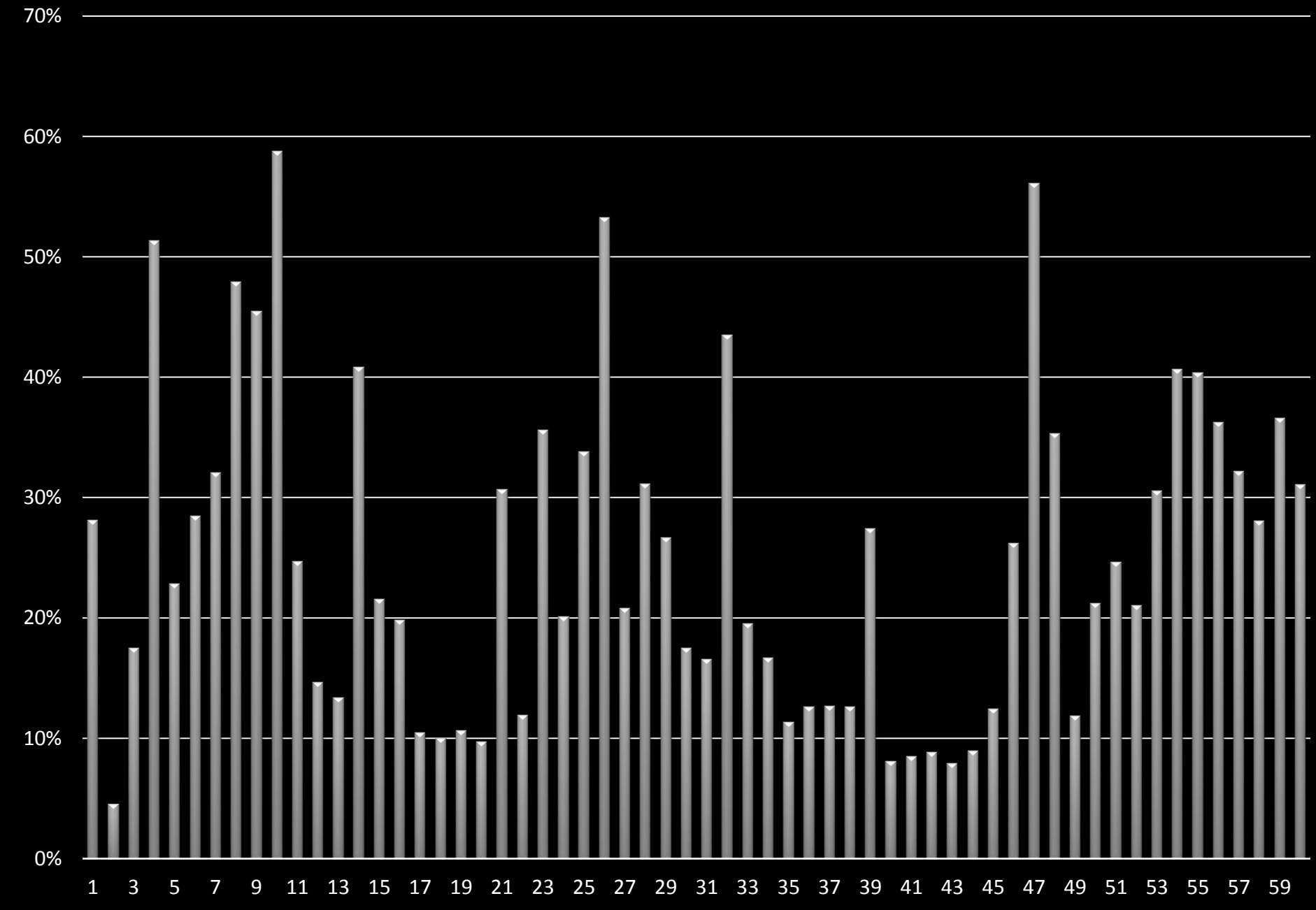
25.00
20.00
15.00
10.00
5.00
0.00
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57 59

Installed Load Efficiency Ratio



Study of Distribution System

Energy loss / Heat ingress / Leakages

- Cooling water system
  - Pressure drop
- Compressed air system
  - Pressure drop
  - Leakages
- Electrical distribution system
  - Cable losses
  - Transformers
  - Capacitors

Utilization

- Over / Under Sized Equipment
  - Pumps, refrigeration compressors, cooling towers
- High Grade Energy for Low Grade Applications
  - Compressed air for cleaning, brine in place of chilled water
- Unwarranted & Rigid Specifications.
  - Stringent hall Conditions, air conditioning / lighting in unoccupied area

Recovery of Waste Energy

- Recovery from Hot / Cold Effluent

Cost of Energy

- Avail Maximum Tariff Concessions & Benefits
  - Unity PF, Night Operation, Bulk Discount, Bulk Purchases
- Switchover to cheaper Fuel
  - Electrical to fuel (LPG / HSD / Biofuel) heating / solar system, heat pump and/or de-superheater for hot water
- Power Exchange
  - Procuring power through power exchange

Thank

You!