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Kazakhstan Energy Sector Strategic Engagement P180209

Power System Analysis to Support Clean Energy Development Strategies for Kazakhstan

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Executive Summary

Project Context and Approach

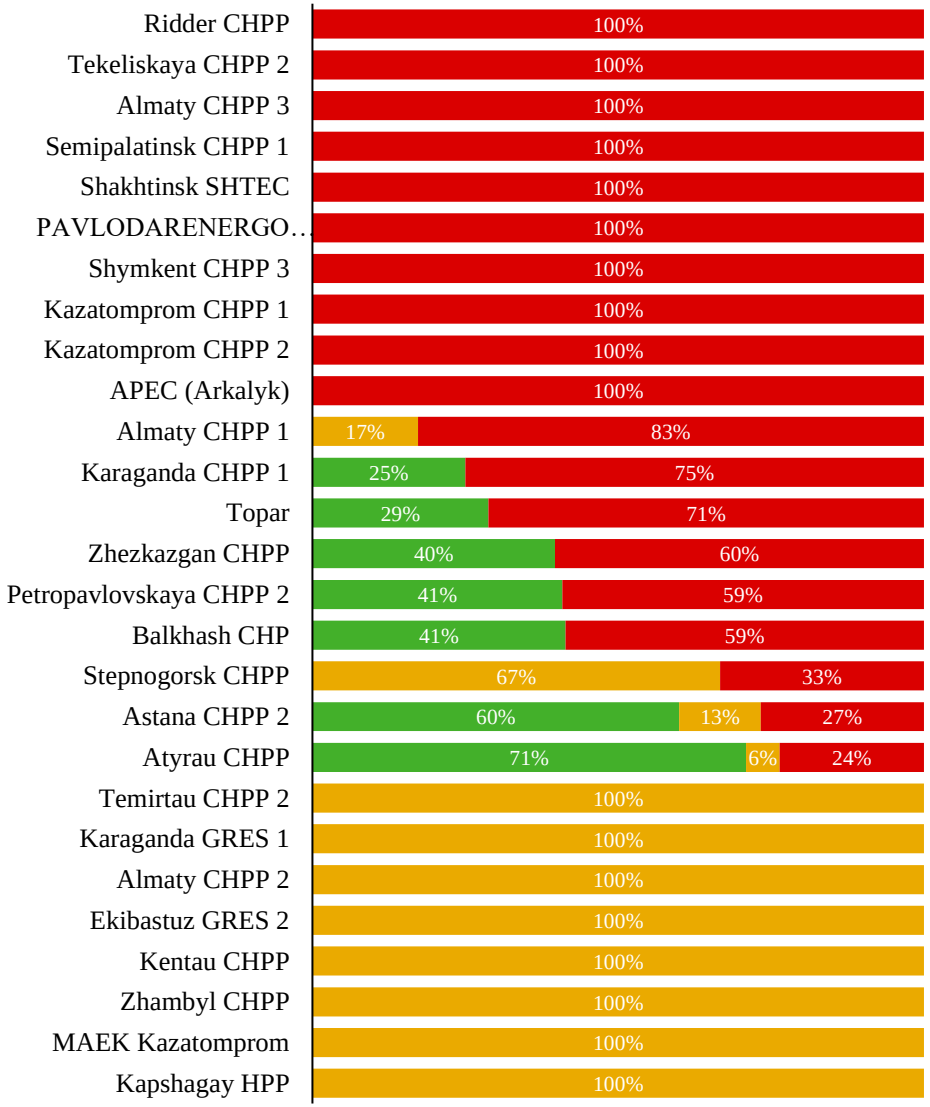
1. Preparation & Consultations	2. Plant visits and interactions with plant officials	Recommendations**
1. Preparation of questionnaire in line with TOR requirements. 2. Review and consultations with KOREM and MoE 3. Briefing calls with power plant officials 4. Prepared site visit checklist	1. Visit to power plants covering 19.5 GW of capacity including both power and heating (CHP) units 2. Data compilation and analysis of technical and operational parameters of power plants 3. Assessment of plant condition based on site visits covering equipment condition, structural vulnerabilities, fuel management, Emission monitoring and ash handling, health and safety compliance 4. The analysis and outputs as part of the study is based on (i) inputs provided by respective power plants, (ii) visual observations made during respective site visits to plants for one-day each; and (iii) concerns / issues put forward by power plant officials during site visits	1. Power plant status and relative positioning 2. Policy Recommendations

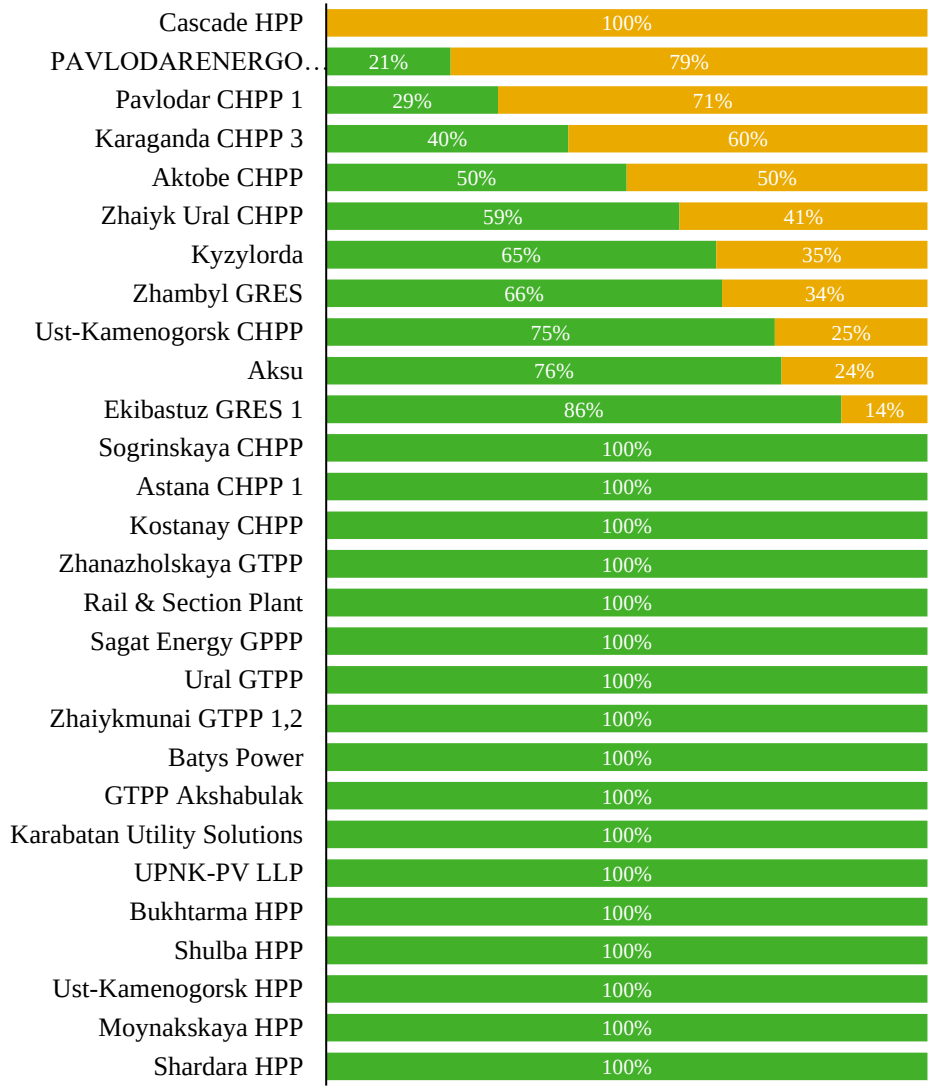
Oct–Nov 2022 | Dec 2022–Feb 2023 | Mar 2023–Apr 2023

**The analysis and outputs as part of the study is based on (i) inputs provided by respective power plants, (ii) visual observations made during respective site visits to plants for one day each, and (iii) concerns / issues put forward by power plant officials during site visits.

Schematic Report Card

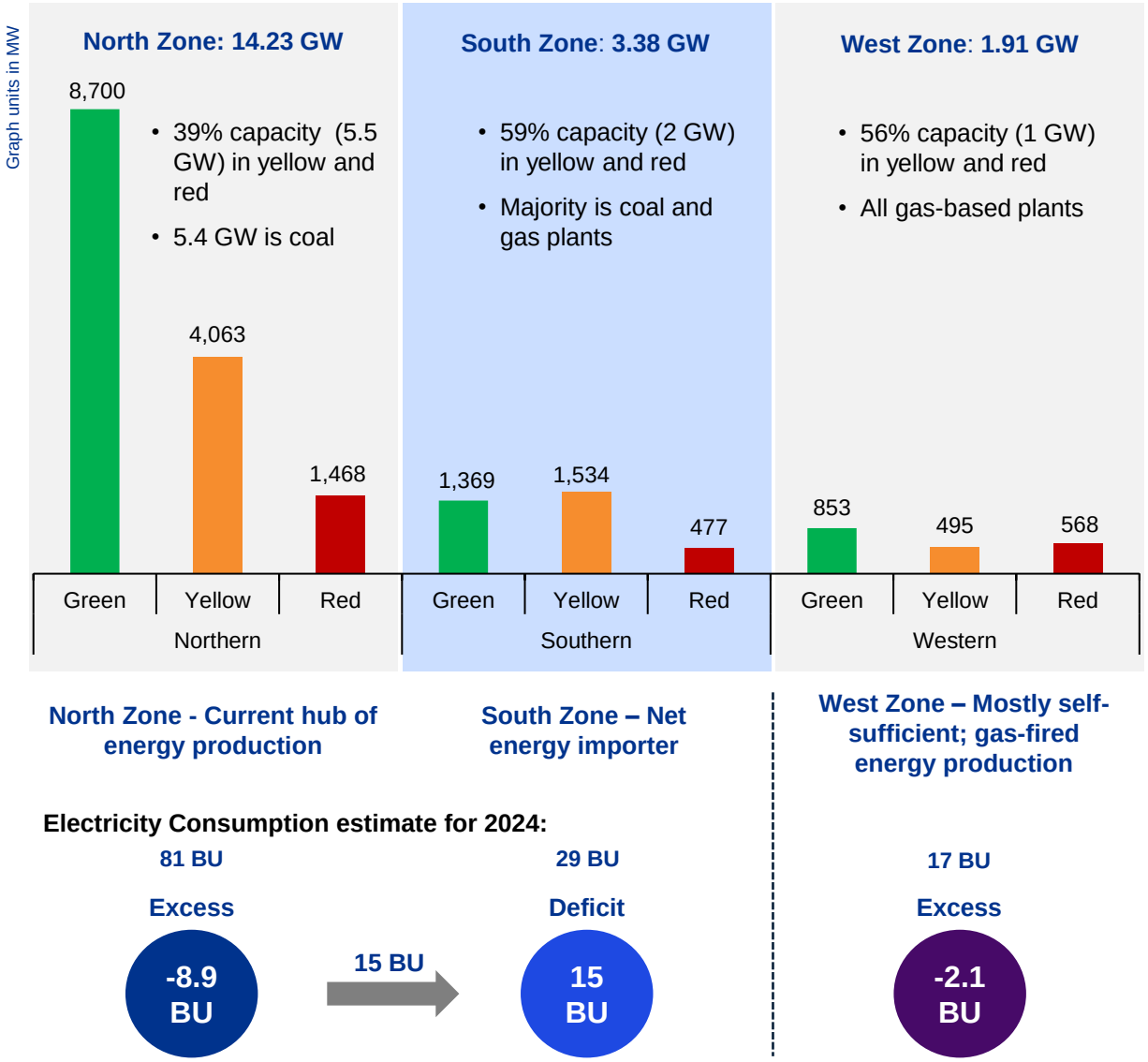
Rating	MW
Green Good operating conditions; focus on improved O&M	10,923
Yellow Consider for Renovation and Modernization (R&M)	6,092
Red Overall conditions sub-optimal; consider for phase out	2,513
Total	19,528





The above list covers 55 plants. ArcelorMittal PVS not included as technical inputs from plant were not received. GPES EPC Industry and Zhanaozen GPES have not been included since site visits were not conducted

Implications of Locational Distribution



<u>North Zone</u>: *Coal dominated energy-industrial hub; need to diversify energy mix through "just transition" to renewables.*

- Ridder and Shakhtinsk in red zone, needed for heat delivery
- R&M needed for yellow zone Ekibastuz GRES-2 (1,000 MW), a portion of Aksu (600 MW)
- **Financing new coal, a challenge -** 1.4 GW coal overdue for phase out

<u>South Zone</u>: *Region with energy deficit. 1.4 GW high-capacity plants require prioritization.*

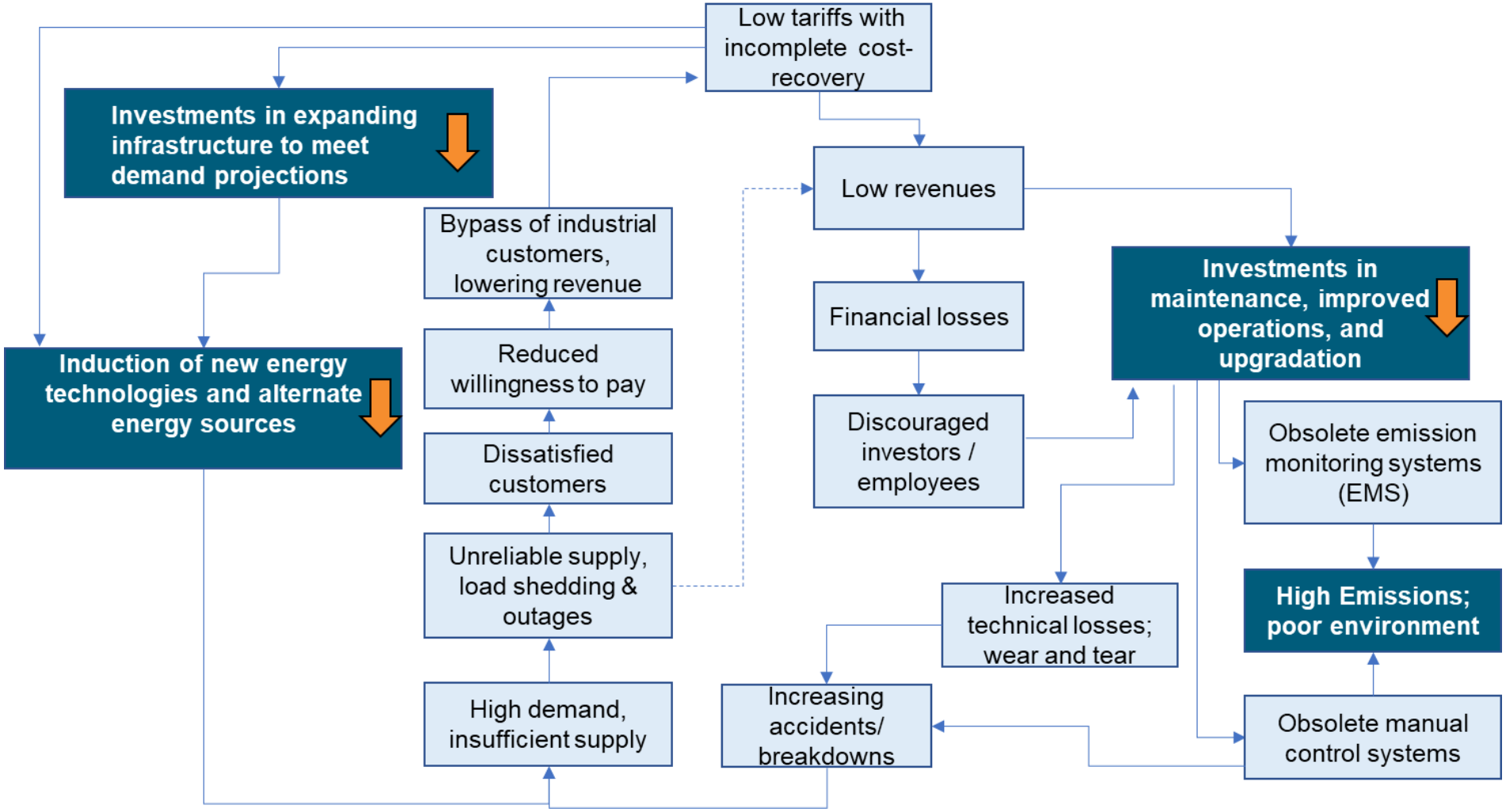
- Shymkent and Tekeli in red zone, critical from heat perspective
- Gasification of yellow zone Almaty CHPP-2 (600 MW) planned
- R&M for yellow zone Zhambyl GRES (420 MW / 1.2 GW; gas) due
- Majority hydro plants renovated except Kapshagay (364 MW) and Cascade (44 MW)

<u>West Zone</u>: *Largely gas-fired capacity mix; improve operations.*

- R&M due for yellow zone MAEK Kazatomprom TPP (450 MW)
- Improve operations of gas-based plants; pilot new technologies like fuel cells and modular LNG

It Is Important to Break the Link between Low Tariffs and Delayed Investments

A vicious cycle gripping Kazakhstan's power sector today:



'Tariffs for Investments' needed to make energy sector reliable, climate resilient, and financially viable.

The main recommendations

- Improve operational performance through timely O&M
- Undertake Renovation and Modernization (R&M) where identified
- Accelerate energy transition aligned with development and climate goals (net-zero by 2060)
- Develop a modern, smart, and resilient energy system for the future
- Improve comfort and affordability through energy efficiency, distributed technologies, modern monitoring, and targeted subsidies

Recommendations (1/3)

Improve operational performance through timely O&M	• **Using plant-wise rankings as guidance** conduct **immediate repairs** of Boiler-Turbine-Generator (B-T-G) equipment, including balance of plant • Address urgent **structural concerns** especially on chimneys and buildings • Ensure **availability of critical spares** to handle breakdowns, and prepare **emergency response plans** and train employees for these
Undertake Renovation and Modernization (R&M) where identified	• Undertake **renovation and modernization to extend the service life** for yellow category units in consultation with OEMs • Undertake **modernization and efficiency improvement** of district heating systems, prioritize investments in infrastructure upgrades, automation, and digitalization guided by color ranking and further analysis at plant level • Develop **tariff for investment** program to ensure sufficient funds for R&M works

Recommendations (2/3)

Accelerate energy transition aligned with development and climate goals (net-zero by 2060)	• Plan **phase down of red** category units, especially coal-fired, developing alternatives • **Enable gas use as transition fuel** with hydrogen-ready CCGT projects; identify opportunities for efficient use of gas (modular and large scale) • **Scale up RE capacity** through dedicated Renewable Energy Zones and well-structured auctions *(wind and geothermal in west, solar in south and south-west, pilot geothermal in new construction in south).* • Develop/pilot **grid connected storage systems** for balancing of power • Enforce **emission standards** through regulatory mechanism (including carbon pricing); ensure **mandatory reporting and inspection** • Pilot **just transition programs** to mitigate the social and economic impacts of coal phase-out
Develop modern, smart and resilient energy systems for the future	• Develop least cost generation expansion plan along with necessary grid upgrades • Introduce **Intelligent Power Systems** through use of SCADA, ERP, other analytics tools leveraging AI, IoT etc. • Undertake intensive **training programs and skilling** of sector professionals

Recommendations (3/3)

Improve comfort and affordability through energy efficiency, distributed technologies, modern monitoring and targeted subsidies

- Graduate to Gigawatt-scale RE projects for **competitive bidding**
- **Rationalize rate-making practices for heat and power** with an objective to remove cross-subsidies between heat and electricity
- Prepare a plan for **targeted distribution of subsidies** to protect vulnerable consumers while also avoiding industrial bypass to maintain system viability
- Plan and initiate development of **alternate capacity for critical heating plants** in regions like Ridder, Tekeli etc.
- Explore **pilots on sustainable heating options**, such as decentralized heating through electric heat pumps, geothermal based heating etc.
- Encourage **adoption of energy efficiency** solutions across the economy
- **Establish output conditions** (plant KPIs and emission norms) for setting tariffs for thermal power plants

Action Plan in Summary

Short Term Actions (6 months)	Medium / Long Term Actions
1. Red Category Units	
• **Undertake repairs and major / minor overhauls** of B-T-G equipment to meet winter demand for heat and electricity	• **Phase out units** in medium term • In case of lack of alternatives for heat plants, **phase out** units in long term • **Accelerate transition to gas and scale up RE deployments**
2. Yellow Category Units	
• **Conduct Residual Life Assessment (RLA)** to identify critical areas of upgradation and overhaul; and implement key recommendations	• **Undertake renovation to extend the service life of units**
3. Green Category Units	
• Prepare **for scheduled maintenance** on an ongoing basis	• Improve performance and efficiency through **digital interventions**
4. All Units	
• **Emergency operation** – prepare SOPs and ensure **availability of critical spares** to minimize outages • Address urgent **structural concerns** especially on chimneys & buildings • Test & rectify major alarms, smoke detectors, fire-fighting systems etc. • **Improve cost reflectiveness of tariff**: Re-introduce tariff for investment for maintenance and renovation activities	• **Regularize processes** such as monitoring of spares, updating SOPs, etc. • **Conduct structural surveys** *(where not already done)* to identify vulnerable areas, and take corrective actions • Establish **output conditions** (plant KPIs and emission norms) for setting tariffs

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Context

1. Government of Kazakhstan has embarked on a path to drive reform agenda for a clean energy economy.
2. Kazakhstan aims to progressively withdraw its dependence on fossil fuel for electricity and heating demand.
3. As of 2021, the electricity & heating sector is highly dependent on coal (~57% of the total installed capacity), followed by gas at ~25% and large hydro at ~11%.[1]
4. Share of RES is gradually increasing. Wind, solar, and small hydro together account for nearly 7% of installed capacity. [1]
5. Vast majority of the power systems have been in operation for decades, without any significant changes or upgrade.
6. Modernization of power systems and reliability of power data has been a key concern in this regard.
7. Going forward, the Government aims to modernize power systems and scale up clean energy infrastructure in Kazakhstan.
8. In this regard, the World Bank funded a project for assessment of power generation sector and identification of clean energy development strategies for Kazakhstan.

[1]*Source: IEA.*

Objective

The project aimed to collect baseline data on select heat and power plants, covering existing technologies, operational efficiencies, data management, etc., to

- Assess the current conditions and plant characteristics;
- Assess the age and performance of plants to determine power plant's status and relative positioning; and
- Develop Policy and Regulatory Framework & Financing Strategy to scale up private sector investments, particularly in clean energy infrastructure.

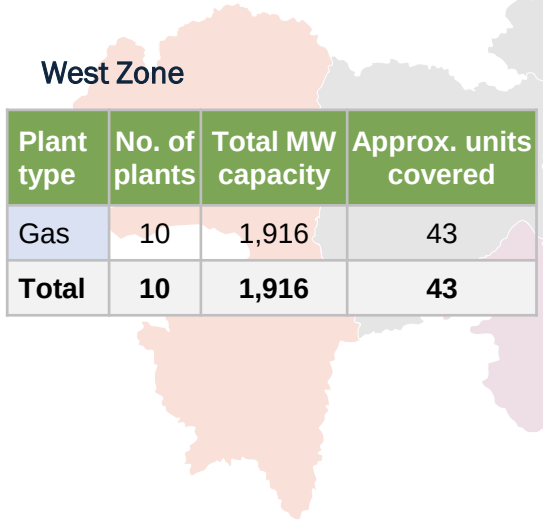
The project Terms of Reference (TOR) states the significance and urgency of grid resiliency and reliability in Kazakhstan. It states that the study aims to provide recommendations on priority areas of improvement by assessing the current status of power systems, supported through data collection within a short 5-month period. The TOR recognizes that the successful execution of the study depends on access to relevant data and information on time. In this regard, KOREM (Ministry of Energy designee) has been a strong support in leading coordination efforts to ensure access to data and facilitating dialogues with relevant stakeholders.

Approach and Methodology

1. Preparation & Consultations | **2. Plant visits and interactions with plant officials** | **Recommendations****

1. Preparation of questionnaire in line with TOR requirements
2. Review and consultations with KOREM and MoE
3. Briefing calls with power plant operators in 4 groups between November 11 and 16, 2022
4. Prepared site visit checklist

- Visit to 56 plants across North, South, and West Zones was carried out over 3 months.
- Total of 19.5 GW capacity and 250 units covered* including both power as well as heating (CHP) units



West Zone

Plant type	No. of plants	Total MW capacity	Approx. units covered
Gas	10	1,916	43
Total	**10**	**1,916**	**43**

North Zone

Plant type	No. of plants	Total MW capacity	Approx. units covered
Coal	23	12,135	105
Gas	5	339	21
Hydro	3	1,745	19
Petcoke*	1	12	4
Total	**32**	**14,231**	**149**

**For the purpose of analysis, Petcoke is considered as part of gas.*

South Zone

Plant type	No. of plants	Total MW capacity	Approx. units covered
Coal	4	810	14
Gas	6	1,737	21
Hydro	4	834	23
Total	**14**	**3,380**	**58**

**Out of total 58 power plants, 56 plants visited. The remaining 2 plants (11 units) are gas-based plants in west zone including:*
1. GPES LLP "EPC Industry", a 3 MW (2 units) plant which is currently not operational.
2. "OralMunayProm" LLP GPES Zhanaozen, a 30 MW (9 units) plant which has relatively new units (17 MW commissioned in 2011).

The map provided here is for illustration only, without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city, or area.

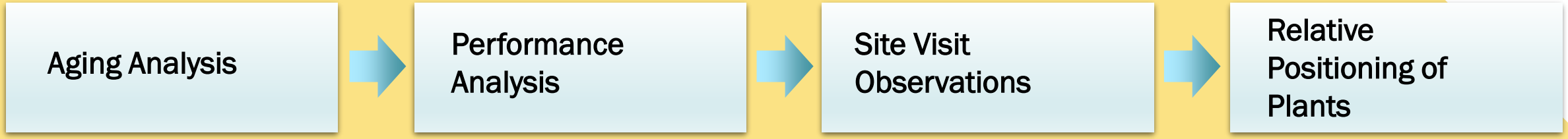
1. Power plant status and relative positioning
2. Policy recommendations

Oct–Nov 2022 | Dec 2022–Feb 2023 | Mar 2023–Apr 2023

**The analysis and outputs as part of the study is based on (i) inputs provided by respective power plants, (ii) visual observations made during respective site visits to plants for one day each, and (iii) concerns / issues put forward by power plant officials during site visits.

1	2	3	4
Detailed performance analysis and site visit observations	Power plant characteristics and relative positioning	Key focus areas for efficient operations of power plants	Development framework and financing strategy

Approach Adopted for Analysis



- **Excel-based model** for mapping unit-wise details of all power plants
- Data compilation and analysis of technical and operational parameters of power plants
- Assessment of plant condition based on site visits
- Key parameters analyzed
  - *Age structure*
  - *Operating parameters such as specific fuel consumption, auxiliary power consumption, etc.*
  - *Details on renovation and modernization*
  - *Site observations on O&M practices, structural vulnerability, safety, environmental standards, etc.*

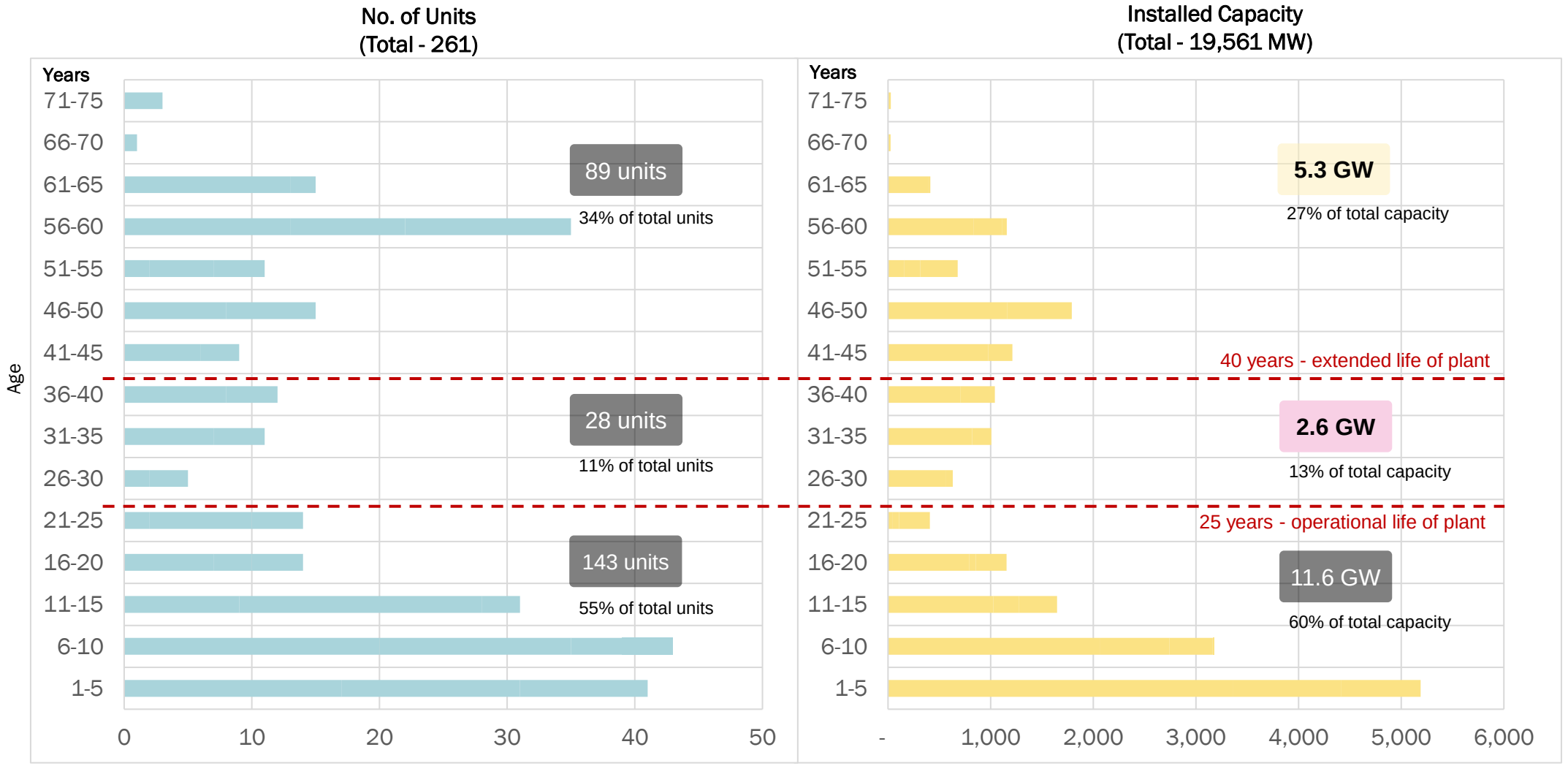
Note:

- Aging and performance analyses have been done on the basis of data shared by power plants. Data for 2021 was considered as it was available for majority of plants.
- While analysis has been done for all 58 plants (basis available data), only 55 plants have been considered for the final rating. ArcelorMittal PVS was not included as technical inputs from plant were not received. Further, GPES EPC Industry and Zhanaozen GPES were not included since site visits were not conducted.
- List of assumptions and data gaps are available in the Annex 1.

Aging Analysis

Aging Analysis of Turbo Units - 45% of units exceed 25 years of operational life; this translates to 7.9 GW capacity

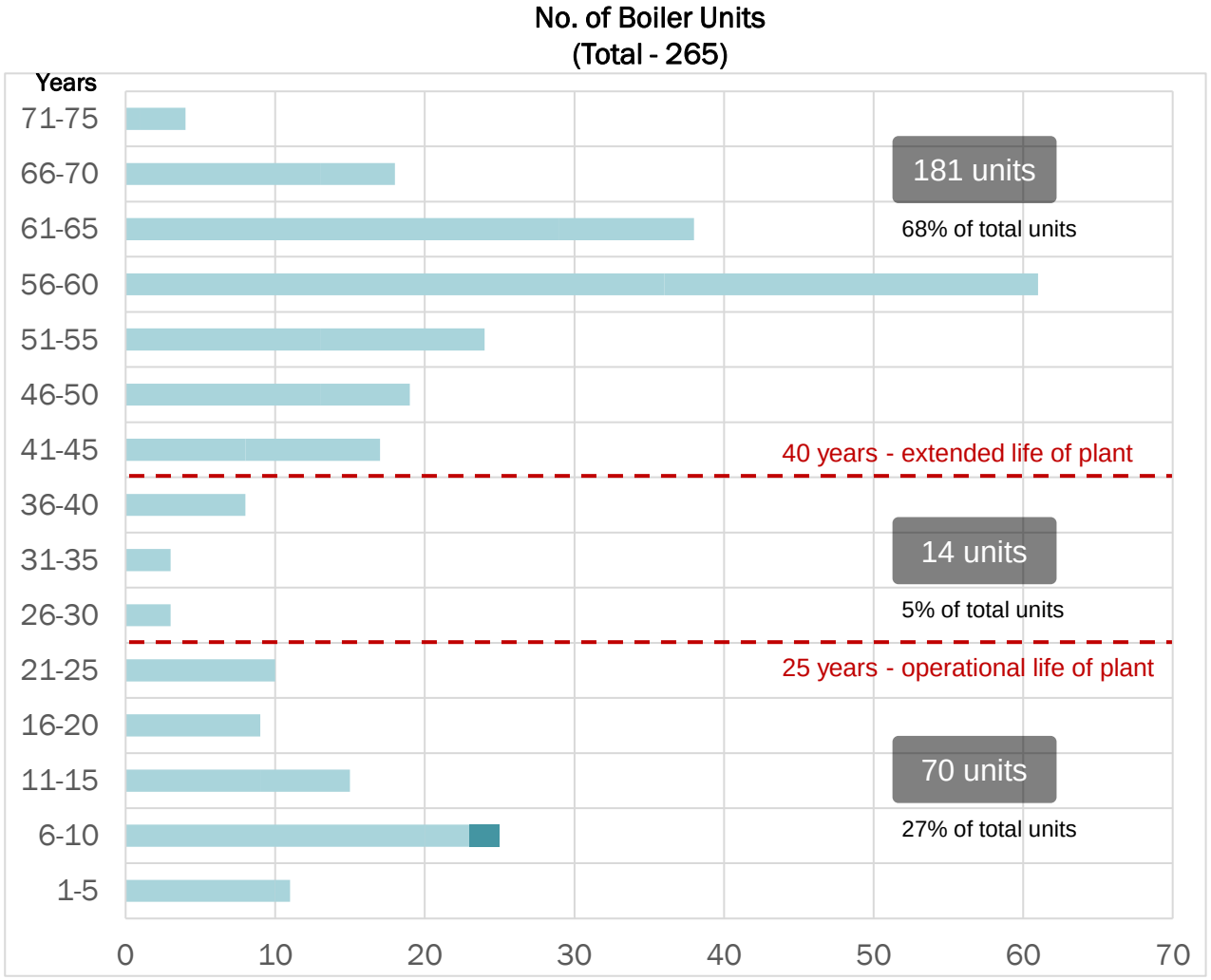
Aged Capacity: 5.3 GW of capacity has exceeded 40 years of operational life. Among these, coal plants contribute to 3.6 GW, followed by gas at 1.3 GW and hydro at 400 MW.



1. Well-maintained hydro plants can operate for longer durations. However, strengthening of civil works is generally recommended at a span of 40–50 years.
2. In light of cross-connected boiler and turbine systems, this analysis considers the age of turbo-generator units to ensure consistency across plants.

Aging Analysis of Boilers - 73% of units exceed 25 years of operational life

Boilers and associated equipment are found to be significantly older than turbo units. 68% of boilers have exceeded even 40 years of operations.



Age of both turbine and boiler units was considered for overall analysis

- For majority of plants, older boilers were generally associated with relatively older turbo units.
- However, some plants deviate from this trend. For instance, turbo units of Ridder, Sogrinskaya, and Stepnogorsk CHPP were relatively new, but their boilers are significantly older.
- These deviations have been appropriately considered in the overall analysis.

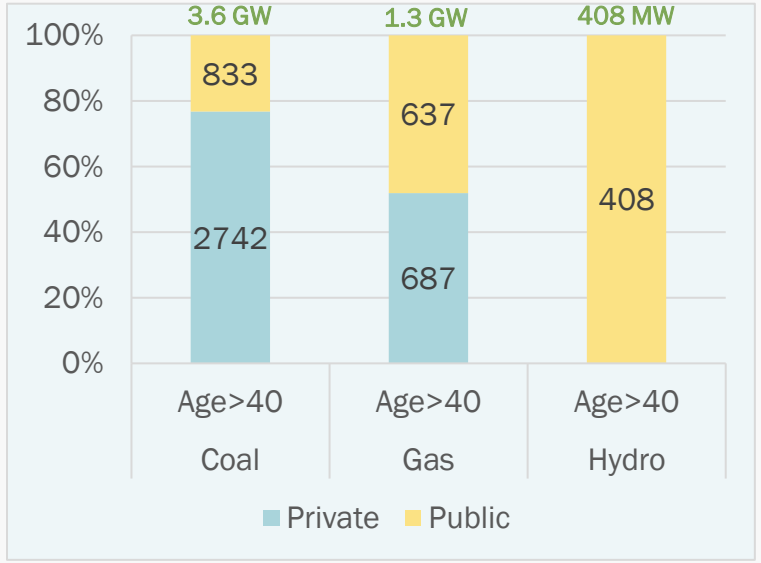
Organizational Perspective - Six companies alone account for 75% of total aged* capacity (5.3 GW)

Out of the total 19.6 GW covered in the study, 15.8 GW (80%) is accounted by just 6 companies. These companies also account for 75% of the aged capacity, i.e., capacity over 40 years of operational life:

Company name	Total capacity	Capacity over 40 years	Share of aged capacity
1. Kazakhmys (*Private*)	1,040 MW	695 MW	13%
2. Kazakhstan Utilities Systems (*Private*)	1,067 MW	412 MW	8%
3. CAEPCO (*Private*)	1,206 MW	430 MW	8%
4. Zhambyl GRES (*Private*)	1,230 MW	420 MW	8%
5. ERG (*Private*)	2,985 MW	840 MW	16%
6. Samruk Energy (*Public*)	8,307 MW	1,200 MW	23%
Total	**15,833 MW**	**3,997 MW**	**75%**

Ownership split of 5.3 GW aged capacity:

- Overall, 64% of aged capacity belongs to private firms.
- At technology level, this share varies as follows:



*_Aged_ refers to units or capacities that have exceeded 40 years of operational life.

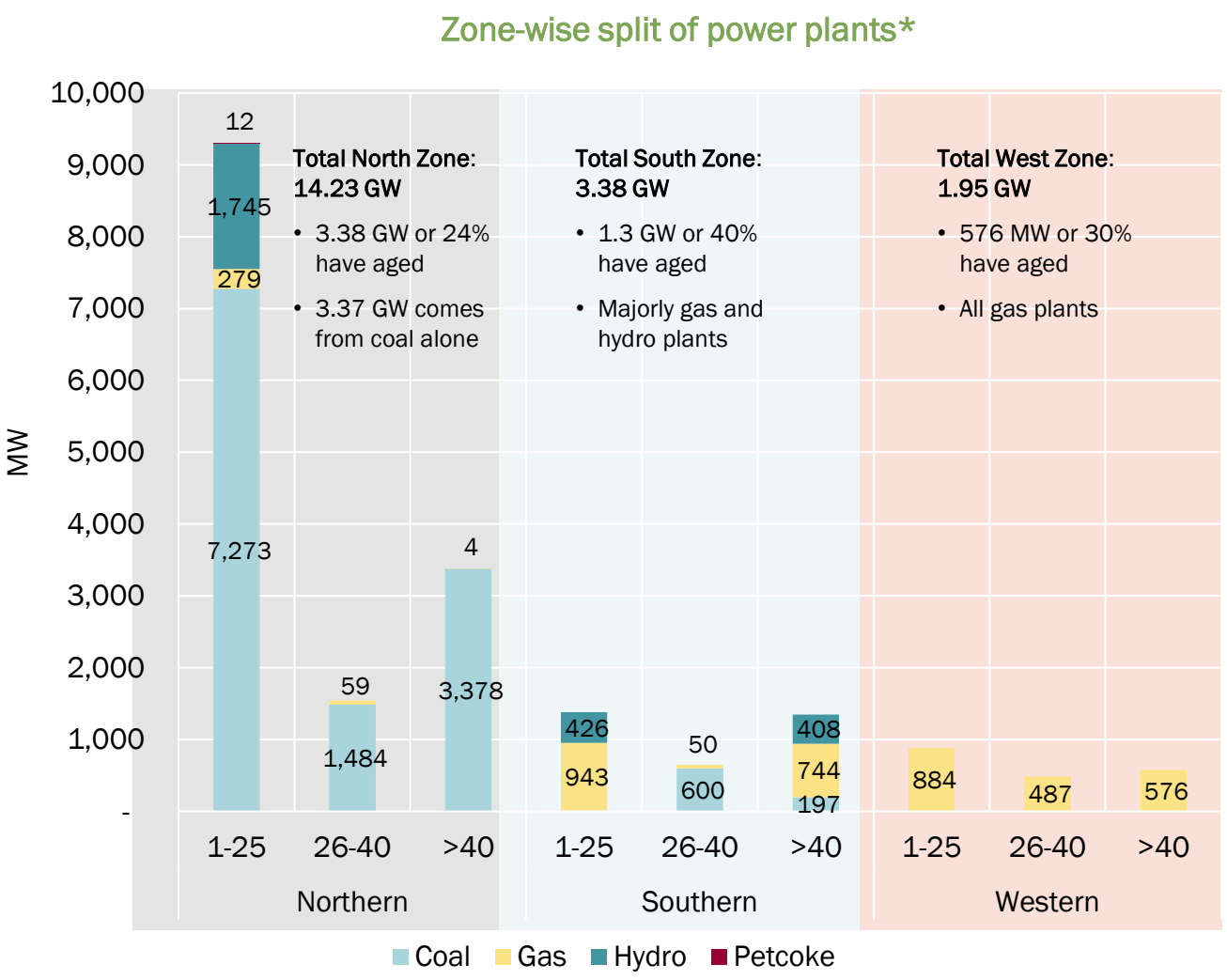
Reconstruction and Modernization - While R&M initiatives have been undertaken, there is scope to do more

Type of power plant	Total units	No. of units modernized	Total capacity	Capacity modernized	Potential capacity to be modernized
Coal	119	36 (30%)	12.9 GW	5.9 GW (45%)	**5.6 GW**
Gas	96	18 (19%)	4 GW	1 GW (26%)	**1.9 GW**
Hydro	42	23 (55%)	2.6 GW	1.9 GW (73%)	**408 MW**

- Out of 261 turbo-generator units* covered in the study, 77 units (8.8 GW) were found to have undergone renovation or modernization in some form.
- **Hydropower plants were found to be in better state with majority of equipment already modernized.**
- **Majority of the larger-size units have undergone R&M works** - *out of 23 units which are greater than 200 MW, 65% have undergone R&M.*
- **Significant modernization was undertaken in the past decade**; possibly indicating momentum gathered by the tariff for investment program.

*In light of cross-connected boiler and turbine systems, this analysis considers the age of turbo-generator units to ensure consistency across plants.

Zonal Perspective – South and West Zones have higher share of aged capacity; may aggravate power shortages and import dependence



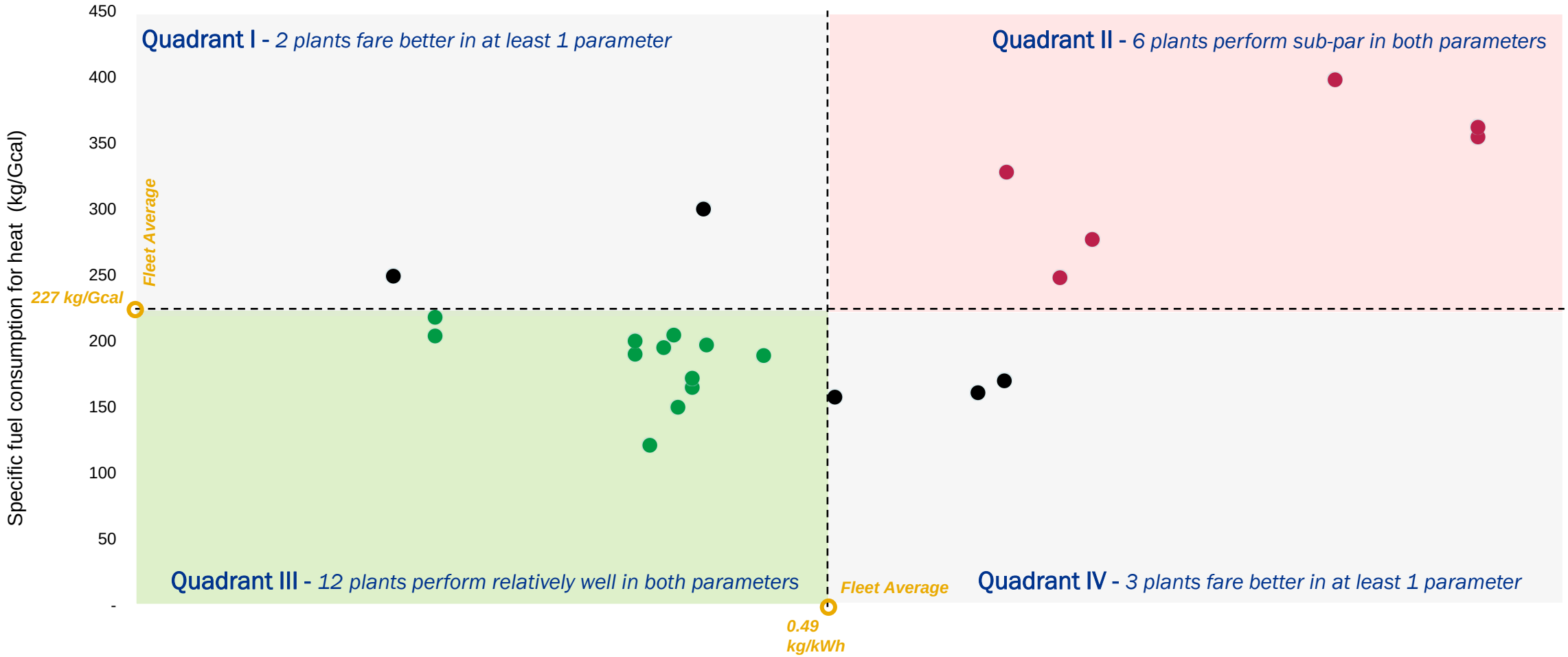
*Plants are further mapped in 3 age brackets of 1-25 years, 26-40 years ,and greater than 40 years

- **North Zone** is the hub of electricity generation comprising mostly of coal plants. However, it has
  - Highest aged capacity of ~3.4 GW; 80% of this comes from private sector plants, and
  - Another 11% of capacity is in the 26-40 age bracket.
- **South Zone** has energy deficit. Thus,
  - With 40% of capacity over 40 years, it will increase dependence on imports from north, and
  - It offers an opportunity to scale up RE, including geothermal as South Zone has significant potential.
- **West Zone** is isolated and had energy deficit in 2022:
  - 30% of assets in upper age limit can increase power shortages and grid instability.
  - Another 25% capacity lying in 26-40 age bracket may aggravate the issue.
  - It offers an opportunity to scale up RE, including geothermal as West Zone has significant potential.

Performance Analysis

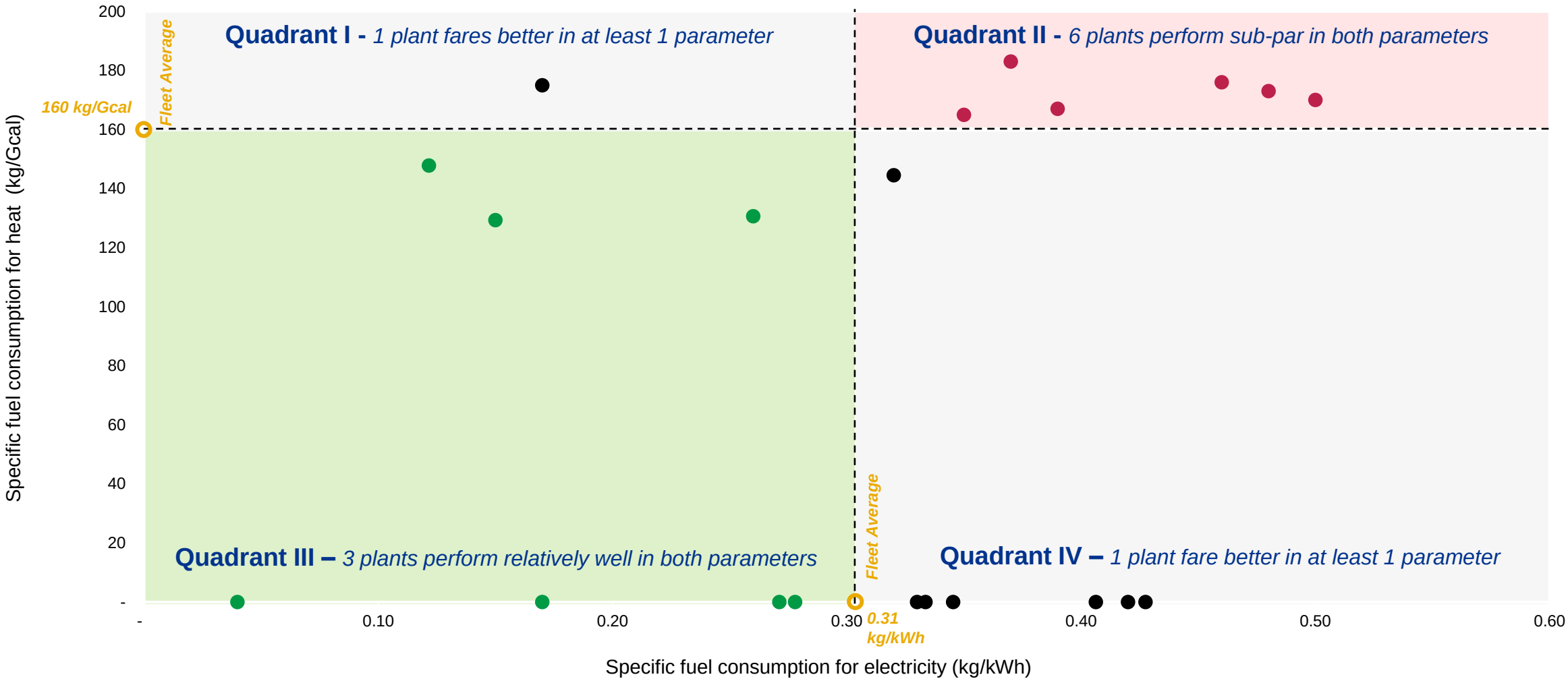
Performance Analysis of Coal Plants - Considerable plants fare below par vis-à-vis fleet average

The following graph illustrates the relative performance of **23 coal-fired plants** based on 2 parameters - **specific fuel consumption for electricity (kg/kWh) and heat (kg/Gcal).**



Performance Analysis of Gas Plants - Considerable plants fare below par vis-à-vis fleet average

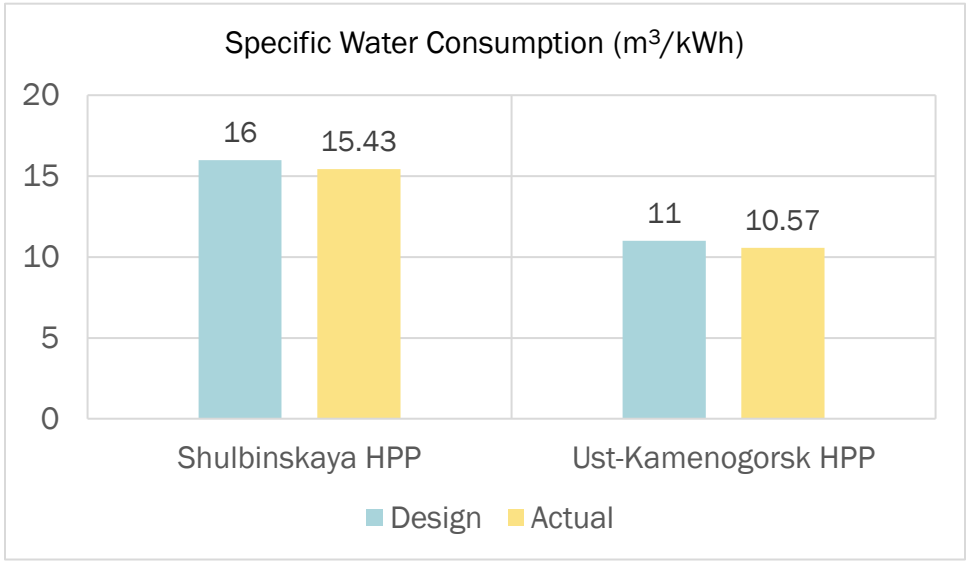
The following graph illustrates the relative performance of **21 gas-fired plants** based on 2 parameters – **specific fuel consumption for electricity (kg/kWh) and heat (kg/Gcal)**

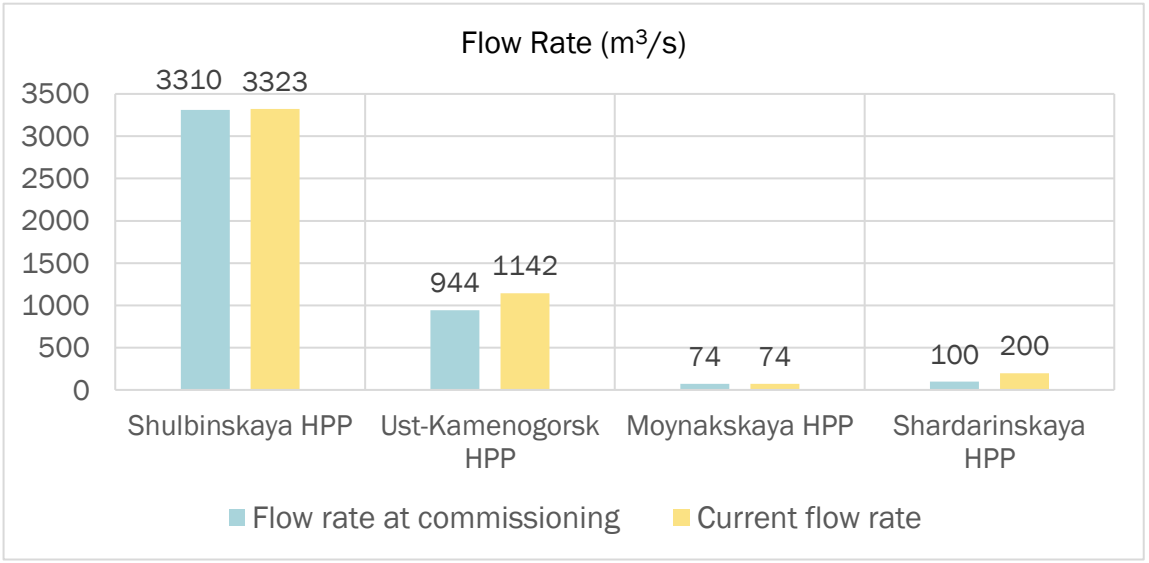


Benchmark or average for Specific fuel consumption will vary for different gas technologies such as Open Cycle or Combined Cycle. However, here all plants are being reflected together for illustrative purpose (as segregated data is not available)

Performance Analysis of Hydro Plants

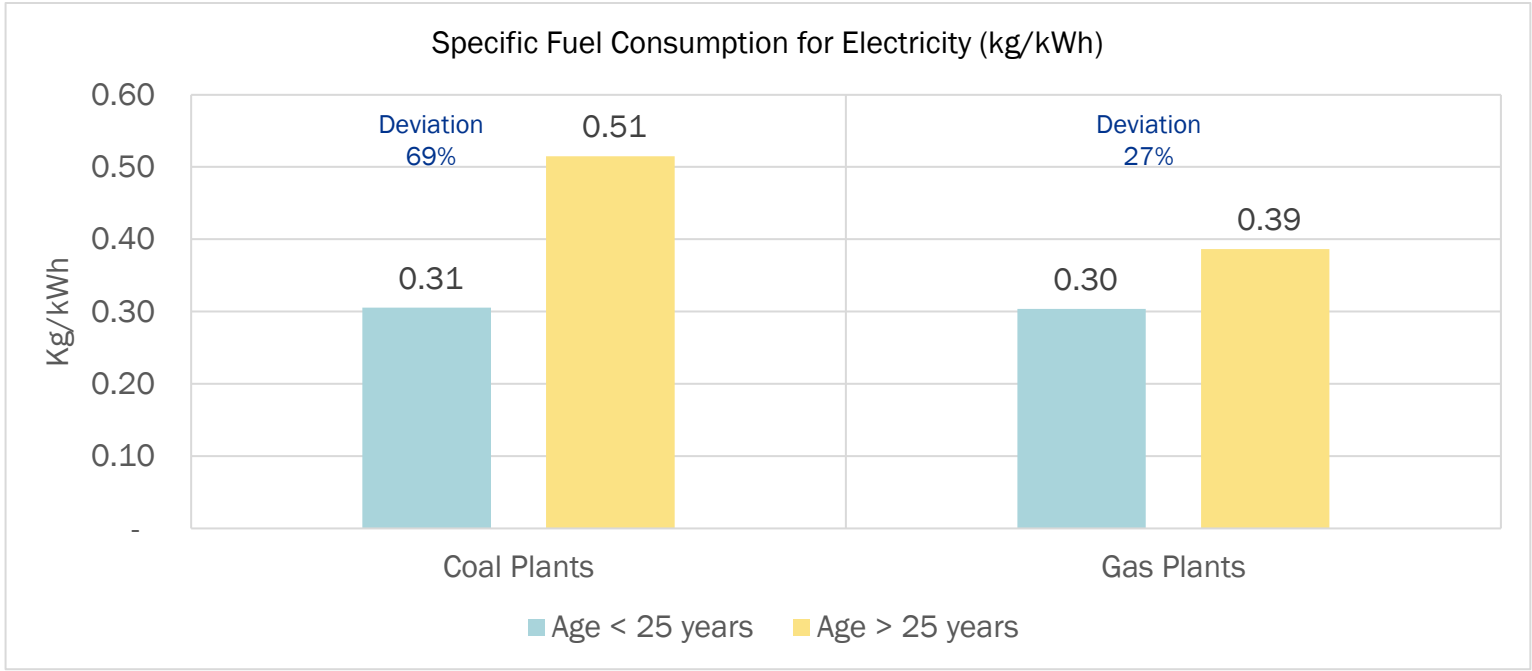
- For hydro plants that have provided performance data, it is observed that there is minimal deviation in the designed and the actual operating parameters.
- For instance, the graphs below exhibit the performance with respect to specific water consumption and flow rate. Further, auxiliary consumption for hydro plants was also found to range between 0.2% and 1.38% - an indicator of efficient performance.
- This has been largely possible due to the timely and effective R&M and OEM-recommended maintenance cycles. Well-maintained hydro plants can be operated for much longer periods than fossil fuel based units.



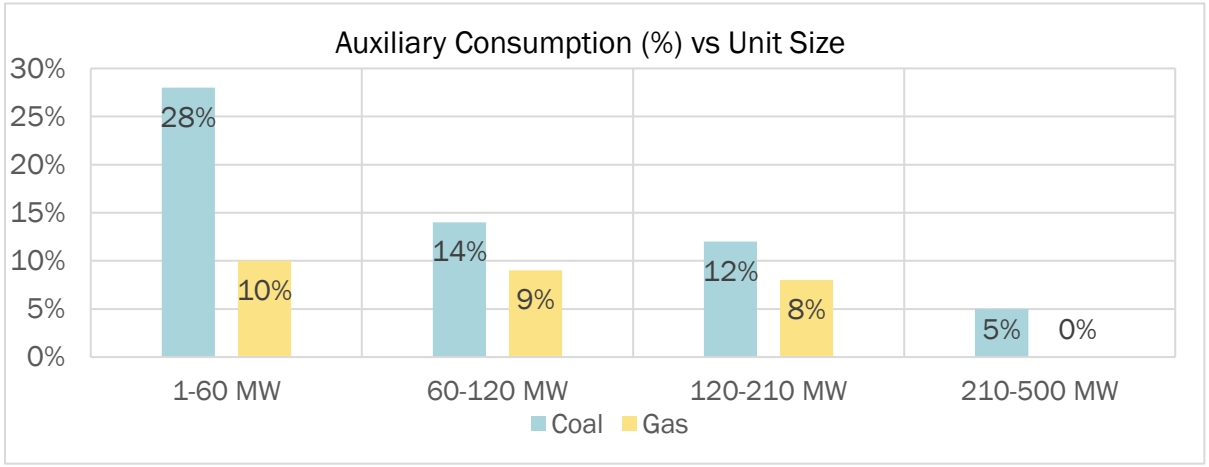


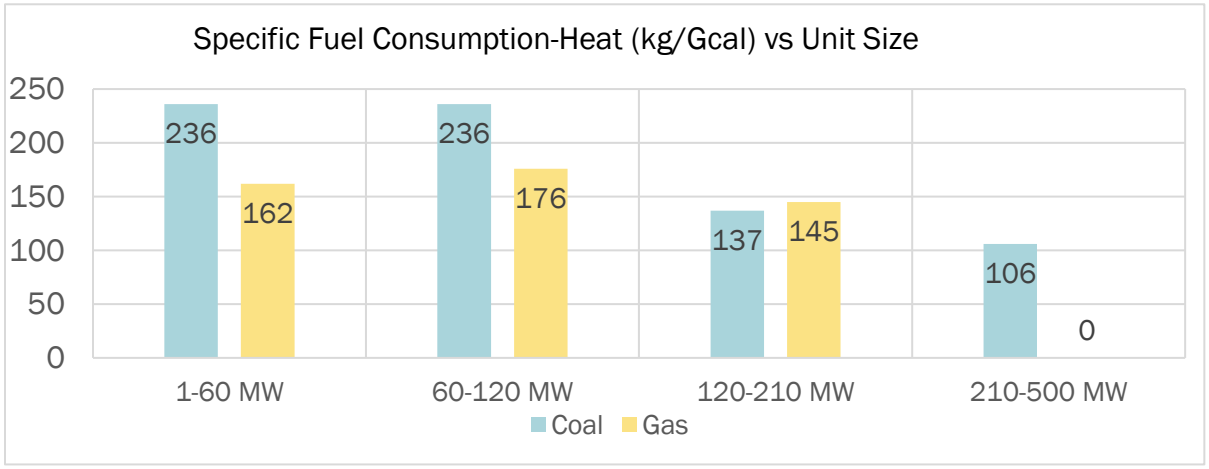
Age of Plant Impacts Performance - There is marked decline in performance for older plants

- The operating parameters were also analyzed with respect to the age of power plants. It was observed that there is clear decline in performance of older plants.
- The chart below maps the specific fuel consumption (kg/kWh) for plants that have all units less than 25 years in age against those plants that have all units greater than 25 years of age.
- There is significant deviation in the performance with older plants showing a decline. A decrease in efficiency for older plants can lead to
    - Higher fuel consumption;
    - Higher emissions; and
    - Higher fuel costs,



Capacity of the Unit Also Impacts Operational Efficiency - Vintage units of smaller capacity are generally associated with lower efficiency





Note: There are no standalone gas turbine units in the 210 – 500 MW capacity range.

Capacity-wise assessment demonstrated that vintage units with relatively smaller capacities were associated with lower efficiency.

- This has significant consequences as old and smaller unit capacities dominate the generation mix.
- Out of the 261 units assessed in this study, **over 60% ranged between 1 and 60 MW**. The smallest unit capacity was as low as just 1 MW.
- Of the total 19.5 GW assessed in the study, almost half of the capacity comes from units that are less than 120 MW.
- **Only 7% of units were above 210 MW**. Highest capacity was 500 MW.

Key Observations from Site Visits

Site Observations - Thematic Areas

1. Structural Vulnerabilities
2. Fuel Sourcing
3. Operational Performance
4. O&M Practices
5. Water Quality Management
6. Emissions Control and Monitoring
7. Ash Management
8. Control Systems
9. Health and Safety
10. Other Observations

1. Structural Vulnerabilities - Aging assets lead to weakened structural integrity of structures (1/2)

- 41 out of the 58 plants covered in the study said to have conducted structural surveys.
- Many of the survey reports reveal adverse findings pertaining to the structural integrity of power plants and chimneys.
- Structural issues and physical deterioration were also observed during the site visits.

Damaged and unsafe civil structures

A technical survey report shared by **Shakhtinsk CHP** stated that its building structures were in unsatisfactory and emergency conditions, requiring complete dismantlement.

Damaged fuel tanks

Damaged fuel tanks were observed in **Karaganda GRES-1**. This poses potential safety risk as leakage / spillage may cause fire or explosion hazard.

1. Structural Vulnerabilities - Corrective actions are being deferred (2/2)

- **Key reasons for identified defects were physical wear and tear and untimely repair work.**
- **However, it was found that corrective actions were being deferred in some cases.**

- A recent structural survey in **Almaty CHPP-3** observed that the condition of the plant's chimney poses significant safety concerns.
- Accordingly, the survey report recommended immediate strengthening of the plant's chimney to prevent any possible damages and accidents.
- However, **repairs have been deferred due to factors such as**
  - Financial constraints,
  - Lack of expertise, and
  - Future transition to gas turbines.

Structural deficiencies in chimney

2. Fuel Sourcing - Poor coal quality and interrupted gas supply impact plant efficiency and availability

- **Limited availability of high-quality coal has led to plants (designed for better quality) shifting to lower-quality coal over time.**
- **Low-quality coal impacts plant performance and accelerates aging causing increased incidents of outages and repairs.**

Many plants were **designed to use Karaganda Basin coal;** however, they were **forced** to switch to **lower-quality Ekibastuz coal.**

Most coal power plants use **open storage** yard which introduces **moisture** and **reduces** the **calorific value**.

In some plants, the **size** of **crushed coal** was found to be well **over 25 mm**, which **adversely** impacts **boiler efficiency.**

Availability of gas also emerged as a key concern: Interactions with several gas plants indicated that there are frequent interruptions in gas supply. For instance, Batys Power Ural GTES underwent a 20-day shutdown in January 2023 due to gas shortages.

Use of **lower-quality coal, open storage, and inadequate coal processing may have adverse effects on the operational efficiency of the plant** and can result in

- Accelerated aging,
- Clogging,
- Early wear of tubes (SH and ECO bundles),
- Higher emissions,
- Lower boiler efficiency, and
- Increased fuel consumption.

3. Operational Performance - There is clear scope to optimize performance

Site visits and interactions with plant officials highlighted some key operational challenges such as inefficient coal combustion, low vacuum, and heat/energy loss.

Some of these points were also observed during the visits:

- Instances of **excess O_2% (~9%)** were observed in some plants on the day of visit. This point toward presence of excess air in boiler, thereby leading to inefficient combustion.
- In some cases, **high flue gas exit temperature** was also observed indicating heat loss in the system.
- Plants such as Semey CHPP reported of 34% energy loss due to **unburnt carbon.**
- Many plants also highlighted the issue of **high cooling water temperature** in summers, leading to low vacuum.
- These deviations can be attributed to ineffective combustion, inefficient heat exchange, and inadequate soot clearing and maintenance practices.

There is a need to ensure stricter monitoring of operational parameters and build technical capacity of the workforce to undertake effective operations.

MAEK Kazatomprom CHPP-1

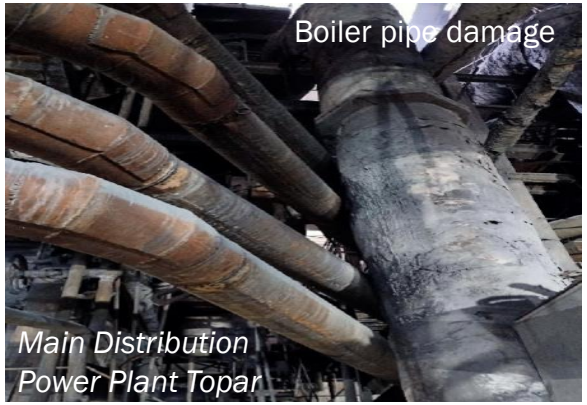
Stricter monitoring of operational parameters is essential

4. Operation and Maintenance - Poor maintenance practices can exacerbate performance issues

- **Lack of proper maintenance has resulted in visible damage to civil structures and equipment, dust accumulation, rusting, leakages, etc.**
- **Best international practices such as preventive maintenance and condition-based monitoring of equipment were not as prevalent.**

Some common gaps in O&M practices were observed across plants.
Discussions with plant officials provided following insights:

- Budget constraints are a major barrier to hiring O&M experts.
- Running maintenance is done approximately once a year.
- Capital maintenance is carried out in much larger intervals *(4–5 years).*
- Many plants do not have long-term contracts for spare parts.



5. Water Quality - Shortened life of equipment due to poor water and steam chemistry

Water quality management was found to be inadequate. As a result, poor water and steam chemistry can potentially shorten equipment life.

- While sodium and chlorine levels are monitored, several plants do not monitor pH (which causes corrosion) and silica (causes equipment erosion) levels regularly.
- Further, certain plants do not have demineralized water systems and use softened water instead - which is known to shorten boiler life.
- Recommended frequency for steam water analysis is once a shift. However, this was found to vary across plants with some plants conducting once every 6 hours to once a month which can adversely impact equipment.
- Poor water treatment and management practices can potentially lead to - reduced efficiency, increased maintenance costs, and environmental damage.


Water sample collection is open to contamination

Ust-Kamenogorsk CHPP


Collected sample being stored in plastic bottles

Almaty CHPP-1

6. Emissions Control and Monitoring - Adherence to environmental norms found wanting

- Emissions control systems were inadequate and not in line with government regulations.
- Article 186, Item 4 and Article 418, Item 16 of the Environmental Code of Kazakhstan mandate automated emission monitoring system to be available from January 1, 2023.
- Although mandated by the government, monitoring of emissions in the country is not yet automated or continuous.


Black smoke from chimney indicates inefficient emission control

Kentau CHPP

- Only 33% of coal plants use electrostatic precipitators (ESP) - others relied on wet scrubber systems.
- Advanced emission control systems such as flue gas desulfurization was nonexistent.
- Although mandatory, very few plants have installed or are in the process of installing continuous emission monitoring systems (CEMS).
- Instead, emission monitoring is predominantly conducted periodically with portable manual devices.

7. Ash Management - Depleting ash storage is becoming a growing concern

- **Plants are unable to manage ash effectively as some of them are running out of ash storage capacity.**
- **In some plants, ash disposal is being done manually during boiler shutdowns.**

- Many plants, such as CHPPs in Astana and Almaty, are running out of storage capacity for wet ash.
- Some plants like Kentau CHPP are not finding takers for ash (e.g., cement companies).
- Conditions of ash dump were also found to be inadequate in few plants. At Tekeli CHP, wet ash canal was 40% covered with soil and stones, thus restricting movement.

Ash Dump No. 1 of Astana Energy CHPP-2 is 95-97% full

Astana Energy CHPP-2

8. Control Systems - Increased probability of operational errors due to manual systems

- **Many of the control systems were found to be manual or semiautomated**
  - 65% of power plants said to have DCS / SCADA systems
  - Outdated control systems (i) are prone to error, (ii) have slow response time, (iii) incur higher maintenance costs, and (iv) lack advanced analytical capabilities

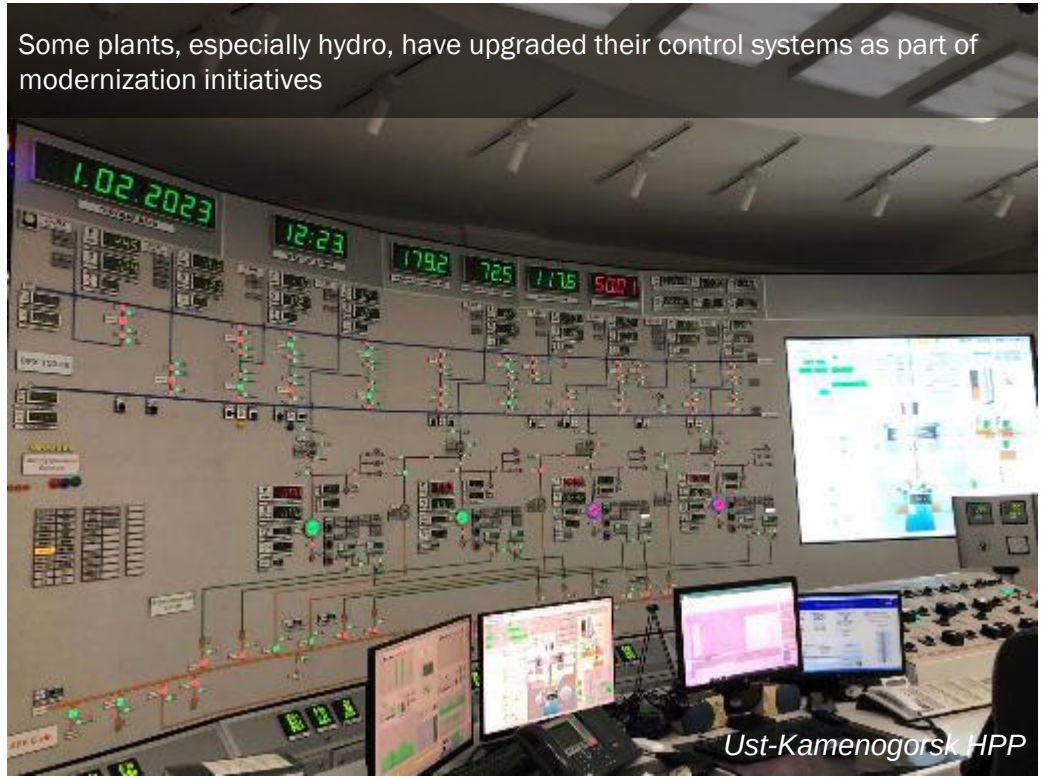
Sogrinskaya CHPP


Manual and old control systems

Aksu Plant


Semipalatinsk CHPP


ArcelorMittal CHPP-2


Some plants, especially hydro, have upgraded their control systems as part of modernization initiatives

Ust-Kamenogorsk HPP

9. Health and Safety - Hazardous conditions in and around the power plants

- **Significant concerns from a health and safety perspective were observed across most plants.**

Dust and debris

Steam, water, oil, oil fume leakages

Unpreparedness for fire hazards

Low illumination

10. Other Themes - Additional points emerging from site interactions

Cost-reflective Tariffs	• **Tariffs** are a significant **concern** for most power plants as they are not cost-reflective. • Several plants reported that they are **unable** to **raise capital** for renovation due to low top-line income.
Availability of Technical Expertise	• Many plants **could not retain control room personnel** due to financial constraints and **low salaries.** • Low salaries result in lack of experienced and well-qualified personnel. • Kentau CHPP changes up to 50% of its workforce each summer due to **financial constraints** in the summer.
Planning for Electricity and Heat Demand	• Since West Kazakhstan is isolated from the main grid, there is risk of outages in case of inadequate generation capacities and/or failure of cross-border connections to manage peak demand. • One of the important points coming out from the discussions was the **need to undertake accurate forecasting of power and heating demand** for ensuring optimal resource allocation, maintaining grid reliability, and ensuring adequate supply.
Industrial Customers	• Many plants were set up to supply electricity / heat to nearby industrial customers; however, many of the **industries have been shut down** / abandoned, leading to loss of revenue. • For instance, Shymkent CHPP initially provided electricity and heat to **Shymkent oil processing plant** while Kentau CHPP was established to support **Kerasay mining operation.**

Best Practices – Several best practices observed across visited plants

Several observed best practices can significantly improve operational efficiency and safety if adopted by plants nationwide.

Maintenance Practices in Hydropower Plant

- During the site visits, it was observed that **hydropower plants** were relatively **well maintained.**
- The equipment was kept **neat** and **clean** along with required **maintenance** and **repairs.**
- The turbine hall was seen to be **clean** with **no dust**, **water leakage** / **accumulation**, etc.

Safety Briefings and Personal Protection Equipment

- The site visit team was given a **comprehensive safety briefing** as well as **Personal Protection Equipment** (PPE) in some plants such as **Aksu**, **Almaty Cascade**, **Shymkent CHPP,** etc.
- Internationally accepted **safety methods** such as **Lock-out Tag-out (LOTO)** system is being followed in some plants.

Well-maintained turbine hall of Moynakskaya HPP

Moynakskaya HPP

Lock-out tag-out system followed in some plants

Atyrau GPPP *Bukhtarma HPP*

[1]*Source: IEA.*

1	2	3	4
Detailed performance analysis and site visit observations	Power plant characteristics and relative positioning	Key focus areas for efficient operations of power plants	Development framework and financing strategy

Methodology

Insights and findings on the dimensions of Age, Performance, and Site Observations were brought together to evaluate the overall performance of power plants:

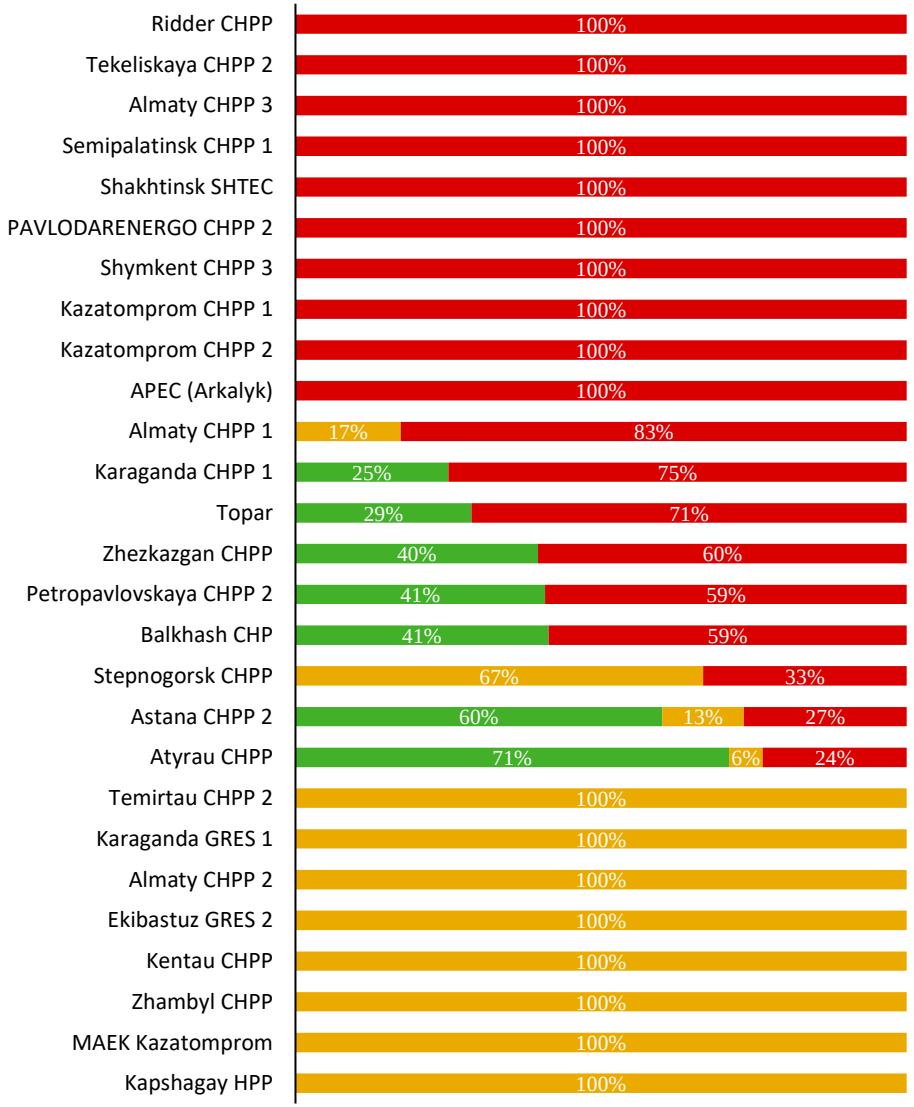
- **Dimension 1 (Age):** Plants were rated on three age brackets of (i) 1–25 years, (ii) 26–40 years, and (iii) greater than 40 years.
- **Dimension 2 (Performance):** Relative performance of plants was mapped on key operating parameters such as specific fuel consumption for electricity and heat.
- **Dimension 3 (Site Observations):** High level assessment of physical conditions of equipment, emission and ash management, health and safety, control systems, O&M practices, etc.

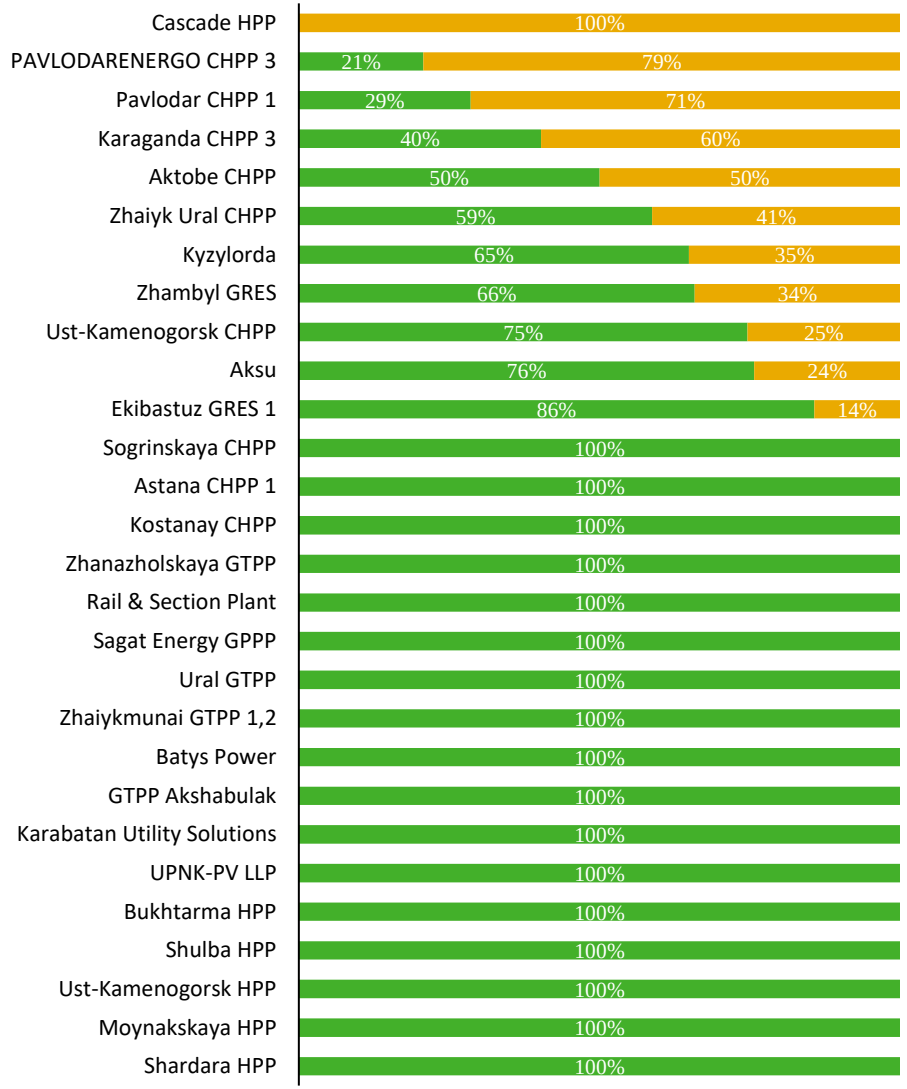
The plants were then rated on these three dimensions, based on which an overall relative positioning was determined:

Rating	Age	Performance	Site visit	Overall
Green	Majority of the plant capacity is less than 25 years in age	All operational indicators are less than fleet average	Overall satisfactory standards observed in majority aspects	**Good operating conditions overall -** Plant to continue to operate while maintaining best standards
Yellow	Majority capacity is between 25 and 40 years	Indicators are greater than average but within a defined upper limit	Inadequate or unsatisfactory standards in some of the aspects	**Scope to enhance performance or practices** - Units need renovation and modernization to improve their performance and extend service life
Red	Majority capacity exceeds 40 years in age	All indicators are above average and exceed the defined limit	Inadequate standards and obsolete systems which pose significant safety and operational risks	**Overall conditions are suboptimal and unsafe -** Units are in suboptimal condition and in need of immediate repairs if continued operation is required in short term. They may be phased out over medium to long term (subject to availability of alternative capacity)

Schematic Report Card of Kazakhstan's Power and Heat Facilities

Rating	MW
Green Good operating conditions; focus on O&M	10,923
Yellow To be considered for R&M	6,092
Red Overall conditions suboptimal; may be considered for phase out	2,513
Total	19,528



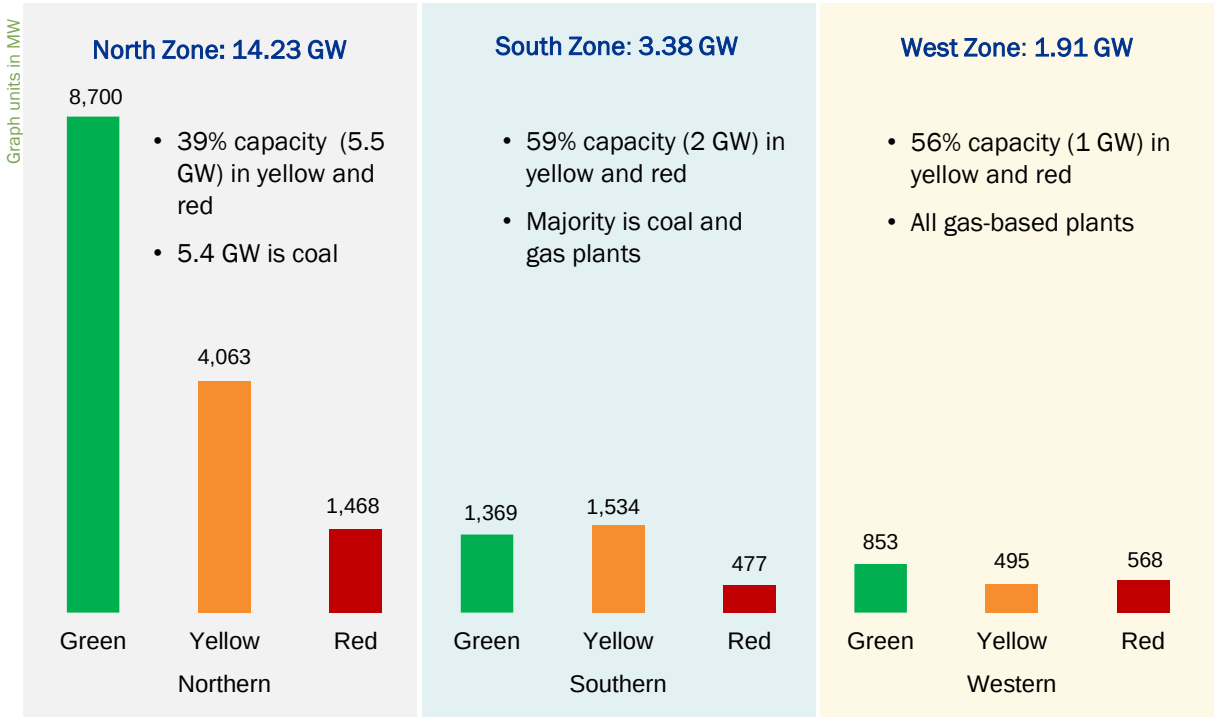


Legend:

- % capacity in red category
- % capacity in yellow category
- % capacity in green category

The above list covers 55 plants. ArcelorMittal PVS not included as technical inputs from plant were not received. GPES EPC Industry and Zhanaozen GPES have not been included since site visits were not conducted

Implications of Locational Distribution of Energy Generators

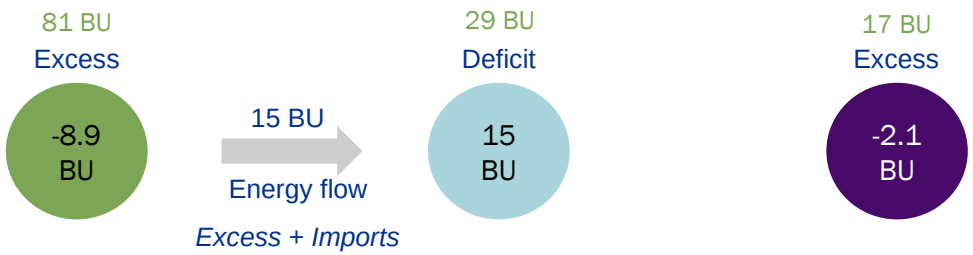


North Zone - Current hub of energy production

South Zone - Net energy importer

West Zone - Mostly self-sufficient; gas-fired energy production

Electricity consumption estimate for 2024:



North Zone: *Coal dominated energy-industrial hub; need to diversify energy mix through 'just transition' to renewables.*

- Ridder and Shakhtinsk in red zone, needed for heat delivery
- R&M needed for yellow zone Ekibastuz GRES-2 (1,000 MW), a portion of Aksu (600 MW)
- **Financing new coal, a challenge** - 1.4 GW coal overdue for phase out

South Zone: *Region with energy deficit. 1.4 GW high-capacity plants require prioritization.*

- Shymkent and Tekeli in red zone, critical from heat perspective
- Gasification of yellow zone Almaty CHPP-2 (600 MW) planned
- R&M due for yellow zone Zhambyl GRES (420 MW / 1.2 GW - gas)
- Majority hydro plants renovated except Kapshagay (364 MW) and Cascade (44 MW)

West Zone: *Largely gas-fired capacity mix; improve operations.*

- R&M due for yellow zone MAEK Kazatomprom TPP (450 MW)
- Improve operations of gas-based plants; pilot new technologies like fuel cells and modular LNG

Red Category - List of Plants (1/2)

- Total 59 units were identified in red category - these are spread across 19 plants.
- Out of these, 10 power plants have all their units falling in the red category. These plants are as follows:

S. No.	Power plant name	Fuel	Zone	Ownership	% of capacity in red	Installed capacity (MW)	Red Category Capacity (MW)
1	JSC "Ridder CHPP"	Coal	Northern	Private	100%	59	**59**
2	Tekelia Energocomplex LLP, Tekeliskaya CHPP-2	Coal	Southern	Private	100%	24	**24**
3	JSC "Almaty Power Plants" CHPP-3	Coal	Southern	Public	100%	173	**173**
4	"Teplcommunnergo" Semipalatinsk CHPP-1	Coal	Northern	Public	100%	24	**24**
5	LLP "Shakhtinskteploenergo" SHTEC	Coal	Northern	Public	100%	18	**18**
6	PAVLODARENERGO JSC CHPP-2	Coal	Northern	Private	100%	110	**110**
7	JSC "3-Energoortalyk" Shymkent CHPP-3	Gas	Southern	Private	100%	160	**160**
8	MAEK-Kazatomprom LLP CHPP-1 (Aktau)	Gas	Western	Private	100%	43.9	**43.9**
9	MAEK-Kazatomprom LLP CHPP-2	Gas	Western	Private	100%	416.8	**416.8**
10	APEC (Arkalyk)	Gas	Northern	Public	100%	4	**4**
							1,033 MW

Red Category - List of Plants (2/2)

For the remaining 9 power plants, only specific units were found to be in the red category. Details are provided below:

S. No.	Power plant name	Fuel	Zone	Ownership	Installed capacity (MW)	% of capacity in red	Red Category Capacity (MW)	Remarks on units falling in red category
1	JSC "Almaty Power Plants" CHPP-1	Gas	Southern	Public	145	83%	**120**	TGs 1 and 2 exceed 50 years in age
2	Karaganda Energocenter LLP CHPP-1	Coal	Northern	Private	24	75%	**18**	Blocks 2 and 3 are over 60 years; block 5 exceeds 57 years
3	Main Distribution Power Plant Topar	Coal	Northern	Private	643	71%	**458**	5 out of total 7 units are over 55 years in age
4	Kazakhmys Energy LLP Zhezkazgan CHPP	Coal	Northern	Private	252	60%	**152**	Stations 5 and 6 exceed 60 years while station 7 is over 50 years
5	JSC "SEVKAZENERGO" Petropavlovskaya CHPP-2	Coal	Northern	Private	541	59%	**320**	Boiler equipment stations 1-5 and turbine units 3, 6, and 7 reached physical limit
6	Kazakhmys Energy LLP Balkhash CHP	Coal	Northern	Private	145	59%	**85**	Turbine units 6 and 7 exceed 60 years in operation
7	Stepnogorsk CHPP LLP	Coal	Northern	Private	180	33%	**60**	Station 5 which is the largest unit (60 MW) is over 40 years
8	"Astana-Energy" JSC CHPP-2	Coal	Northern	Public	600	27%	**160**	2 out of 6 TG units are over 40 years
9	JSC "Atyrau CHPP"	Gas	Western	Private	454	24%	**107**	TGs 2, 6, and 7 exceed 45 years
							1,480 MW	

Yellow Category - List of Plants (1/3)

- Total 74 units were identified in yellow category - these are spread across 23 plants.
- Out of these, 9 power plants have all their units falling in the yellow category. These plants are as follows:

S. No.	Power plant name	Fuel	Zone	Ownership	% of capacity in yellow	Installed capacity (MW)	Yellow Category Capacity (MW)
1	ARCELORMittal Temirtau JSC CHPP-2	Coal	Northern	Private	100%	435	**435**
2	TOO "Bassel Group LLS" Karaganda GRES-1	Coal	Northern	Private	100%	84	**84**
3	JSC "Station Ekibastuz GRES-2"	Coal	Northern	Public	100%	1,000	**1000**
4	JSC "Almaty Electric Stations" CHPP-2	Coal	Southern	Public	100%	600	**600**
5	LLP "MAEK-Kazatomprom" TPP	Gas	Western	Private	100%	450	**450**
6	JSC "Almaty Electric Stations" Kapshagay HPP	Hydro	Southern	Public	100%	364	**364**
7	JSC "Almaty Power Plants" Cascade HPP	Hydro	Southern	Public	100%	43.7	**43.7**
8	JSC "Tarazenergocenter" Zhambyl CHPP	Gas	Southern	Public	100%	44	**44**
9	GCE "Kentau Service" Kentau CHPP	Coal	Southern	Public	100%	12.5	**12.5**
							3,034 MW

Yellow Category - List of Plants (2/3)

For the remaining 14 power plants, only specific units were found to be in the yellow category. Details are provided below:

S. No.	Power plant name	Fuel	Zone	Ownership	Installed capacity (MW)	% of capacity in yellow	Yellow Category Capacity (MW)	Remarks on units falling in yellow category
1	PAVLODARENERGO JSC CHPP-3	Coal	Northern	Private	555	79%	**440**	While R&M has been done for 8 turbines and boilers, 4 boilers are still over 40 years. They need R&M
2	JSC "Aluminium of Kazakhstan" Pavlodar CHPP-1	Coal	Northern	Private	350	71%	**250**	4 of the 6 turbine units are over 30 years in age
3	Stepnogorsk CHPP LLP	Coal	Northern	Private	180	67%	**120**	2 of 5 TG units are in 26–40 years bracket
4	Karaganda Energocenter LLP CHPP-3	Coal	Northern	Private	670	60%	**400**	1 of the 6 units falls in the 26–40 years age bracket
5	JSC "Aktobe CHPP"	Gas	Northern	Private	118	50%	**59**	TGs 1, 2, 5, and 6 are over 30 years of age with no R&M conducted till date
6	JSC "Zhaiykteploenergo" Ural CHPP	Gas	Western	Private	48.52	41%	**20**	TAs 2 and 3 exceed 30 years of operations
7	GKP "Kyzylordateploelectrocenter" CHP	Gas	Southern	Public	71.2	35%	**25**	1 of 5 units falls in the 26–40 years age bracket

Yellow Category - List of Plants (3/3)

S. No.	Power plant name	Fuel	Zone	Ownership	Installed capacity (MW)	% of capacity in yellow	Yellow Category Capacity (MW)	Remarks on units falling in yellow category
8	JSC "Zhambyl GRES named after T.I.Baturov"	Gas	Southern	Private	1,230	34%	**420**	TGs 5 and 6 are due for R&M. Other 4 units were renovated in 2020 and 2021
9	Ust-Kamenogorsk CHPP LLP	Coal	Northern	Private	372.5	25%	**94.5**	TGs 4, 6, 7, 8, and 10 are due for R&M. Other 3 units have been modernized
10	JSC "Eurasian Energy Corporation" Aksu STATE DISTRICT POWER PLANT	Coal	Northern	Private	2,475	24%	**600**	Turbine blocks 7 and 8 are due for R&M. Other 6 units have been modernized
11	JSC "Almaty Power Plants" CHPP-1	Gas	Southern	Public	145	17%	**25**	1 of the 3 units falls in the 26–40 years age bracket
12	LLP "Ekibastuz GRES-1 named after B. Nurzhanov"	Coal	Northern	Public	3,500	14%	**500**	Block 4 is due for R&M. Other 5 units were modernized between 2020 and 2022
13	"Astana-Energy" JSC CHPP-2	Coal	Northern	Public	600	13%	**80**	1 of the 6 units falls in the 26–40 years age bracket
14	JSC "Atyrau CHPP"	Gas	Western	Private	454	6%	**25**	1 of the 12 units falls in the 26–40 years age bracket
							3,059 MW	

Green Category - List of Plants (1/4)

- Total 116 units were identified in green category – these are spread across 34 plants.
- Out of these, 17 power plants have all their units falling in the green category. These plants are as follows:

S. No.	Power plant name	Fuel	Zone	Ownership	% of capacity in green	Installed capacity (MW)	Green Category Capacity (MW)
1	Sogrinskaya CHPP LLP	Coal	Northern	Private	100%	75	**75**
2	"Astana-Energy" JSC CHPP-1	Coal	Northern	Public	100%	22	**22**
3	State Enterprise "Kostanay Fuel and Energy Complex" Kostanay CHPP	Gas	Northern	Public	100%	12	**12**
4	LLP "Zhanazholskaya GTPP" (Aktobe)	Gas	Northern	Private	100%	168	**168**
5	AKTOBE Rail and Section Plant LLP GPPP	Gas	Northern	Private	100%	37.2	**37.2**
6	Ural GTPP LLP	Gas	Western	Private	100%	54	**54**
7	Zhaiykmunai LLP GTPP-1 & GTPP-2 (Uralsk)	Gas	Western	Private	100%	36.5	**36.5**
8	Batys Power LLP Ural GTES-200	Gas	Western	Private	100%	100	**100**

Green Category - List of Plants (2/4)

S. No.	Power plant name	Fuel	Zone	Ownership	% of capacity in green	Installed capacity (MW)	Green Category Capacity (MW)
9	JSC "Crystal Management" GTPP "Akshabulak"	Gas	Southern	Private	100%	87	**87**
10	Karabatan Utility Solutions LLP CCGT	Gas	Western	Private	100%	310	**310**
11	«Kazzinc» LLP Bukhtarma SEC, Bukhtarma HPP	Hydro	Northern	Public	100%	675	**675**
12	JSC "Moynakskaya HPP U.D. Kantaeva"	Hydro	Southern	Public	100%	300	**300**
13	JSC "Shardara HPP"	Hydro	Southern	Public	100%	126	**126**
14	NPP Shulba HPP LLP	Hydro	Northern	Public	100%	702	**702**
15	Ust-Kamenogorsk HPP	Hydro	Northern	Public	100%	368	**368**
16	UPNK-PV LLP, coke oven gas power plant	Petcoke	Northern	Private	100%	12	**12**
17	TOO «SagatEnergy» GPPP Atyrau	Gas	Western	Private	100%	2.4	**2.4**
							3,087 MW

Green Category - List of Plants (3/4)

For the remaining 17 power plants, only specific units were found to be in the green category. Details are provided below:

S. No.	Power plant name	Fuel	Zone	Ownership	Installed capacity (MW)	% of capacity in green	Green Category Capacity (MW)	Remarks on units falling in green category
1	LLP "Ekibastuz GRES-1 named after B. Nurzhanov"	Coal	Northern	Public	3,500	86%	**3000**	7 of the 8 units are new and below 10 years of operating age
2	JSC "Eurasian Energy Corporation" Aksu STATE DISTRICT POWER PLANT	Coal	Northern	Private	2,475	76%	**1875**	6 of the 8 units underwent R&M and are under 20 years of age post R&M
3	Ust-Kamenogorsk CHPP LLP	Coal	Northern	Private	372.5	75%	**278**	3 of the 8 units (1 × 38 MW, 2 × 120 MW) are under 10 years of age.
4	JSC "Atyrau CHPP"	Gas	Western	Private	454	71%	**322**	8 of the 12 units are new and under 15 years of age
5	JSC "Zhambyl GRES named after T.I.Baturov"	Gas	Southern	Private	1,230	66%	**810**	4 of 6 turbine units underwent R&M in 2020–2021
6	GKP "Kyzylordateploelectrocenter" CHP	Gas	Southern	Public	71.2	65%	**46.2**	3 units conducted R&M between 2020 and 2022
7	"Astana-Energy" JSC CHPP-2	Coal	Northern	Public	600	60%	**360**	TAs 4, 5, and 6 are below 20 years of age.
8	JSC "Zhaiykteploenergo" Ural CHPP	Gas	Western	Private	48.52	59%	**28.52**	Block 3 CCGT unit is 17 years of age
9	JSC "Aktobe CHPP"	Gas	Northern	Private	118	50%	**59**	TGs 3 and 4 are both under 10 and 20 years of age, respectively

Green Category – List of Plants (4/4)

S. No.	Power plant name	Fuel	Zone	Ownership	Installed Capacity (MW)	% of Capacity in Green	Green Category Capacity (MW)	Remarks on Units falling in Green Category
10	JSC "SEVKAZENERGO" Petropavlovskaya CHPP-2	Coal	Northern	Private	541	41%	**221**	R&M conducted for 3 units in 2016
11	Kazakhmys Energy LLP Balkhash CHP	Coal	Northern	Private	145	41%	**60**	Turbine station 2 underwent R&M in 2016, and turbine station 3 is around 20 years of age
12	Karaganda Energocenter LLP CHPP-3	Coal	Northern	Private	670	40%	**270**	Turbine units G5 and G6 are under 11 years of age
13	Kazakhmys Energy LLP Zhezkazgan CHPP	Coal	Northern	Private	252	40%	**100**	Turbine stations 4 and 8 are under 10 years of age
14	LIP "Main Distribution Power Plant Topar"	Coal	Northern	Private	643	29%	**185**	Block 1 is under 15 years of age. Block 2 underwent R&M in 2019
15	JSC "Aluminium of Kazakhstan" Pavlodar CHPP-1	Coal	Northern	Private	350	29%	**100**	Blocks 4 and 5 are under 20 years of age
16	Karaganda Energocenter LLP CHPP-1	Coal	Northern	Private	24	25%	**6**	Block 6 is under 10 years of age
17	PAVLODARENERGO JSC CHPP-3	Coal	Northern	Private	555	21%	**115**	R&M undertaken for 2 boiler and 2 turbo units
							7,836 MW	

Risks and Blind Spots

The relative positioning of power plants provided above is meant to serve as a reference to take priority and structured actions for modernization of power generation in Kazakhstan.

Although care has been taken to conduct the study with veracity based on data provided by plants supported through visits and interactions, following points should also be taken into consideration:

- **Alternate capacity** - Any subsequent actions on modernizing or phasing-out of power plants should appropriately consider the availability of alternate capacities to serve the affected area/population.

- **Occupational safety and other hazards** - While health and safety standards were assessed as part of the analysis, accidents and occupational hazards can arise due to unforeseen circumstances and deficiencies / lack of oversight in operations and maintenance, and hence cannot be ascertained in advance.

- **Demand loss** - Several plants have reported significant reduction in demand due to closure of industries. This may have an adverse impact on the revenues and operations of even the better performing power plants.

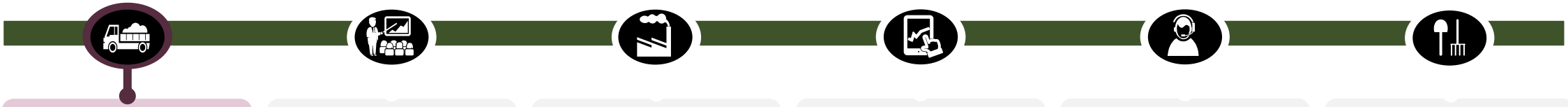
- **Data limitations** - While the analysis has been conducted using the data and inputs provided by plants, discussions with plant level officials, visual observations, etc., missing inputs, correctness of data provided by plants, and data discrepancies might limit the accuracy of some inferences.

While recognizing the above, a relatively common area across plants is the scope for improvement in operating practices and capacity building. This appears to be an immediate opportunity to bring in stability in operations and improve efficiency with relatively lower cost implications.

1	2	3	4
Detailed performance analysis and site visit observations	Power plant characteristics and relative positioning	Key focus areas for efficient operations of power plants	Development framework and financing strategy

Key Areas of Focus for Efficient Operations of Power Plants

Activities



Fuel sourcing & management | Staff productivity & management | Plant equipment performance | Operation & maintenance | Control systems & monitoring | Emission & ash management

It was observed during the visits that coal storage is mostly done in open yards, without proper fuel stacking and planning for waste reduction and / or proper fuel utilization.

Improvement areas

1 Maintain fuel quality

- Covered coal storage
- Drying and moisture reduction
- Systematic stacking of coal
- Routine fuel quality analysis
- Ensure gas filtration to remove moisture / gas condensate, etc.

2 Reduce waste

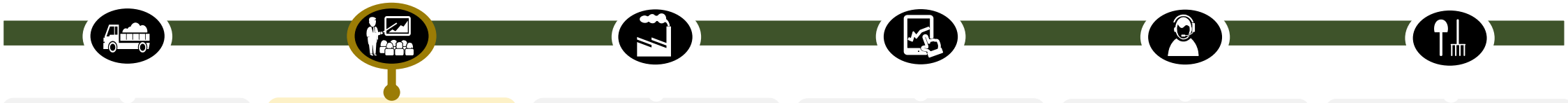
- Modernize weighing systems for measuring weight of coal entering the burner
- Quantity and quality checkpoints across the line with routine measurement

3 Reduce chances of damages to equipment

- Magnetic separator with metal detector or metal pick up devices.
- Gas chromatography and mass flow rate metering to ensure elements within OEM specified limits
- CO_2 and smoke sensors in closed coal storage yard
- Ultra high molecular weight HDPE coating or sheets in hoppers, transfer chutes, etc., to prevent choking
- Ensure OEM specified fuel temperature, pressure, and mass flow at burner inlet

Key Areas of Focus for Efficient Operations of Power Plants

Activities



Fuel sourcing & management | **Staff productivity & management** | Plant equipment performance | Operation & maintenance | Control systems & monitoring | Emission & ash management

Plants have indicated that lack of specialized experts and/or staff have been a concern with respect to plant operations and crisis / emergency management.

Improvement areas

1 Train staff

- Establishment of training department along with performance software package
- Mandatory training days for each employee on O&M practices, new technologies, and modern control systems
- Identification and training of staff on possible technical surprises with defined procedures

2 Prepare standard guides

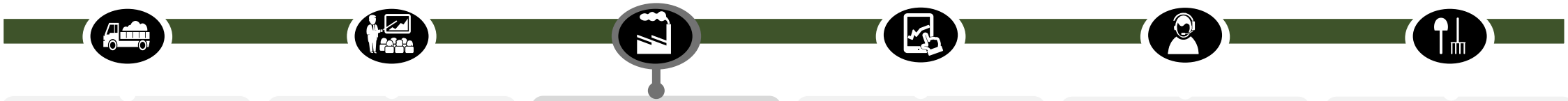
- Standard operating procedures to guide floor staff to perform daily technical repetitive processes
- Develop and provide access to all plant maintenance procedures and guidebooks
- Develop critical operation checklist and safety (EHS) guidelines
- Develop emergency operation procedures

3 Establish accountability

- Ensure ERP system for work assignment, defining KRAs and KPIs across different departments
- Routine performance monitoring procedures on technical/financial parameters
- Performance-based incentive mechanism to promote reliable and efficient operations

Key Areas of Focus for Efficient Operations of Power Plants

Activities



Fuel sourcing & management | Staff productivity & management | **Plant equipment performance** | Operation & maintenance | Control systems & monitoring | Emission & ash management

It was observed that monitoring of performance of major equipment and plant KPIs is not done daily. Further, lack of routine audits and structural assessments was resulting in frequent damages and accidents.

Improvement areas

1 Monitor operations

- Daily monitoring of major equipment efficiencies like boiler, turbine, generator, compressor, ID fan, boiler feed pump, HRSG, condenser, cooling towers, air pre-heater, ESP or filtration system, etc.
- Daily monitoring and reporting of plant KPIs like heat rate, availability, reliability, load factor, outages (forced/planned), etc.

2 Conduct routine checkups

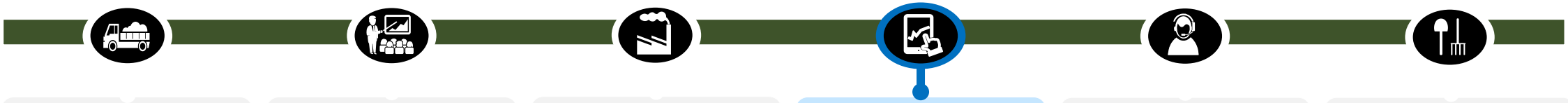
- Routine safety and performance audit for timely capital repairs and upgrade
- Routine structural assessments for civil work upgrades
- Monitor and document operating hours, along with normal loading and peak loading ramp rates
- Check the status of critical components of major equipment for timely replacement

3 Set limit and improve efficiency

- Setting maximum limits as per OEM guidelines on fatigue cycles and creep limits, startups / shutdown, load ramping rates, etc.
- Implementing energy conservation measures like VFD, energy efficiency motors, LED bulbs, etc., through EE cell

Key Areas of Focus for Efficient Operations of Power Plants

Activities



Fuel sourcing & management | Staff productivity & management | Plant equipment performance | **Operation & maintenance** | Control systems & monitoring | Emission & ash management

It was observed that lack of proper maintenance has resulted in visible damage to civil structures and equipment, dust accumulation, rusting, leakages, etc., as well as poor water and steam chemistry.

Improvement areas

1 Plan for water, steam, and waste management

- Maintenance of DMW, CW, and steam quality as per OEM recommendations*
- Routine lab analysis and reporting of water/steam quality to determine levels of pH, silica, sodium, etc.
- Routine borescope inspection for compressor, combustor, etc., as per OEM recommendations
- Maintenance of main and auxiliary circulating cooling water qualities as per OEMs
- Hazardous waste disposal compliances systems and monitoring

2 Prepare for surprises

- Predictive and reliability maintenance implementation (like vibration) through digital technologies like AI, ML, IIOT, etc.
- Remote diagnostics expert teams
- Drone-based and CCTV surveillance for quick action on any defects, leaks, fires, etc.
- Ensure timely supply of spares and maintenance for major equipment and critical components through Annual Maintenance Contract (AMC) and / or Performance Guarantee (PG)

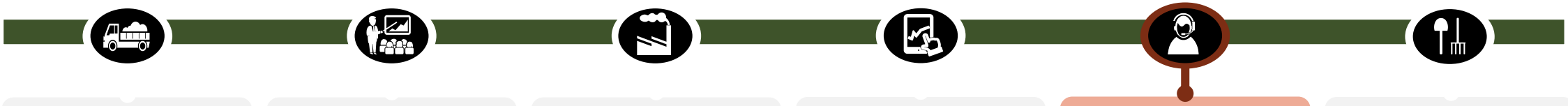
3 Set guidance

- Develop SOPs and manuals for shift-wise staff
- Maintain shift handover procedures and records
- Maintain equipment/ event history

**DMW means demineralized water and CW means cooling water*

Key Areas of Focus for Efficient Operations of Power Plants

Activities



Fuel sourcing & management | Staff productivity & management | Plant equipment performance | Operation & maintenance | **Control systems & monitoring** | Emission & ash management

It was observed that the control systems in many of the plants were manual or semiautomated which (i) are prone to error, (ii) have slow response time, (iii) incur higher maintenance costs, and (iv) lack advanced analytical capabilities.

Improvement areas

1 Upgrade to modern controls

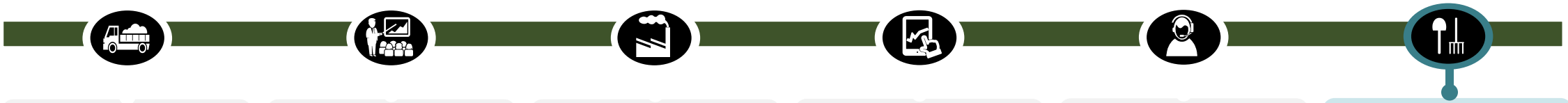
- Install Digital Distributed Controls System at central control room with event recorders and historian servers
- Upgrade to digital systems (SCADA) from manual / knob-operated desks and analog meters for load dispatch, frequency and voltage controls
- Install eco-friendly gas fire suppression system in control room along with smoke detectors and advanced addressable fire alarm panels, etc.
- Implement ERP system for asset management, plant maintenance, work management, inventory management, field service management, etc.

2 Integrate and monitor plant operations and KPIs

- DCS integration of main and balance of plant like generator excitation system, plant compressed air, ash handling and coal handling plant, DM water plant, soot blowers of boiler, ESP, etc.
- Centralized display and control of all operations of isolators, breakers, metering, protection relays of transformers, voltage management and transmission, etc.
- Alarm and advisory system set for combustion dynamics, emission controls, KPI monitoring, etc.

Key Areas of Focus for Efficient Operations of Power Plants

Activities



Fuel sourcing & management | Staff productivity & management | Plant equipment performance | Operation & maintenance | Control systems & monitoring | **Emission & ash management**

It was observed that emission control systems were inadequate, and plants are not able to manage ash effectively as some of them are running out of ash storage capacity.

Improvement areas

1 Adopt modern emission control systems

- Use electrostatic precipitators (ESP)
- Implement De-NOx system
- Zero liquid discharge (ZLD) system for wastewater management
- Effluent regeneration and disposal system
- Flue gas desulfurization (FGD) system
- Use greaseless wicket gate and O_2 diffusers in penstocks and vents to avoid grease pollution on water source

2 Integrate and monitor

- Connect emission systems with DCS to monitor and record all critical parameters through web server
- Emission and waste disposal compliance reporting to be part of monthly review management meeting for any deviation and remedial actions

3 Explore avenues for reuse

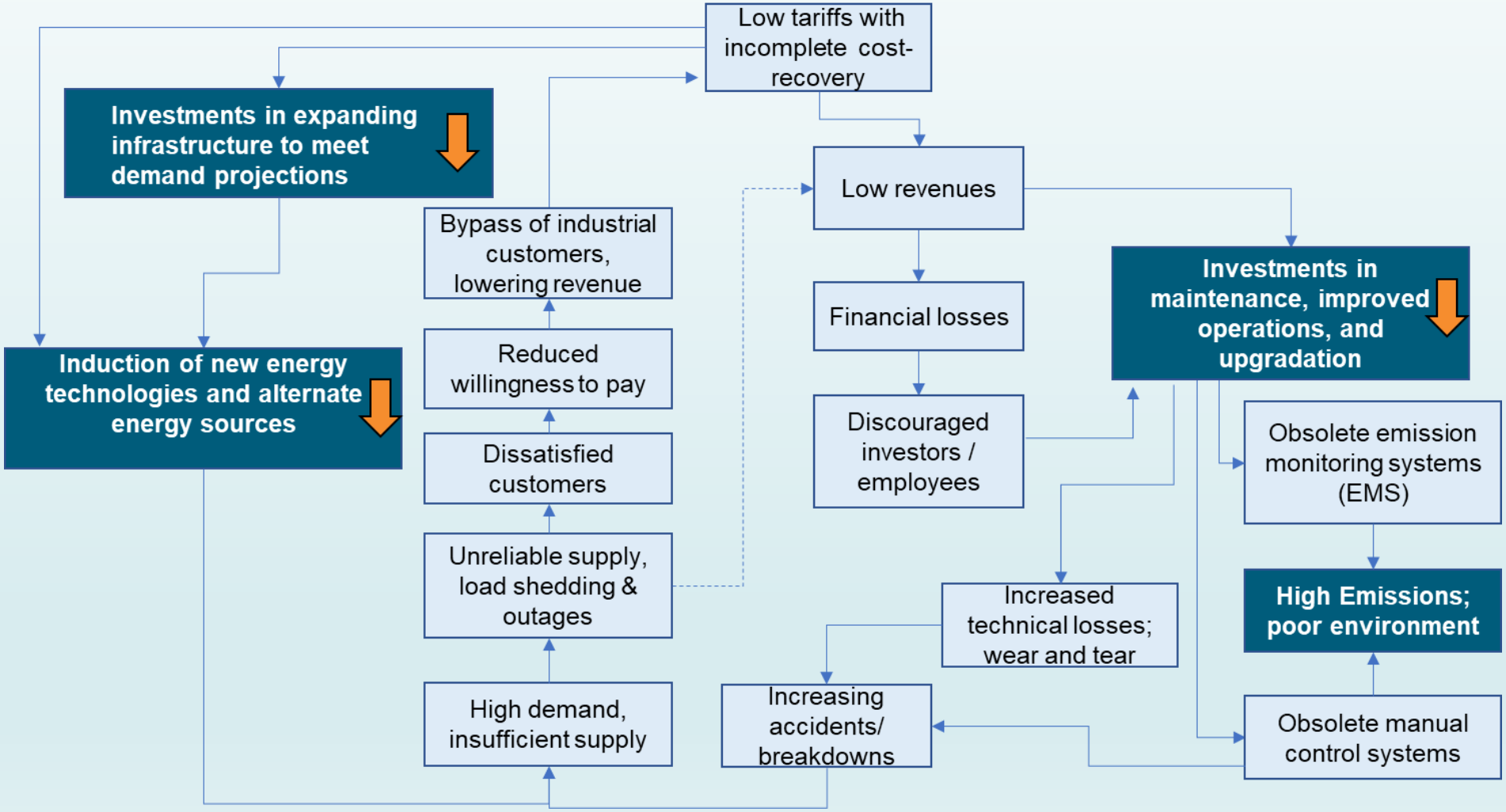
- Set up emission and waste minimization (or EHS) department
- Tie up with cement / bricks / tiles manufacturing or road laying agencies for utilization of fly and bottom ash
- Reuse treated effluents (oil, grease, alkaline, TSS*, etc.)

**TSS means total suspended solids*

1	2	3	4
Detailed performance analysis and site visit observations	Power plant characteristics and relative positioning	Key focus areas for efficient operations of power plants	Development framework and financing strategy

It Is Important to Break the Link between Low Tariffs and Delayed Investments

A vicious cycle gripping Kazakhstan's power sector today:



'Tariffs for Investments' needed to make energy sector reliable, climate resilient, and financially viable.

Important Actions Are Required to Address Current Challenges and Pave the Way toward Complete Transformation and Net Zero by 2060 (1/2)

The Country Climate and Development Report of the World Bank proposes a set of actions to pave way toward net zero by 2060. This includes urgent actions and medium-term actions.

A. Urgent actions

1. Developing a **roadmap for achieving 2030 climate targets**, with policy and institutional mechanism and clear implementation timelines consistent with achieving net-zero emission by 2060.
2. **Scaling up renewable energy deployments** through well-structured and transparent auctions, improving project bankability, facilitating land acquisition and power evacuation through power purchase agreements, etc.
3. Developing a **social mitigation plan** to protect the poor from price adjustments and implementing a **communication and outreach campaign.**
4. Implementing **stringent energy efficiency standards in industry and building sector.**
5. Developing a plan for **ramping down coal use in power and heating** sectors.
6. Preparing a comprehensive **energy efficiency strategy** and associated implementation programs.
7. Performing technology **demonstrations/pilots of emerging technologies** such as CCS in industry and the power sector, clean hydrogen production, battery storage, geothermal for heating, productive uses of associated gas, etc.
8. **Preparing targeted incentive schemes** and capacity-building program for farmers and other vulnerable consumers.
9. Establishing **mechanism to coordinate the government's response** to climate change led by a central authority.

Continued....

Important Actions Are Required to Address Current Challenges and Pave the Way toward Complete Transformation and Net Zero by 2060 (2/2)

B. Medium-term actions

1. **Gradual removal of fossil fuel subsidies** through cost-reflective tariff methodologies, led by independent regulator or authority with price-setting functions.
2. **Development of storage (battery, pumped hydro, hydrogen) and flexible power plant projects** through ancillary services market, wholesale electricity trade, and removal of regulatory barriers.
3. Targeted **incentives for transmission and distribution system flexibility** and implementation of **demand-side management** practices through rebates, prices, and tariffs.
4. Design and implementation of **investment program to commercialize new technologies and business models in sustainable heating** infrastructure through (i) renovation of buildings, (ii) reduction of heat losses in pipelines, (iii) drilling of exploratory geothermal wells, (iv) distributed technologies, including heat pumps and rooftop solar, etc.
5. Reforms **promoting emissions trading and auctioning** to ensure large installations contribute toward climate targets.

Harnessing the Alternate Energy Resource Potential in the Country Is Essential on the Journey toward Net Zero (1/2)

Technology	Potential	High potential areas	Deployment status
Wind	• 920 bn kWh / year • Speed of 4–5 m/s at 30 m across ~50% of the country	Atyrau and Mangystau region, as well as some Northern and Southern region	Low
Solar	• 2.5 bn kWh / year • 2,200–3,000 hours / year	South, Central, South-East, and South-West region	Low
Hydropower	• 170 bn kWh / year (overall) • 62 bn kWh / year (feasible)	Irtysh River Basin in the north; the Ili River Basin in the southeast; and the Syrdary, Tas, and Chus River Basins in the south	Medium

Note: The map provided here is for illustration only, without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city, or area.

Source: IEA

Harnessing the Alternate Energy Resource Potential in the Country Is Essential on the Journey toward Net Zero (2/2)

Technology	Potential	High potential areas	Deployment status
Geothermal	• 4.3 GW • 97,000 Mtoe	Western region, Southern region, Central region	Low
Nuclear	• 906,800 tons of uranium	Eastern region, Almaty region	Low
Biomass	• 1.5 tC / ha / year of ne -primary production		Low
Waste-to-Energy	• 4–5 Mt of solid household waste / year with 80% in landfills	Aktobe, Almaty, Ust-Kamenogorsk, Nur-Sultan, Karaganda, Shymkent	Low

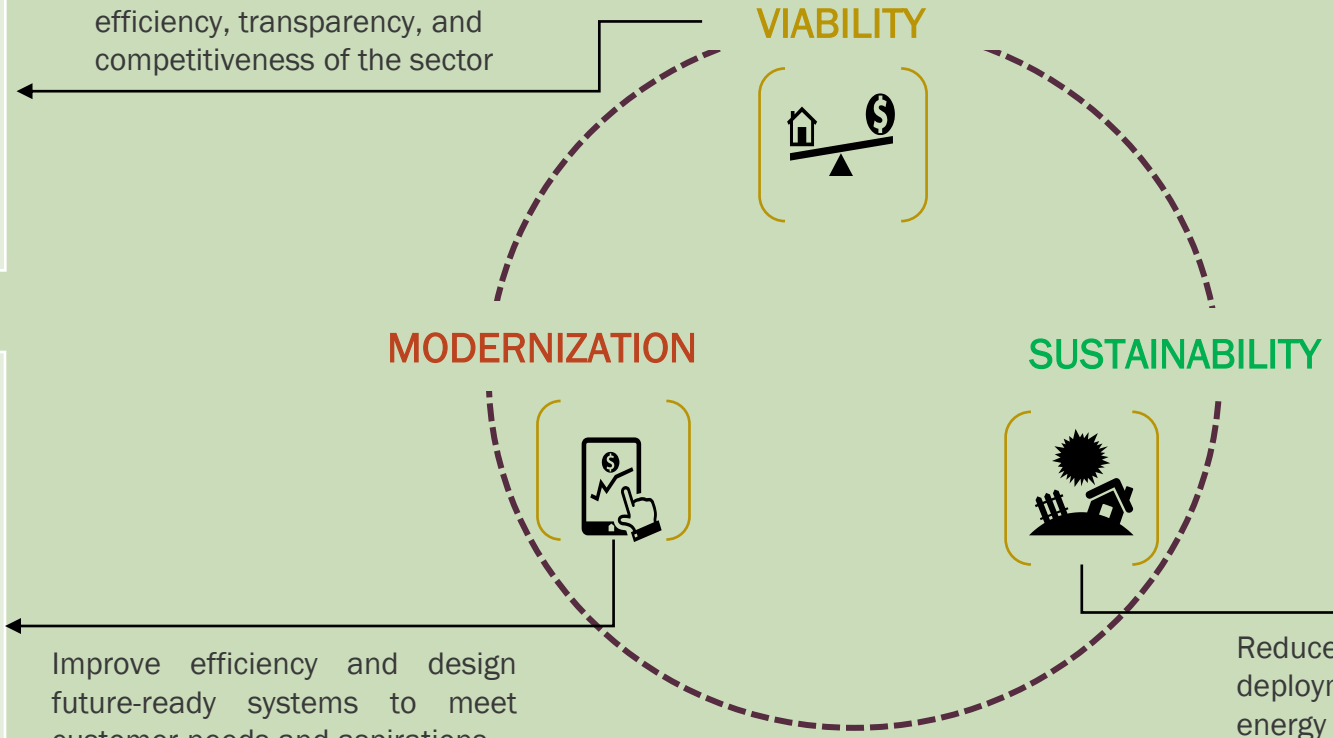
Source: IEA

A Development Framework Based on the Principles of Viability, Modernization, and Sustainability Is Suggested to Address Challenges and Facilitate the Net-zero Journey

Development Areas

- Set cost-reflective tariff,
- Introduce targeted end user subsidies,
- Implement energy efficiency programs,

Increase operational efficiency, transparency, and competitiveness of the sector



Development Areas

- Scale up natural gas infrastructure as transition support to meet power and heating demand,
- Increase scale and accelerate deployment of RE projects,
- Include storage as part of future RES auctions,
- Enforce emission and pollution standards.
- Mandate GHG emissions and flexibility conditions.

Development Areas

- Promote renovation and modernization of plants,
- Phase out old and aging thermal power plants,
- Focus on network augmentation,
- Promote energy-efficient smart solutions / process innovations,

Improve efficiency and design future-ready systems to meet customer needs and aspirations

Reduce emissions and increase deployment of new and clean energy systems to transition toward low-carbon pathways

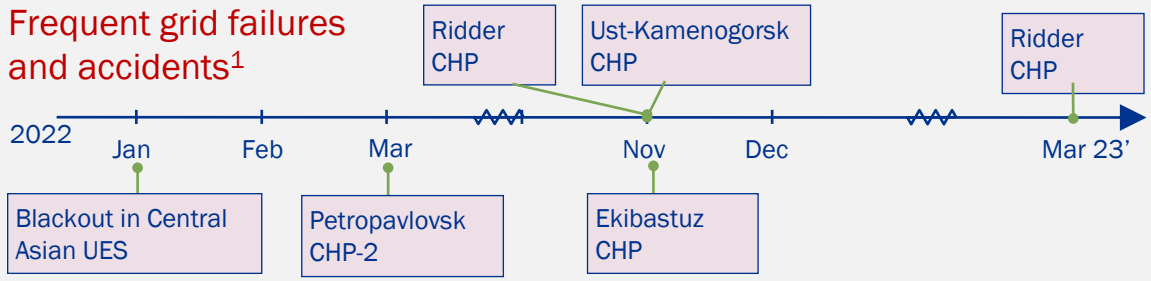
Each of these aspects are covered in detail in the subsequent sections.

Modernization: Improve efficiency and design future-ready systems to meet customer needs and aspirations (1/3)

Reasons

1. The existing generation and transmission assets are getting old and degrading, while new capacities are not being built.
2. Equipment degradation and obsolescence have led to grid failures and accidents in recent times.
3. Thermal plants that were commissioned decades ago have old/outdated equipment and control systems with limited availability of spares and repair materials.
4. The old power plants have inefficient and manual O&M practices which increase risk of accuracy, damages to equipment, and error in operations.
5. Estimates show increasing shortfall in energy supply against the rising demand and peaking requirements have necessitated the need for investments in generation capacity, including flexible generation, energy efficiency, and network augmentation,

Frequent grid failures and accidents[1]



Inefficient water treatment, damages, leakages, etc., among many others observed during site visits.

KEGOC estimates indicate

- Deficit of 5.2 billion kWh by 2028 with the existing and planned generation capacity; and
- Increase in lack of balancing power from 894 MW in 2022 to 1,110 MW in 2028.

[1]*Source: News Articles.*

Modernization: Improve efficiency and design future-ready systems to meet customer needs and aspirations (2/3)

Interventions

1. Develop a comprehensive plan to identify and prioritize critical infrastructure in need of renovation or replacement.
2. Develop a comprehensive energy efficiency plan appropriately designed to help damp down peak power and heat usage, which avoids disruptions while making the necessary additions/modernization of power systems.
3. Undertake comprehensive residual life assessment of plants to estimate the remaining life of critical assets.
4. Implement regular inspection programs to report the status of power plants and its major equipment.
5. Implement regular maintenance programs to extend the lifespan of existing equipment and infrastructure while ensuring safety and reliability.
6. Establish a roadmap for the phaseout of coal-fired power plants, with specific milestones and targets for retiring or converting (from coal to gas) existing facilities.
7. Establish regulatory requirements for modernization with timeline for upgrading control systems, including criteria such as reliability, cybersecurity, and interoperability.

Modernization: Improve efficiency and design future-ready systems to meet customer needs and aspirations (3/3)

Interventions

8. Implement an ERP system to monitor performance, interventions, and investments undertaken across power plants. This will promote transparency between power plant owners and the ministry, and encourage an open book regulation system.

9. Develop a comprehensive strategy for modernizing and improving the efficiency of existing centralized heating systems, including investments in infrastructure upgrades, automation, and digitalization.

10. Optimize transmission system operations and minimize losses/accidents by

    - Augmenting transmission infrastructure;
    - Implementing advanced monitoring technologies for real-time control and stability and quick identification and reporting of inefficiencies / risks / discrepancies; and
    - Developing and maintaining contingency plans and emergency response protocols to address grid disruptions quickly and effectively to minimize their impact on consumers and businesses.

Viability: Increase project bankability, transparency, and competitiveness in the sector (1/3)

Reasons

1. Plants have stated lack of funds as a major reason for low maintenance and renovation.
2. Due to low returns, the market is unattractive for investors and lenders.
3. Most of the electricity is sold through bilateral contracts, with very low share traded on the centralized market, which leads to uncertainties, imbalances, and underfunding of the industry.
4. Larger industrial customers are exiting the system through self-generation because of higher tariffs for cross-subsidizing households. This has resulted in lower customer base to sustain new investments in power generation that are needed as demand grows.[2]

Several research reports and news articles have indicated that the electricity tariff is not cost reflective and is one of the lowest in the region[1]

[1]*Source: News Articles.*
[2]*Country Climate and Development Report of the World Bank.*

Viability: Increase project bankability, transparency, and competitiveness in the sector (2/3)

Interventions

1. Establish administrative and regulatory mechanism (like a single independent regulator with all price-setting functions) to ensure flexible, transparent, and recovery-based tariff setting process for electricity and heat. This can include the following:
    - Routine tariff review and approval mechanism through a defined regulatory structure.
    - Reintroduction of 'tariff-for-investment' program for plants to apply and get approval of higher tariffs against committed investment plans in modernization and expansion.
    - Establishment of output conditions (plant KPIs and emission norms) for setting tariffs for thermal power plants.
    - Ways to incentivize and encourage energy-efficient smart solutions / process innovations.
2. Prepare a plan for targeted distribution of subsidies to protect the most vulnerable consumers against tariff increase.
3. Develop a communication and outreach strategy for dissemination of the tariff and subsidy reforms plan.
4. Develop heating sector master plan for each locality covering management (decentralized / centralized) guidelines as well as regulatory guidelines on reliability and quality standards.

Viability: Increase project bankability, transparency, and competitiveness in the sector (3/3)

Interventions

5. Evaluate the feasibility and cost-effectiveness of transitioning to alternative heating models, such as decentralized heating or district heating systems, considering the financial, social, and environmental implications.

6. Implement energy efficiency and savings program by defining labeling standards for buildings, appliances, and industrial processes as well as adopting incentives / benefits for consumers.

7. Develop and implement a comprehensive generation capacity expansion plan to identify the necessary least-cost new generation capacity mix to meet the increasing demand for electricity in the country, covering multiple options for new generation capacity, such as renewable energy, natural gas, hydro, geothermal, nuclear energy, storage, etc.

8. Develop and implement a comprehensive transmission network plan to identify the necessary least-cost infrastructure for transmitting electricity across the country by prioritizing areas with the highest demand and potential for new generation capacity as well as areas for power plant retirements or refurbishments.

Sustainability: Reduce emissions and increase deployment of new and clean energy systems to transition toward low-carbon pathways (1/3)

Reasons

1. There is significant renewable energy potential, which needs to be harnessed.
2. New and renewable energy capacities are not able to compete with much lower-priced coal-fired capacity.
3. High emissions and pollution from old and aging assets, most of which may have lived their operational life, are raising environmental concerns.
4. The shortage of flexible capacity is likely to become an increasing challenge, particularly in an isolated system like the West Zone.
5. There is significant power supply and reliability concern with increasing focus on electrification of transport and other industrial process changes.

- Wind, solar, and hydro together have a potential of ~1,100 bn kWh per annum.[2] Solar potential is highest in Kyzylorda and Turkestan regions (south-west); hydropower in East Kazakhstan; and wind in Akmola, Aktobe, Kostanay, and Zhambyl regions (west). The tariff cap for thermal power plants is in the range of 7–10 KZT, while minimum tariff recovered for RE in recent auctions (in 2020) was in the range of 15–16 KZT.[1]

- As per OECD estimates, carbon intensity in Kazakhstan is one of the highest (kg of CO_2 from energy use per USD of GDP) at 1.30, compared to the Russian Federation at 0.79, China at 0.79, the United States at 0.41, India at 0.43, and the EU-27 at 0.26.
- West Zone relies significantly on parallel operation with the Russian power system to cover imbalances and maintain frequency stability.

[1]*Source: WB, Energomost*
[2]*IEA, USAID, and IEAE*

Sustainability: Reduce emissions and increase deployment of new and clean energy systems to transition toward low-carbon pathways (2/3)

Interventions

1. Accelerate the deployment of renewable energy sources, such as wind, solar, and hydropower.
2. Facilitate RES investments through competitive and transparent procurement approach, investment facilitation desk, single window clearance system, fast-track approvals, easy access to land, etc.
3. Ensure appropriate opportunity sizing for RES auctions to facilitate economies of scale and attract investments.
4. Focus on energy storage as part of future grid upgrade / RES tenders for peak demand management. RE integrated Battery Energy Storage Systems (BESS) can be an effective solution for frequency regulation, particularly for the Western Power Zone.
5. Develop a comprehensive plan for use of natural gas as a transition fuel for power and heat to bridge the gap between coal-fired power and renewables, considering its lower emissions profile and potential for flexible generation. Secure gas supply for the internal market and develop necessary infrastructure in the process.
6. Enforce air pollution standards and GHG emissions limit for coal-fired power plants through regulatory mechanism ensuring mandatory reporting and inspection.
7. Undertake a comprehensive impact assessment study to assess the impact of other sectors like electrification of transport and industrial process, use of hydrogen and ammonia (blue and green), etc., on power systems.

Sustainability: Reduce emissions and increase deployment of new and clean energy systems to transition toward low-carbon pathways (3/3)

Interventions

8. Undertake a comprehensive study to develop a roadmap for green hydrogen economy.

9. Assess the potential of emerging technologies and consider undertaking technology demonstrations / pilots for CCS in industry and the power sector, clean hydrogen production, battery storage, green heating options.

KazMunaiGaz is piloting carbon capture and storage (CCS) technologies to produce blue hydrogen (hydrogen produced from natural gas using CCS)[1].

10. Develop just transition programs and economic diversification strategies to mitigate the social and economic impacts of the coal phaseout on affected communities and regions.

11. Hold regular stakeholder review meetings and document views on sustainable development plans.

Globally, geothermal is being explored as an alternative source for heat. Some of the examples of pilot projects include the following:

- **Turawell Geothermal CHPP, Hungary:** Commissioned in 2017 with an electricity capacity of 3 MW, the plant also generates thermal energy which is sold to nearby community for farming and cultivation. The plant is owned by Zhejiang KaiShan Pressure Vessel Co. Ltd and operated by KS Orka Renewables Pvt. Ltd of Singapore (KS ORKA).

- **Hellisheidi Geothermal Power Station, Iceland:** The plant was commissioned in five phases, from 2006 to 2011. It has a capacity of 200 MW in thermal power (950 liters per second of hot water production) and 303 MW in electricity. This plant is owned by ON Power.

[1]Source: News articles

In Summary - Key Recommendations (1/3)

Improve operational performance through timely O&M

- **Use plant-wise rankings as guidance** to conduct **immediate repairs** of Boiler-Turbine-Generator (BTG) equipment, including balance of plant.
- Address urgent **structural concerns** especially on chimneys and buildings.
- Ensure **availability of critical spares** to handle breakdowns, and prepare **emergency response plans** and train employees for these.

Undertake renovation and modernization (R&M) where identified

- Undertake **renovation and modernization to extend the service life** for yellow category units in consultation with OEMs.
- Undertake **modernization and efficiency improvement** of district heating systems, and prioritize investments in infrastructure upgrades, automation, and digitalization guided by color ranking and further analysis at plant level.
- Develop **tariff for investment** program to ensure sufficient funds for R&M works.

In Summary - Key Recommendations (2/3)

Accelerate energy transition aligned with development and climate goals (net zero by 2060)

- Plan **phasedown of red** category units, especially coal-fired, developing alternatives.
- **Enable gas use as transition fuel** with hydrogen-ready CCGT projects; identify opportunities for efficient use of gas (modular and large scale).
- **Scale up RE capacity** through dedicated Renewable Energy Zones and well-structured auctions *(wind and geothermal in west, solar in south and south-west, pilot geothermal in new construction in south).*
- Develop/pilot **grid connected storage systems** for balancing of power.
- Enforce **emission standards** through regulatory mechanism (including carbon pricing); ensure **mandatory reporting and inspection.**
- Pilot **just transition programs** to mitigate the social and economic impacts of coal phaseout.

Develop modern, smart, and resilient energy systems for the future

- Develop least-cost generation expansion plan along with necessary grid upgrades.
- Introduce **Intelligent Power Systems** through use of SCADA, ERP, other analytics tools leveraging AI, IoT, etc.
- Undertake intensive **training programs and skilling** of sector professionals,

In Summary - Key Recommendations (3/3)

Improve comfort and affordability through energy efficiency, distributed technologies, modern monitoring, and targeted subsidies

- Graduate to gigawatt-scale RE projects for **competitive bidding.**
- **Rationalize rate-making practices for heat and power** with an objective to remove cross-subsidies between heat and electricity.
- Prepare a plan for **targeted distribution of subsidies** to protect vulnerable consumers while also avoiding industrial bypass to maintain system viability.
- Plan and initiate development of **alternate capacity for critical heating plants** in regions like Ridder, Tekeli, etc.
- Explore **pilots on sustainable heating options**, such as decentralized heating through electric heat pumps, geothermal-based heating, etc.
- Encourage **adoption of energy efficiency** solutions across the economy,
- **Establish output conditions** (plant KPIs and emission norms) for setting tariffs for thermal power plants,

To Undertake the Interventions under the Development Framework, Mobilization of Investments Is Required, through Targeted Financial Mechanisms

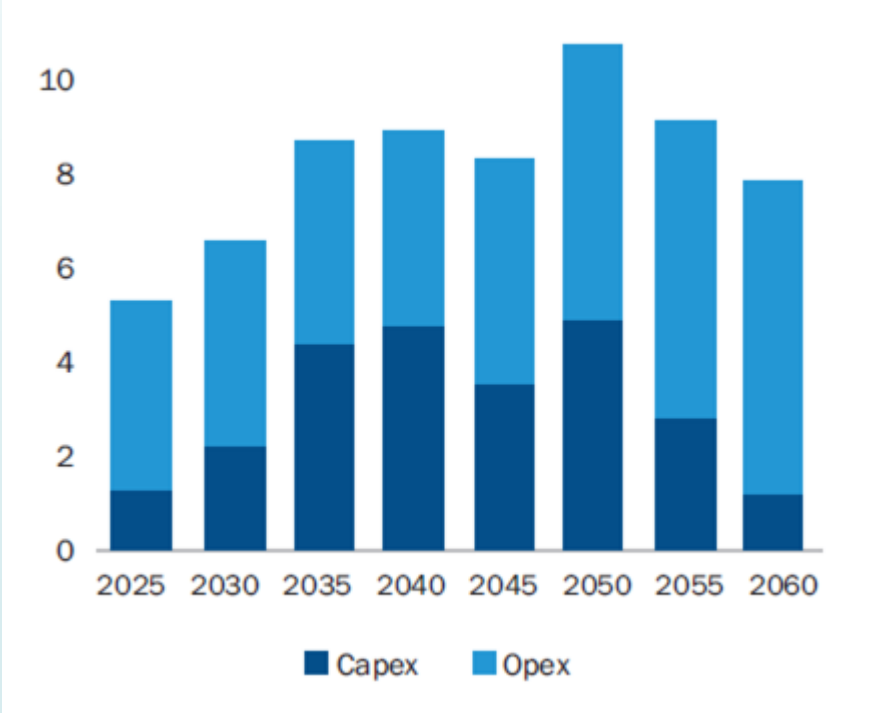
As per estimates in the Country Climate and Development Report of the World Bank, Kazakhstan's transition to net zero will require investments across the board, in areas such as

1. Modernizing / Replacing aging infrastructure (~USD 920–1,150 bn)*
2. Setting up new capacities (~USD 109 bn)
3. Establishing storage and flexible systems (~USD 4.8 bn)
4. Improving energy efficiency (~USD 70 bn)

*Inclusive of power, buildings, transport, and industry.

These investments need to be mobilized through a menu of targeted financial mechanisms along with conducive and enabling investment environment.

Annual capital expenditure (Capex) and operating cost (Opex) for the power sector to achieve net zero



Source: World Bank, Country Climate and Development Report: Kazakhstan.

Financing Mechanisms

Various Existing and/or New Financing Mechanisms May Be Considered for Mobilizing Resources into Modernization and Scale-Up (1/3)

Some of the potential financial mechanisms that may be considered include the following:

#	Financial mechanism	Description	Global maturity	Experience in Kazakhstan	Scope for leveraging private sector capital	Suitable for
1	Tariff / viability adjustments	Targeted program for tariff / viability adjustments as per (i) investments in modernization of assets (ii) compliance to emission norms; (iii) investment in priority sectors such as renewable energy or CHPs, etc.	High	Low	High	• Modernizing assets • Capacity expansion • Balancing systems • Energy efficiency
2	Public-private partnerships	PPP entails collaboration between the government and private sector companies to finance and implement infrastructure projects. PPPs offer risk sharing, efficiency gains, and access to private sector expertise. Private sector companies can provide funding for power sector projects and share in the risks and benefits of the project.	High	Low	High	• Modernizing assets • Capacity expansion • Balancing systems • Energy efficiency
3	Capital subsidy	Capital subsidy is usually a one-time payment to cover a share of the up-front capital cost of modernization and development of RE projects. The subsidies generally take the form of reimbursements once the project has been approved and commissioned.	High	Low	High	• Capacity expansion • Balancing systems
4	Capacity tariff market	Tariff structure that encourages the development of new power plants by providing a tariff for the installed available capacity. This tariff can incentivize the modernization as well as development of new power plants to meet the growing demand for electricity in the country.	High	Medium	High	• Modernizing assets • Capacity expansion

…Contd. (2/3)

#	Financial mechanism	Description	Global maturity	Experience in Kazakhstan	Scope for leveraging private sector capital	Suitable for
5	Sustainability linked green bonds (SLB)	An SLB is a type of loan structured around KPIs (environmental, social, and governance targets) of the issuer. Proceeds from SLBs can be used for decommissioning plants, meeting costs for repurposing coal plant into gas / renewable energy plant, and meeting just transition cost (reskilling, rehiring, compensation package, etc.).	Medium	Low	High	• Replacement/phasing out thermal plants • Capacity expansion
6	Tax credit / tax rebate	Tax credit or tax rebate is direct reduction in tax liability. Introduction of policies that offer tax rebate on activities such as manufacturing, purchase, import, development of clean energy technologies can provide monetary incentives to increase adoption of clean energy technologies.	High	Low	High	• Capacity expansion • Balancing systems • Energy efficiency
7	Concessional bilateral / multilateral loans	Concessional loans are characterized by longer repayment terms and lower or zero interest rates for climate change activities. These loans can be directed toward low-carbon technologies that are economically viable but face market- and finance-related challenges (e.g., energy-efficient technologies). International funders are the main sources of concessional loans.	High	Medium	Medium	• Modernizing assets • Capacity expansion • Balancing systems • Energy efficiency

…Contd. (3/3)

#	Financial mechanism	Description	Global maturity	Experience in Kazakhstan	Scope for leveraging private sector capital	Suitable for
8	Market-based mechanisms (such as RECs, carbon markets)	Market-based mechanisms provide monetary incentives (through trading of RECs or carbon credits) to encourage large-scale participation of private sector players in implementing effective mitigation technologies/projects in energy and waste sectors. Market-based mechanisms have high potential in scaling up investments from one project to multiple projects across sectors.	High	Low	High	• Capacity expansion • Energy efficiency
9	Bonds (green bonds, climate bonds, etc.)	A type of loan used to finance clean energy projects, in which the debt is to be paid back with interest within a specified time period. The funds from investors (international donors / government / private companies) are received by an issuing entity (typically a private/public bank) for further disbursement as loans to project owners.	High	Low	Medium	• Capacity expansion • Balancing systems
10	Net metering	Net metering is a billing mechanism that credits RE system owners for the electricity they add to the grid. If a consumer generates more energy than s/he uses, the excess can be credited to the grid and the consumer will be billed for net energy used.	High	Low	Medium	• Capacity expansion

Action Plan

- Overall Action Plan
- Specific Action Plan for Red Category Plants

Action Plan (1/4)

Short-term actions (6 months)	Medium (6 months-2 years) / Long-term actions (>2 years)
1. Red Category Units	
• **Undertake immediate repairs and major / minor overhauls** of BTG equipment to meet winter demand for heat and electricity, guided by color rankings. Overall aim should be to phase out while focusing on critical repairs for short-term operations; additional plant-wise studies needed. • **Accelerate development of ongoing projects through regular reviews and addressing bottlenecks, if any.**	• **Accelerate transition to gas** in the medium term. • **Phase out units** in the medium term. • In case of lack of alternatives for heat plants, **phase out** units in the long term. • **Scale up renewable energy deployments** to ensure alternate electricity capacity for units being phased out (medium term). • Conduct **pilots on alternative heating options** leveraging geothermal, decentralized heating (electric heat pump), etc. (medium term).
2. Yellow Category Units	
• Conduct **residual life assessment (RLA)** (where not already done) to identify critical areas of upgrade and overhaul. • **For plants that have conducted RLA,** implement key recommendations and assess its economic impact. • Based on above, prepare **detailed schedule of overhaul** to be done in 2023 and fast-track it to ensure completion before winter.	• **Undertake renovation to extend the service life of units** (medium term). • Undertake **modernization projects** to improve performance and efficiency of units (like gas insulated switchgears, ERP, AI, IOT. etc.) (long term).

Action Plan (2/4)

Short-term actions (6 months)	Medium (6 months-2 years) / Long-term actions (>2 years)
3. Green Category Units	
• Prepare **detailed schedule of repair** for completion before winter.	• Undertake **modernization projects** to improve performance and efficiency of units (like gas insulated switchgears, ERP, AI, IOT etc.) (medium term).
4. All Units: Emergency Response to Minimize Outages	
• **Prepare SOPs for emergency operation** and train staff. • Ensure **availability of critical spares** to handle equipment breakdowns. • Install **battery or diesel back-up generators** for emergency operations.	• **Regularize processes** such as monitoring of spares, updating SOPs, etc. (medium term).
5. All Units: Enhancing Production and Availability	
• Ensure **availability of adequate stocks of coal** - institutionalize daily reporting of coal stocks in plant. • Ensure **regular gas supply** to plants (gas supply identified as key concern).	• Initiate **blending of high-quality coal** to mitigate quality issues (medium term). • **Strengthen gas infrastructure** to minimize interruptions in supply (long term).

Action Plan (3/4)

Short-term actions (6 months)	Medium (6 months-2 years) / Long-term actions (>2 years)
6. All Units: Improving Plant Performance	
• **Conduct daily monitoring and reporting of plant KPIs** like heat rate, availability, reliability, load factor, outages, etc. • **Improve maintenance practices** with annual repair schedules, condition-based maintenance, periodic diagnosis tests, etc. • **Conduct energy audits** and implement energy efficiency measures.	• **Adopt advanced maintenance practices** leveraging predictive analytics for early detection of issues (medium term). • **Strengthen ash management practices** - Implement high concentration slurry disposal to reduce land requirement for ash dyke (medium term). • **Build technical capacity of workforce** through regular trainings (medium term).
7. All Units: Ensuring Safe Working Condition	
• **Address urgent structural concerns** by implementing priority actions, especially on chimneys and buildings. • **Evaluate civil foundations** of all major equipment and structures, • **Address major fire hazards** such as coal dust, oil spillage, etc. • **Test and rectify** major alarms, smoke detectors, fire fighting systems, etc.	• **Conduct structural surveys** (where not already done) to identify vulnerable areas, and take corrective actions (medium term).

Action Plan (4/4)

Short-term actions (6 months)	Medium (6 months-2 years) / Long-term actions (>2 years)
8. All Units: Enhancing Production and Availability	
• **Improve cost reflectiveness of tariff:** Reintroduce tariff for investment program to enable major maintenance and renovation activities, including requirements under new Ecology Code (emission monitoring system). • **Rationalize heating tariff** with objective to remove cross-subsidies between heat and electricity.	• Establish **output conditions (plant KPIs and emission norms)** for setting tariffs (medium term). • Implement **communication and outreach** strategy for dissemination of the tariff and subsidy reforms plan (medium term).
9. All Units: Capacity and Network Planning	
• Undertake comprehensive least-cost capacity expansion planning study.	• **Implement grid upgrade and balancing power** requirements based on study recommendations (long term).
10. All Units: Just Transition Planning	
• Identify the **affordability levels** for vulnerable section of society.	• Develop **just transition programs** to mitigate social and economic impacts of planned coal phaseout (medium term). • Hold stakeholder meetings and document views on development plans (medium term).

Specific Action Plan for Red Category Plants (1/13)

A total of 19 plants have units classified in the red category. As per the rating methodology, all these units are candidates for phase out. However, during site visits and discussions with stakeholders, it was highlighted that it may not be feasible to phase out these units in the short term. Therefore, some of the actions which may be considered by the respective plants are provided below.

1. RIDDER CHPP

Short term (6 months)

- **All boilers have aged significantly** (5 out of 6 boilers exceed 65 years of operation)
  - Based on site interactions, **boilers 1, 2, and 5** have fully depreciated. Undertake major overhaul* of these boilers for winter operations.
  - Residual life of **boilers 3, 4, and 6** is low. Conduct rapid inspection to identify defects and undertake major / minor overhaul* as per assessment.
- **There are total of 4 turbines** 1, 2, 4, and 5. Turbine 5 was undergoing capital maintenance at the time of visit (February 2023), hence the same should be fast-tracked for timely completion. Further,
  - **Turbines 1, 2, and 4** were not in operation at the time of visit. Conduct rapid inspection of these turbines to identify defects and undertake major / minor overhaul* as per assessment.
- **Last structural survey was conducted in 2016,** and plant does not maintain record of structural damages. Conduct a structural survey and implement critical recommendations to strengthen civil structures.
- **Plant reported multiple failures,** including two accidents in 2023. Emergency response measures to be strengthened including safety training for plant operators. Conduct performance guarantee testing of fire hydrant system, undertake immediate repairs, and ensure it is in working condition.
- **Plant reported there is no long-term supply for spares**. Ensure supply of critical spares for the winter season to mitigate and respond to emergency breakdowns.
- **Plant faced fuel shortages (oil)** recently which affected boiler operations. Secure fuel supply for the short term in advance.

Medium (6 months–2 yrs) & long term (>2 yrs)

- Plan for an alternative capacity for heating in the medium term *(no available alternatives at present).*
- Conduct service life extension of boilers 3, 4, and 6 to ensure extended operation in medium term.
- Prepare a phaseout plan in the long term.

**For details on major and minor overhaul of boilers and turbines, please see the Note at the end of this section*

Specific Action Plan for Red Category Plants (2/13)

2. TEKELISKAYA CHPP-2

Short term (0.5 yrs)	Medium (6 months–2 yrs) & long term (>2 yrs)

• **Plant has 3 boilers over 60 years in age**. Total operating hours of boilers 1, 2, and 3 are 293,108 hours, 298,387 hours, and 297,806 hours, respectively - indicating that they have almost depleted their service life. Hence,
  ▪ Carry out **residual life assessment** for all boilers and **undertake overhaul** (based on key recommendations) to ensure reliable operation in winter season.
• **Plant has 2 turbines over 65 years in age**. Total operating hours of turbines 1 and 2 are 483,445 hours and 391,998 hours, respectively – indicating that they have exhausted their service life (design life is 220,000 hours). Hence,
  ▪ Conduct **immediate inspection and major / minor overhaul** of turbines to ensure reliable operations in winter season.
• **Structural survey highlighted vulnerabilities in chimney (38% physical deterioration). Undertake immediate civil repairs** of chimney including cleaning of internal surfaces, restoration of shaft concrete lining, anti-corrosion treatment of metallic parts, sealing of flue gas leakage conduits, etc.
	• Prepare an action plan for development of new capacity and evaluate the transition to gas in medium term.
	• Prepare a phaseout plan in long term.

3. ALMATY CHPP-3

Short term (0.5 yrs)	Medium (6 months–2 yrs) & long term (>2 yrs)

• **All 6 boilers are of 59 years of age** and have not undergone renovation or life extension. **Conduct hydro tests** for all boilers and **inspection of boiler drums and refractories** for damage / distortions, etc. **Undertake major / minor overhaul** for critical components based on the key findings.
• **Plant reported multiple outages due to abrasive coal**. Following actions may be taken:
  ▪ **Undertake capital overhaul** of coal crusher and milling system, including replacement of grinding materials.
  ▪ Secure supply of high-quality coal for winter months and undertake coal blending to improve fuel quality.
• **Turbines 1 to 4 are 59 years old** and have not undergone any renovation or life extension. **Undertake visual and borescope inspection** of turbines to assess cracks and damages, and undertake major / minor overhaul based on the findings.
• **Structural survey of the plant highlighted vulnerabilities in chimney and cooling tower**. **Undertake immediate civil repairs** of chimney including cleaning of internal surfaces, restoration of shaft concrete lining, anti-corrosion treatment of metallic parts, sealing of flue gas leakage conduits, etc. Similarly, undertake civil repair for cooling towers rectifying all cracks and gaps in the structure.
	• Prepare an action plan for accelerating the transition to gas and fast-track the planned capacity addition in medium term.
	• Prepare a phaseout plan in long term.

Specific Action Plan for Red Category Plants (3/13)

4 . SEMIPALATINSK CHPP-1

Short term (0.5 yrs)	Medium (6 months–2 yrs) & long term (>2 yrs)
• **Boiler 1 is newly constructed while boilers 2 and 3 were reconstructed / modernized around 2015**. However, the plant reported a major issue of 'unburnt carbon'. Hence, following actions may be undertaken: ▪ Undertake **cleaning of boiler tubes** to remove coal deposits on heating surface. ▪ **Inspect heating surfaces** for tube erosion, deformation, or other damages and undertake necessary replacements. ▪ **Address insulation and refractory damages and seal leakages** in fan ducts to improve combustion efficiency. • Based on site interactions, high-pressure heat pipes have fully depreciated. Hence, **undertake immediate replacement of high-pressure pipelines** ahead of winter. • **Plant has 2 turbines**. Turbine 1 was under capital maintenance at the time of site visit - prepare a plan to ensure that maintenance works are completed at the earliest and turbine 1 is available for winter operation. Further, **conduct an overhaul of turbine 2** to ensure it is ready for operation in winter season • Plant reported that bottom ash removal was being done manually**. Overhaul the bottom ash removal system** to make it operational before winter. Also**, conduct filter replacement in electrostatic precipitator** for better emission control.	• Expedite the development of new CHPP of 360 MW in medium term. • Prepare a phaseout plan in long term.

5. SHAKHTINSK SHTEC

Short term (0.5 yrs)	Medium (6 months–2 yrs) & long term (>2 yrs)
• Plant has 3 boilers (no. 1, 3, and 4) commissioned in 1960s. Life extension measures were taken in 2021–2022; however, service life was extended only till 2025 for boiler 1 and till 2024 for boilers 3 and 4. Hence, **undertake minor overhaul of the boilers** for winter operations. • Plant has 3 turbines out of which only 2 are currently operational**.** As these turbines are over 40 years old, **undertake visual and borescope inspection of turbines** to assess cracks and damages and undertake immediate overhaul based on the findings. • **Structural survey indicated emergency state of the chimney. Undertake immediate civil repairs** of chimney including cleaning of internal surfaces, restoration of shaft concrete lining, anti-corrosion treatment of metallic parts, sealing of flue gas leakage conduits, etc. • Surveys have also highlighted that buildings have physically exhausted their resource and pose a safety risk. **Evaluate civil foundation and structural integrity of major equipment and building**, and carry out repairs and strengthening measures.	• Plan for an alternative capacity for heating in the medium term (no available alternatives at present). • Prepare a phaseout plan in long term.

Specific Action Plan for Red Category Plants (4/13)

6. PAVLODAR CHPP-2

Short term (0.5 yrs)	Medium (6 months–2 yrs) & long term (>2 yrs)
• **Plant has 5 boilers (~60 years in age).** Residual life assessment has been conducted, with following results: ▪ Service life of boiler 1 extended till August 2024. ▪ Service life of boiler 2 extended till October 2026. ▪ Total operating hours of boiler 3 is 322,583 hours (exhausted its service life). ▪ Service life of boilers 4 and 5 extended till June and November 2025, respectively. As service life has been extended for most of the boilers, **undertake minor overhaul as per requirement.** • **Plant has 3 turbines over 60 years in age**. They have not undergone any renovation. Residual life assessment conducted, with following results: ▪ Total operating hours of turbine 1 is 389,826 hours, turbine 2 is 394,549 hours, and turbine 3 is 414,276 hours (all turbines have exhausted service life). ▪ Last capital maintenance of turbine 1 was conducted in April 2021, turbine 2 in July 2019, and turbine 3 in July 2020. ▪ Hence, in the short term, conduct visual and borescope inspection and undertake **major / minor overhaul of turbines 2 and 3** as per requirement ▪ Conduct **inspection and regular maintenance** of turbine 1 to ensure uninterrupted operations in winter season.	• Prepare an action plan for development of new capacity and fast-track the same in medium term. • Prepare a phaseout plan in long term.

7. SHYMKENT CHPP-3

Short term (0.5 yrs)	Medium (6 months–2 yrs) & long term (>2 yrs)
• **All 3 boilers and 2 turbines are over 40 years in age** and have not undergone any renovation. Site interactions indicated 20,000 hours of residual operation of these equipment; however, a detailed residual life assessment report was not available. Hence, **conduct immediate inspection** of boilers and turbines through hydro tests, visual inspection, etc., to identify critical areas for overhaul. ▪ Based on the findings, **undertake major / minor boiler overhaul** including replacement of heating surfaces, fixing of refractory and insulation damages, cleaning of boiler tubes, etc. ▪ **Undertake major / minor overhaul of turbines** based on the inspection results, focusing on condition of turbine blades, bearings, and governor valves. • **Plant reported difficulties in running at rated capacity due to gas deficit**. Secure supply of gas and strengthen the pipeline infrastructure to ensure continued operation in the winter season. • Undertake measures to address insulation damages, leakages, coal dust accumulation, and other aspects.	• Fast-track the capacity expansion project *(installation of 2 gas turbines and one boiler)* in medium term. • Prepare a phaseout plan in long term.

Specific Action Plan for Red Category Plants (5/13)

8. KAZATOMPROM CHPP-1

Short term (0.5 yrs)	Medium (6 months–2 yrs) & long term (>2 yrs)

• **All 4 boilers have aged significantly** (exceeded **57 years** of operation):
  ▪ **Residual life of boilers 1, 2, and 3 is low** and the plant reported a **wear rate of 66.7%, 57.1%, and 45.9%, respectively**. For these boilers, **undertake rapid inspection** to identify major defects and carry out immediate repairs on the same.
  ▪ Based on site interactions, **boiler 4 has almost exhausted its residual life** and has reported **88.6% wear**. The last major overhaul of boiler 4 was conducted in 2015 and the plant is currently undertaking feasibility study for modernizing boiler 4. Fast-track this study and take necessary action as per findings.
• **All 4 turbines** of the power plant are **more than 60 years old**:
  ▪ **Turbines 1 and 2 have almost exhausted their residual life** and have reported **wear of 93.7% and 92%, respectively**. **Undertake major overhaul of these turbines** for reliable operation.
  ▪ **Turbine 3 of the plant reported wear of 69.7%.** However, the plant had reported that all turbines are facing load limitations due to wear of parts in the flow path. It is recommended that **turbine 3 also undergoes major overhaul** due to the reported issues.
• The last structural survey was conducted in 2022, and the plant does not maintain a record of structural damages. The buildings and civil structures need reinforcement as per the recommendations of the last structural survey.
• Undertake a comprehensive investigation to determine the reason for high shutdowns in the plant (24 in the last 5 years) and deploy measures to avoid such cases. Emergency response measures need to be strengthened including safety training for plant operators as well adequate stocks of emergency spares to minimize downtime.
	• Plan for alternative capacity in medium term, and fast-track its development.
	• Prepare a phaseout plan in long term.

Specific Action Plan for Red Category Plants (6/13)

9. KAZATOMPROM CHPP-2

Short term (0.5 yrs)	Medium (6 months–2 yrs) & long term (>2 yrs)
• Plant has 13 boilers, of which 3 have been decommissioned. All boilers have exceeded 40 years of age with 8 boilers exceeding 50 years. The average wear rate of boilers is 84%. ▪ **Boilers 11 and 13** reported wear of 66% and 72%, respectively. **Undertake rapid inspection** of these boilers to identify major defects, and undertake immediate repairs on the same. ▪ **Boiler 6** also reported wear of 75%. However, **major overhaul is recommended** as the last capital repair was conducted in 2015. ▪ **Boilers 1–4, 7, 8, and 12** reported wear rate of over 80%. **Undertake major overhaul** of these boilers for reliable operation during winter season. ▪ Defects were observed in the high-pressure pipelines of the boilers. It is necessary to undertake a study to determine the adequacy of current boiler structural support and resolve the same. • Plant has 10 turbines of which 1 is nonoperational. All turbines have exceeded 40 years of age and turbine 7 is under conservation. The average wear rate is 89%. ▪ **Turbines 5 and 6** reported wear of 65% each. A **major overhaul may be conducted** for these turbines as the last capital repairs for these turbines were conducted in 2015 and 2017, respectively. ▪ **Turbines 2, 3, 8, and 9** have almost exhausted their residual life and have reported wear of over 95%. Furthermore, turbines 1 and 10 have exhausted their residual life. **Undertake immediate major overhaul** of these turbines for reliable operation during winter season. ▪ Plant reported load limitation on the turbines due to wear in the flow path. The same is to be investigated and repaired along with condenser tubes during the overhaul / inspections. • The last structural survey was conducted in 2022, and the plant does not maintain a record of structural damages. The buildings and civil structures need reinforcement as per the recommendations of the last structural survey	• Plan for alternative capacity in medium term, and fast-track its development. • Prepare a phaseout plan in the long term.

Specific Action Plan for Red Category Plants (7/13)

10. APEC (ARKALYK)

Short term (0.5 yrs)

- Plant has 1 boiler that is 60 years of age and 1 turbine that is 62 years of age. Further, no renovation or service life extension of the boilers and turbines has been conducted.
  - **Undertake rapid inspection and repairs** of the boiler and turbine to ensure safe and reliable operations in the winter period.
- The last structural survey was conducted in 2018 and the plant does not maintain log of structural damages / incidents. During the site visit, it was observed that the civil structures and buildings had extensive damage and need renovation. It is necessary to immediately **undertake a survey of buildings and do repairs** as necessary to avoid safety hazards.
- Undertake measures to **address insulation damages, leakages, coal dust accumulation,** and other aspects.

Medium (6 months–2 yrs) & long term (>2 yrs)

- During site visit, it was noted that plant is commissioning new boilers and steam turbines. Fast-track the development of same in medium term.
- Plan for phaseout of older units in long term.

11. ALMATY CHPP-1

Short term (0.5 yrs)

- **Plant has 6 boilers, exceeding 55 years in age**. The plant has indicated that one of the boilers has a service life of 25,000 hours remaining; however, detailed assessment is not provided for other boilers. Hence, **conduct a residual life assessment for each of the boilers** to determine the remaining life, and **undertake necessary overhaul** based on findings
- Plant has 3 turbines. Turbines 1 and 2 have exceeded 50 years of age while turbine 3 is 27 years of age.
  - Considering the age of **turbines 1 and 2**, **undertake immediate major overhaul** for reliable operation during winter season.
  - For **turbine 3**, **conduct rapid inspection** to ensure safe and reliable operations followed by a **residual life assessment** to determine useful life.
- **Rusting of pipes and equipment** was observed throughout the plant. **Immediate rectification** actions are to be undertaken to ensure integrity of equipment and continuity of operations.

Medium (6 months–2 yrs) & long term (>2 yrs)

- Prepare an action plan for development of new capacity and fast-track the same in medium term.
- Prepare a phaseout plan in long term.

Specific Action Plan for Red Category Plants (8/13)

12. KARAGANDA CHPP-1

Short term (0.5 yrs)	Medium (6 months–2 yrs) & long term (>2 yrs)

• **Plant has 8 boilers exceeding 54 years in age**. **Undertake major overhaul of all boilers** in the short run to ensure reliable operations in winter.
• **Plant has 4 turbines** of which turbines 2, 3, and 5 are around 60 years of age and turbine 4 was renovated in 2016.
  ▪ Plant reported that **turbines 2, 3, and 5** have already exhausted their residual life. **Undertake major overhaul** of these turbines for reliable operation during winter season.
  ▪ **Turbine 4** was renovated in 2016. The plant **may conduct rapid inspection** for the turbine and implement major / minor overhaul to ensure safe and reliable operations for the upcoming winter season.
• Plant has reported several emergency shutdowns in the last 5 years. The plant may **ensure supply of critical spares** for the winter season to mitigate and respond to emergency breakdowns.
	• Prepare an action plan for development of new capacity and fast-track the same in medium term.
	• Prepare a phaseout plan in long term.

13. MAIN DISTRIBUTION POWER PLANT TOPAR

Short term (0.5 yrs)	Medium (6 months–2 yrs) & long term (>2 yrs)

• **Plant has 16 boilers of which 15 are over 55 years in age** and have not undergone any renovation. Only boiler 3 underwent renovation in 2016 while others have almost depleted their service life. Actions may include the following:
  ▪ **Capital maintenance of boilers 7, 8, 9, 11, 12, 13, 14, and 15** was done between 2015 and 2018 – these boilers are now due for overhaul. Conduct rapid inspection, including hydro test of these boilers, and undertake overhaul as per findings.
  ▪ For other boilers, undertake rapid inspection to identify major defects and **carry out immediate repairs** on same.
• **Plant has 7 turbines, of which 5 are over 55 years** in age and have not undergone any renovation. Actions may include the following:
  ▪ **Capital maintenance of turbines 4, 5, 7, and 8** was done between 2015 and 2018 - these turbines are now due for overhaul. Conduct rapid inspection and major / minor overhaul of these turbines (as per assessment) ahead of winter operation.
  ▪ For other turbines**, undertake rapid inspection** to identify major defects and carry out immediate repairs on the same.
▪ Ash storage pond was found to be over 90% full. **Accelerate the construction of 5th ash pond** as well as explore high slurry concentrate disposal of ash to minimize the water utilization (which will help increase the storage capacity of ash pond).
	• Plan for alternative capacity in medium term, including life extension or modernization of units.
	• Prepare a phaseout plan for other units in long term.

Specific Action Plan for Red Category Plants (9/13)

14. ZHEZKAZGAN CHPP

Short term (0.5 yrs)

- **Plant has seven boilers** (boilers 4, 5, 6, 7, 8, 9, and 11). Six of the boilers have surpassed 50 years of operation and have not undergone any reconstruction or modernization.
  - Based on site interactions, **boilers 4 to 9** have low residual life. **Undertake major overhaul** for these boilers for winter operations. Capital repair of boilers 7, 8, and 9 was last done in 2018–2019; hence, these boilers may be taken up in priority.
  - Conduct **residual life assessment for boiler 7** and carry out necessary repairs based on the findings.
- **Plant has 5 turbines** (turbines 4, 5, 6, 7, and 8), of which 3 have surpassed 50 years of operation and have not undergone any reconstruction and modernization.
  - Based on site interactions, **turbines 5, 6, and 7** have low residual life. **Undertake major overhaul** for these turbines for winter operations. Capital repair of all these turbines is due as they were last conducted in 2018–2019.
  - Conduct immediate repairs and maintenance of turbines 4 and 8.

Medium (6 months–2 yrs) & long term (>2 yrs)

- Prepare action plan for development of new capacity, including life extension and modernization of units. Fast-track in medium term.
- Prepare a phaseout plan for other units in long term.

15. PETROPAVLOVSKAYA CHPP-2

Short term (0.5 yrs)

- Plant has 12 boilers. **Boilers 6, 7, 8, and 12 were renovated in 2016**, while **boilers 1, 2, 3, 4, and 5 have exhausted their service life**.
  - Conduct **immediate inspection of boilers 1 to 5** to identify areas of critical repair and undertake **major / minor overhaul** for winter operations.
  - Carry out **residual life assessment for boilers 9, 10, and 11** and **undertake overhaul** (based on key recommendations) to ensure reliable operation by winter season.
  - Accelerate the **planned preventive repairs** for boilers 6, 7, 8, and 12 for timely completion before winter.
- Plant has 7 turbines. **Turbines 1, 4, and 5 were renovated in 2016**, while **turbines 3, 6, and 7 have exhausted their service life.**
  - Conduct **immediate inspection and major / minor overhaul of turbines 3, 6, and 7** for winter operation.
  - Carry out **residual life assessment for turbine 2,** and undertake overhaul based on findings.
  - Accelerate the **planned preventive repairs** for turbines 1, 4, and 5.
  - Further, examine and implement methods to improve the capacity utilization factor for turbines 1, 3, and 5 (reported capacity utilization factor for the plant was ~57%).
- Emergency response measures to be strengthened including safety training for plant operators. Conduct a performance guarantee testing of fire hydrant system, undertake immediate repairs, and ensure it is in working condition.

Medium (6 months–2 yrs) & long term (>2 yrs)

- Based on the outcomes of residual life assessment, undertake life extension or modernization of units in medium term.
- Prepare a phaseout plan for other units in long term.

Specific Action Plan for Red Category Plants (10/13)

16. BALKHASH CHPP

Short term (0.5 yrs)	Medium (6 months–2 yrs) & long term (>2 yrs)

• **Plant has 4 boilers** (boilers 6, 7, 8, and 9), all of which have surpassed 59 years of operations.
  ▪ **Undertake major overhaul** for these boilers for winter operations. Capital repair of boiler 6 was last done in 2019; hence, it may be taken up in priority.
• **Plant has 4 turbines** (turbines 2, 3, 6, and 7), of which 2 have surpassed 60 years of operation.
  ▪ **Turbines 6 and 7** have exceeded 60 years in age and their capital repairs are due (last conducted in 2018 and 2016). **Undertake major overhaul** of these turbines for winter operations.
  ▪ Conduct **immediate repairs and maintenance of turbines 2 and 3.**
	• Prepare an action plan for development of new capacity, including life extension and modernization of units.
	• Prepare a phaseout plan for other units in long term.

17. STEPNOGORSK CHPP

Short term (0.5 yrs)	Medium (6 months–2 yrs) & long term (>2 yrs)

• **Plant has 6 boilers, and all are over 40 years in age**. Conduct residual life assessment of boilers to assess the service life and undertake the major recommendations. Following actions may be undertaken:
  ▪ Assessment of outage data indicates that **energy boilers 5, 6, and 7 faced maximum number of failures in 2022**, including an accident in boiler 7. Hence, undertake major overhaul of these boilers in the short run for winter operations.
  ▪ **Conduct rapid inspection** for other boilers and implement major / minor overhaul based on the findings.
  ▪ Undertake investigation to determine reason for high accidents in boilers (particularly boilers 5, 6, and 7 with reported 10+ accidents in 2022).
• **Plant has 5 turbines** wherein,
  ▪ **Turbine 5** is over 40 years in age. Conduct major overhaul for winter operations.
  ▪ Conduct **residual life assessment of turbines 3 and 4** and undertake necessary overhaul.
  ▪ **Turbines 1 and 2** underwent life extension of 25,000 hours in 2017 and 2021, respectively. Undertake **planned preventive repairs** for these turbines.
  ▪ Further, investigate reasons for low-capacity utilization of turbines 1 (reported as 39%) and 4 (reported as 15.3%) and implement measures to improve the utilization.
  ▪ Undertake a comprehensive investigation to determine the reason for high accidents in turbines (particularly turbines 1, 2, and 4) and deploy measures to avoid such cases.
▪ It was reported by the plant that the spares level is low (reserves of 10%). It is recommended that spares capacity of critical equipment is increased to avoid delays and subsequent outages.
	• Prepare an action plan for development of new capacity and fast-track the same in medium term.
	• Prepare a phaseout plan for other units in long term.

Specific Action Plan for Red Category Plants (11/13)

18. ASTANA CHPP-2

Short term (0.5 yrs)	Medium (6 months–2 yrs) & long term (>2 yrs)

• **Plant has 14 boilers**. Boilers 1 and 2 have exceeded 40 years in age; boilers 3, 4, and 5 have exceeded 30 years in age; boilers 6 to 14 are less than 25 years.
  ▪ Carry out **residual life assessment for boilers 1 to 5 and undertake major / minor overhaul** (based on key recommendations) to ensure reliable operation by winter season.
  ▪ Accelerate the **planned preventive repairs** for boilers 6 to 14 for timely completion before winter.
• **Plant has 6 turbines**. Turbines 1 and 2 have exceeded 40 years in age, turbine 3 has exceeded 30 years in age, and turbines 4–6 are less than 25 years.
  ▪ Against the standard design life of 220,000 hours - **turbine 1** has operated more than 309,000 hours, **turbine 2** has operated more than 297,000 hours, and **turbine 3** has operated more than 271,000 hours. Hence, conduct major overhaul of these turbines for winter operations.
  ▪ For turbines 4–6, accelerate the **planned preventive repairs** for timely completion before winter.
• **Ash dump number 1 is currently 95–98% full**. To avoid any potential issues, it is imperative to expedite the construction of new ash dump. Further, the plant may explore high slurry concentrate disposal of ash to minimize the water utilization (which will help increase the storage capacity of ash pond).
• **Based on a structural survey, it was observed that the metal structures of the main body have undergone wear up to 50–60%.** The smoke exhaust compartment has been assessed as pre-emergency, whereas the floor slabs of the turbine compartment and wall panels are in an emergency condition. Undertake immediate civil repairs and strengthening of key structures and buildings.
	• Prepare an action plan for development of new capacity, including life extension and modernization of units. Fast-track the same in medium term.
	• Prepare a phaseout plan for other units in long term.

Specific Action Plan for Red Category Plants (12/13)

19. ATYRAU CHPP

Short term (0.5 yrs)	Medium (6 months–2 yrs) & long term (>2 yrs)
• **Plant has 14 boilers,** of which boilers 1 to 7 have exceeded 50 years of age, boilers 8 and 9 have exceeded 40 years of age, boiler 10 is 38 years old, and boilers 11 to 14 are less than 25 years in age. ▪ **Boilers 1 and 2** have reported wear rate of ~40% each. **Undertake rapid inspection** of the boilers to identify defects and **undertake overhaul as per requirement.** ▪ **Boilers 3 to 9** have reported **wear in excess of 80%. Undertake major overhaul** of these boilers for reliable operation during winter season. ▪ **Boiler 10** has reported wear of 71.7%. **Undertake rapid inspection** to identify major defects and **undertake necessary repairs** on the same. ▪ **Boilers 11 to 14** are relatively new and have been operational for less than 100,000 hours. It is recommended that the plant continues operation of these boilers and **undertake annual and capital repairs as per the regular schedule.** • **Plant has 12 turbine units**. Turbines 1, 3, 4, and 5 had undergone R&M in 2012, 1992, 2014, and 2018, respectively. Turbines 2, 6, and 7 have exceeded 45 years of age. Turbines 8 to 12 are less than 25 years in age. ▪ **Turbines 2, 5, and 12** have reported wear of less than 25%. Undertake annual and capital repairs for these turbines as per the planned schedule. ▪ **Turbines 1, 8, 9, and 10** have running hours of less than 100,000 hours and have reported wear of less than 40%. **Undertake rapid inspection** of these to identify major defects and **undertake immediate repairs** on the same. ▪ **Turbines 3 and 4** have almost exhausted their residual life and have reported wear of 80% and 70%, respectively. **Undertake major overhaul** of these turbines for reliable operation during winter season. ▪ **Turbines 6 and 7** have exhausted their residual life and are in critical situation. The plant may consider phasing out of these power plants in the short run depending on the generation schedule requirements. If required to run, the plant may **undertake immediate major overhaul** of these turbines for reliable and safe operation during winter season. • Plant reported a decrease in the level of Zharyk river which is the main water source. This will lead to a reduction in the availability of water, which might interrupt reliable operations. It is imperative that the power plant identifies alternative water sources and implements measures to ensure the availability of adequate water. • Plant has reported 31 emergency shutdowns in the last 5 years. Analyze the root cause of these shutdowns, develop required standard operating procedures for such shutdowns, provide training to operators toward emergency response, and ensure supply of critical spares for the winter season to mitigate and respond to emergency breakdowns.	• Prepare an action plan for development of new capacity, including life extension and modernization of units. Fast-track the same in medium term. • Prepare a phaseout plan for other units in long term.

Specific Action Plan for Red Category Plants (13/13)

Site observations have highlighted instances of leakages, coal dust, refractory and insulation damages, etc., across the plants. Hence, addressing these defects will be an important short-term measure for the power plants. Further, plants may also conduct routine repair and maintenance of auxiliary equipment and balance of plant systems and strengthen operation and maintenance for efficient performance.

Overhaul of Boilers:

1. Minor overhaul of the boiler will involve activities such as hydraulic testing of the boiler and tubes, inspection of boiler drum for damage / distortions, water jet cleaning of furnace, repairing of leaks, inspection and repairing of refractory, servicing of coal mill (for coal plants), testing of bag filters / ESP or wet scrubbers and repairing of safety valves, repairing of insulation damages and other activities, as recommended by the boiler OE.
2. Major overhaul of the boiler will involve activities such as inspection of boiler drum interior for damages and sludge; thickness testing of the boilers and boiler tubes using ultrasound testing or other nondestructive testing (NDT) methods; assessment of short- and long-term overheating including creep and fatigue damages on boiler equipment such as superheater, reheaters , water wall evaporators , drum mountings, all inlet and outlet headers and economizer; testing of the boiler heating surfaces for damages and replacement if necessary; inspection of the refractory for damage and replacement; testing and service of various safety and control valves; testing and repair of soot blowing system; inspection and servicing of various boiler fans including their oil and cooling system; service and recalibration of various measurement gauges; and other activities as recommended by the OEM.

Overhaul of Turbines:

1. Minor overhaul of the steam turbine will include visual inspection of valves, seals, gearbox, etc.; borescope inspection for turbine blades to assess cracks and damage; checking of turbine last stage blades for corrosion and erosion; inspection of bearing and oil seals; review of operational data including steam consumption, operating parameters, and number of trips; and other activities as recommended by the OEM.
2. Major overhaul of the steam turbine will involve activities such as inspection of the turbine casing for damages; lifting and inspection of the rotor for damages; check of turbine blades for smoothness, corrosion, and erosion; inspection of internal clearances and alignment of rotor; monitoring and replacement of bearings, oil seals, gland clearances, and valves; replacement / repair of casing insulation; replacement of spare parts; draining and refilling of oils; inspection of the generator, excitation system, and electrical tests on the generator; and other activities as recommended by the OEM like generator side testing of polarity, resistance, and other characteristics of the windings and excitation systems including all breakers/ protection relays / governing system, etc.

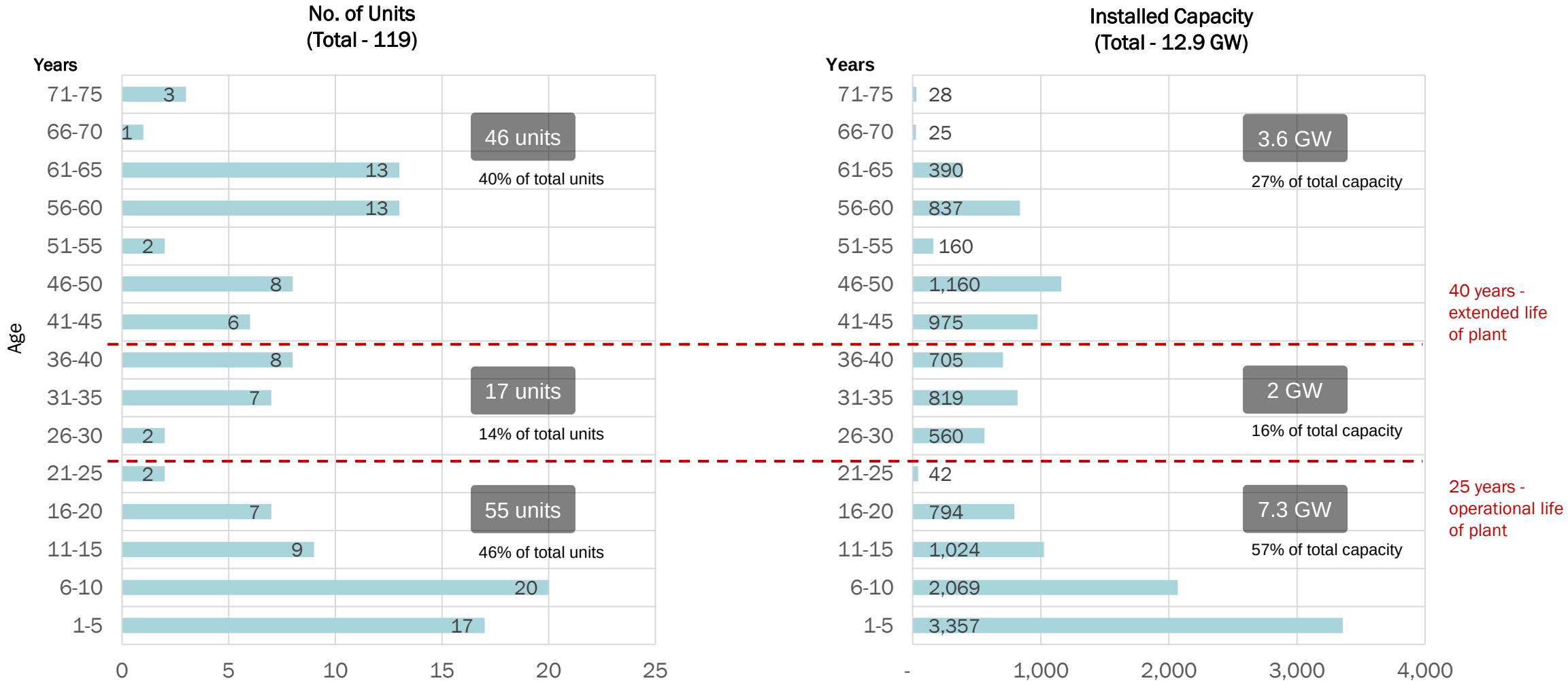
Structural Repair of Chimney:

1. Structural repair of the chimney through activities such as cleaning of the internal surfaces, restoration of protective concrete lining of the chimney shaft, cleaning and anti-corrosion treatment of metallic parts, sealing of flue gas leakage conduits, sealing of gas ducts, and other additional repair works as recommended by the chimney inspection report.

Annexure 1 – Aging and Performance Analysis

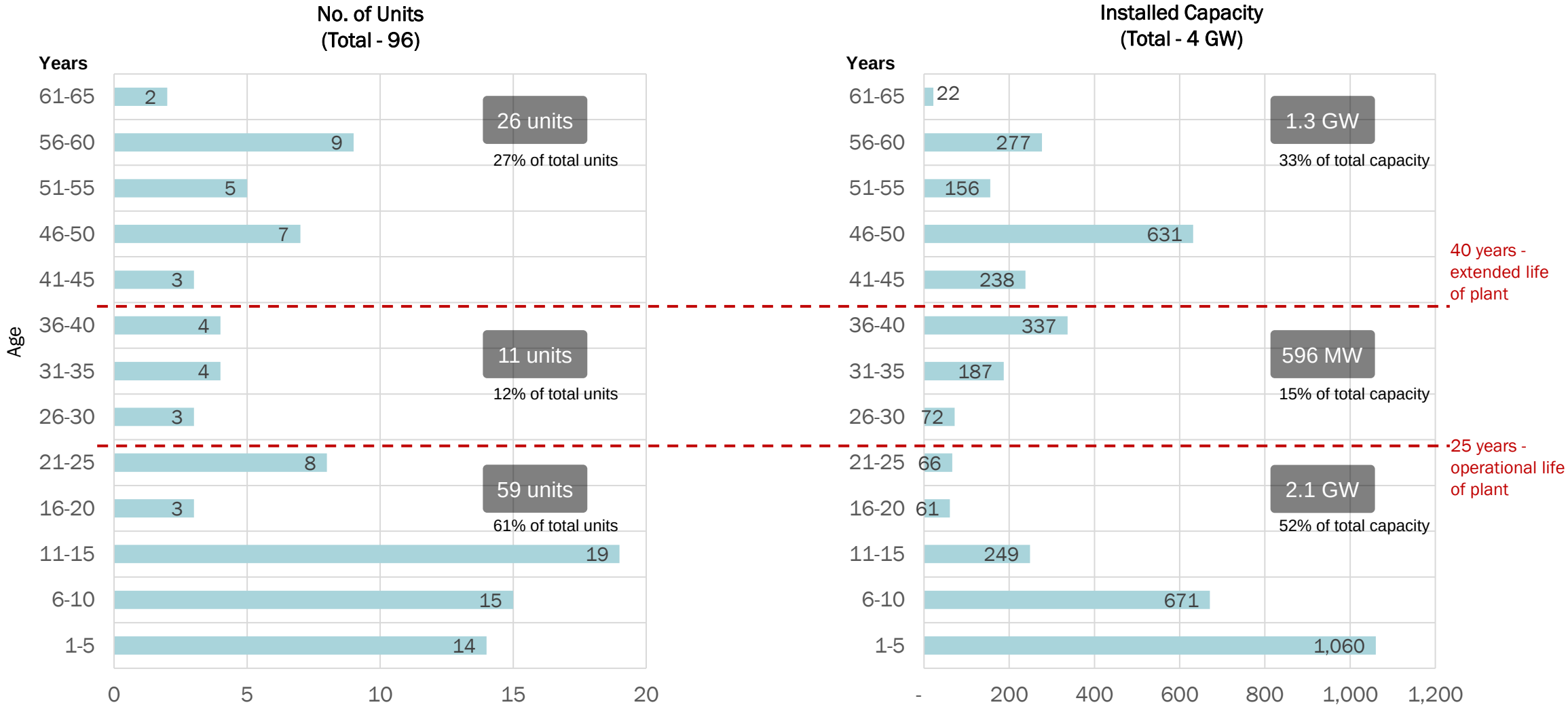
Aging Analysis for Coal Plants - ~40% of coal units exceed 40 years of operational life; this translates to 3.6 GW capacity

Out of the total 5.3 GW capacity over 40 years, coal plants contribute to majority share – 3.6 GW (68%) of coal plants exceed 40 years of operations.



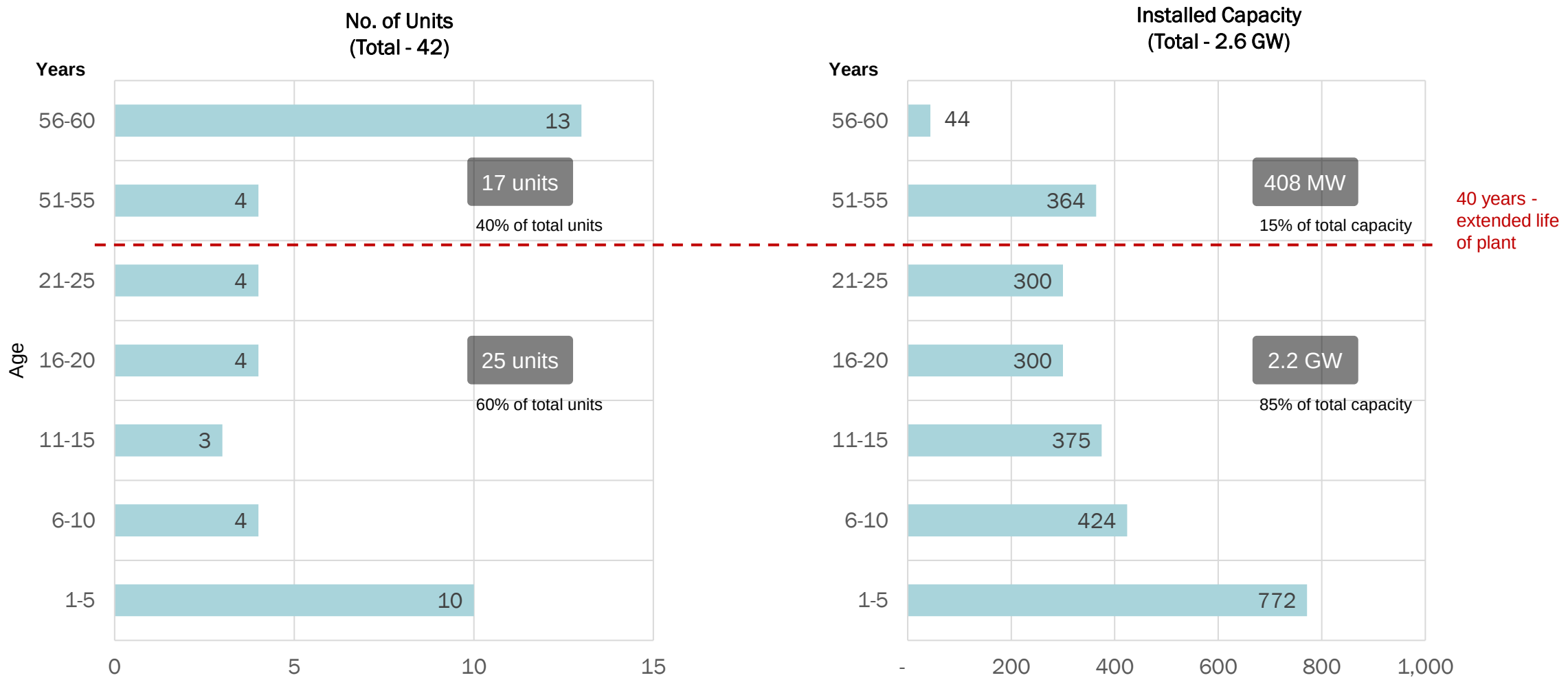
Aging Analysis for Gas Plants - 27% of gas units exceed 40 years of operational life; this translates to 1.3 GW capacity

Out of the total 5.3 GW capacity over 40 years, gas plants contribute to 25% (or 1.3 GW).



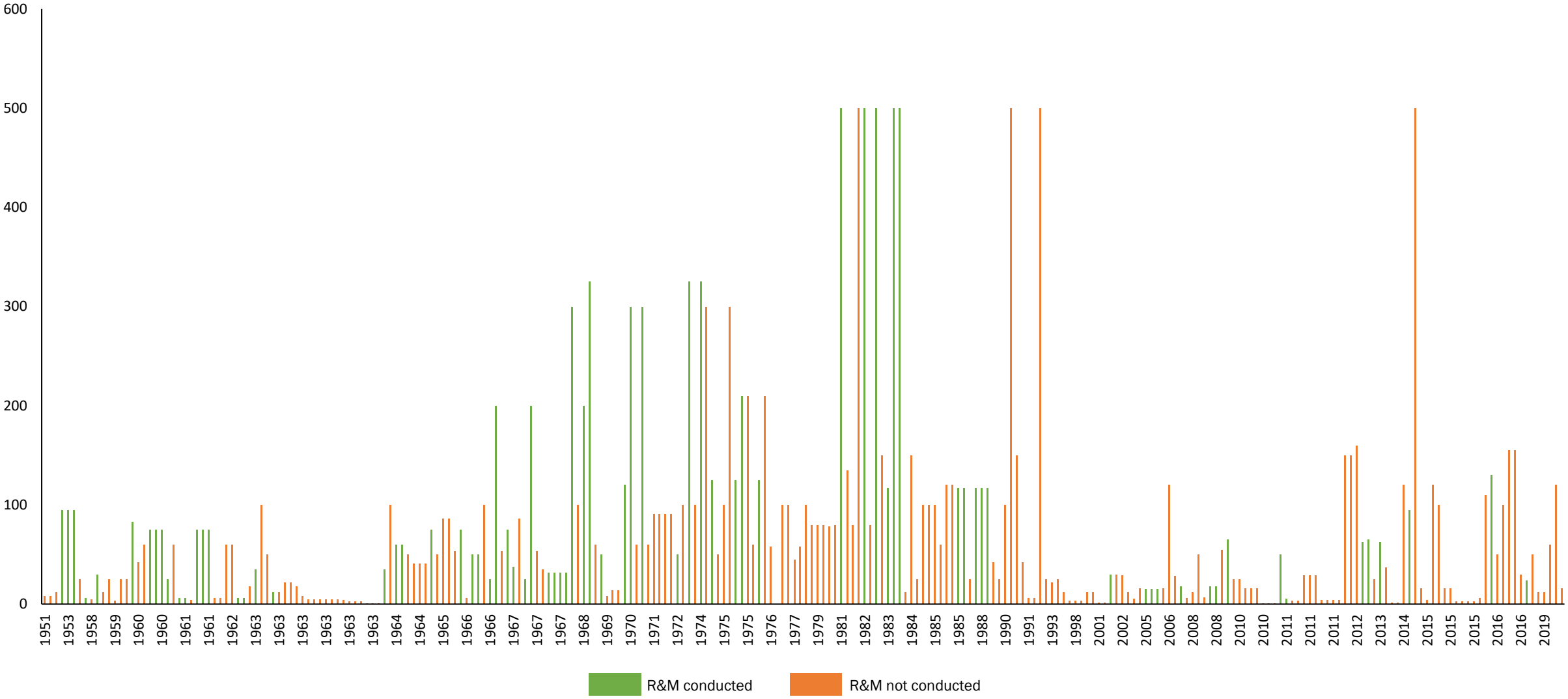
Aging Analysis for Hydro Plants - 40% of units exceed 40 years of operational life; this translates to 408 MW capacity

Out of the total 5.3 GW capacity over 40 years, hydro plants contribute to only 8% (or 408 MW).



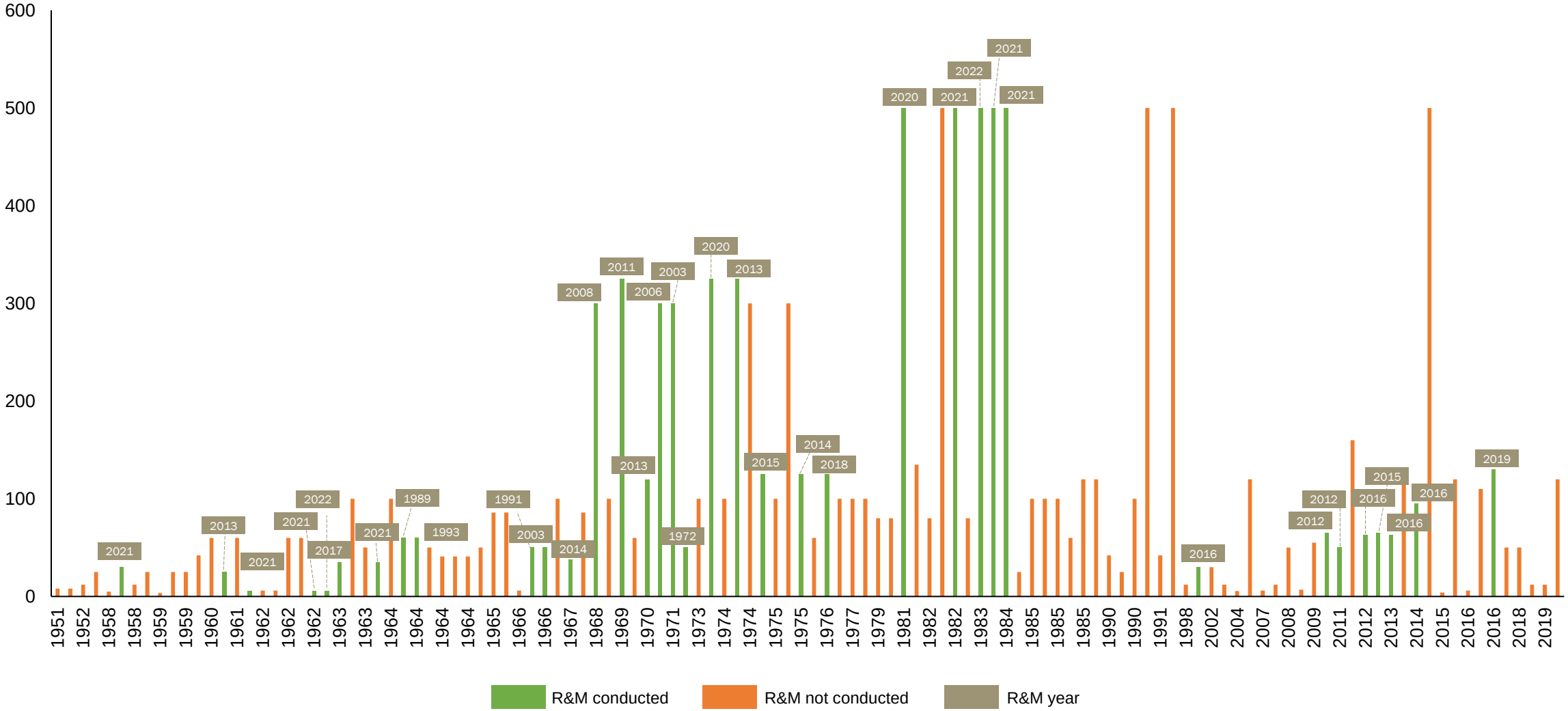
Annual Capacity Addition (MW) - All Units

Majority of the larger-size units have undergone R&M works - out of 23 units which are >= 200 MW, 65% have undergone R&M.



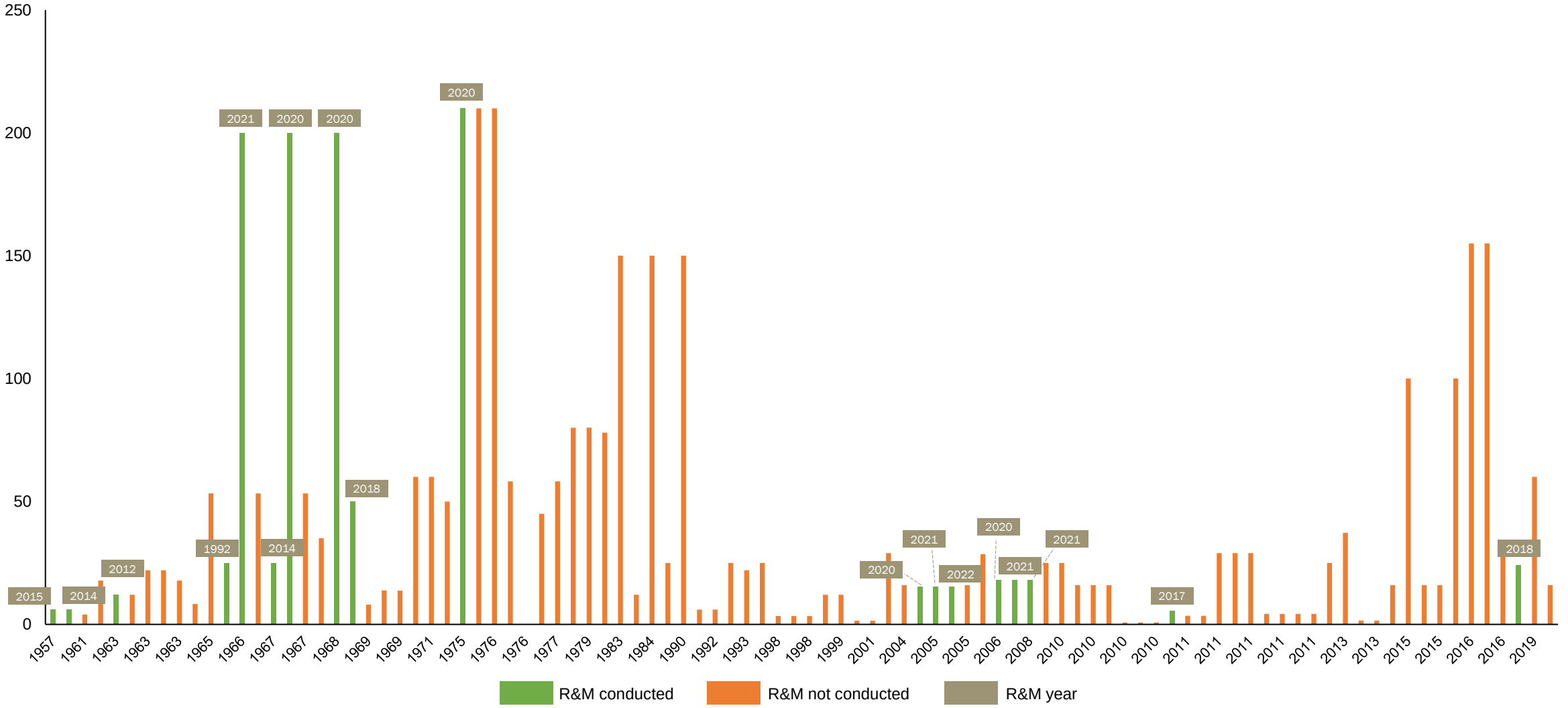
Annual Capacity Addition (MW) - Coal Units

Majority of the larger-size units have undergone R&M works – out of 18 units which are >= 150 MW, 11 units (61%) have undergone R&M.



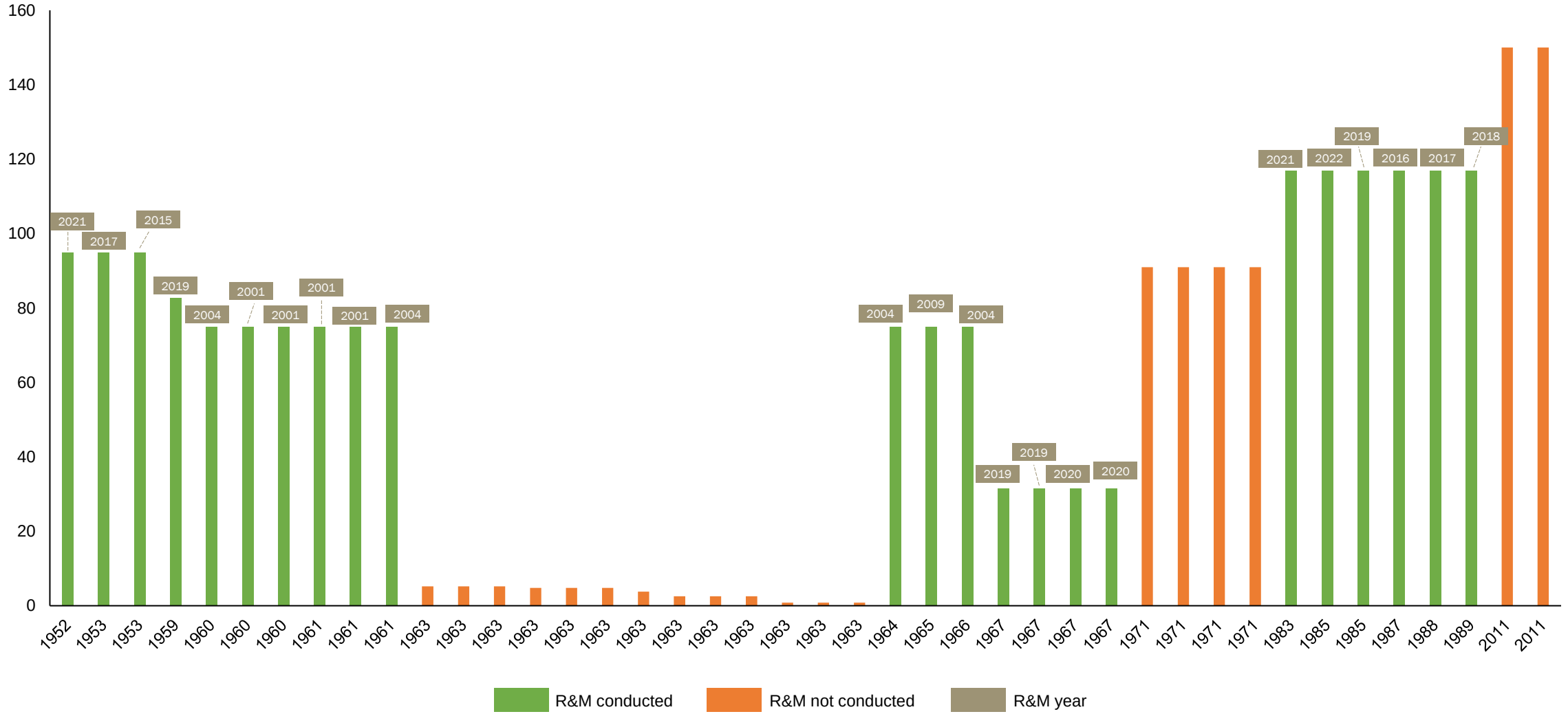
Annual Capacity Addition (MW) - Gas Units

Most of the newly installed units are relatively smaller in capacity



Annual Capacity Addition (MW) - Hydro Units

Majority of hydro units have undertaken modernization works.



Assumptions and Data Gaps (1/3)

Document	Status*
Questionnaire 1 (containing information on Organizational structure, station, major assets, fuel, station operation, operation and maintenance practices, environment, health and safety practices, data management system, etc.)	• Received from 57 plants. • Not all plants shared filled questionnaire template 1. Out of 27 coal plants, 23 have provided information on all these parameters. 2. 21 out of the 23 gas plants have provided data on specific fuel consumption for electrical energy. However, data on specific fuel consumption for heat is only available for 11 plants. 3. 2 of 7 hydro plants have provided information for the listed parameters. • A follow-up email requesting the information or attachment missing in the initial response to Questionnaire 1 was sent out in February. • Response to the follow-up email addressing the information gaps was shared by 10 power plants.
Questionnaire 2 - Data List (containing information on equipment-wise efficiency, losses, runtime, load ramp rate, hot and cold startups, and overall plant-level information on EPC schedule for replacements, major failures, fuel details, steam water chemistry, etc.)	• Received from 9 power plants.
Document list (Documents related to residual life assessment, renovation and modernization, environment and emission assessment report, safety assessment report, performance guarantee (PG) test, major failures or trip accidents report/ records, building stability tests, etc.)	• Received from 11 power plants.

* Status as on 31.03.2023

Assumptions and Data Gaps (2/3)

- Out of the 58 plants covered in the study:
    - No input has been received from ARCELORMittal Temirtau JSC, CHPP-PVS. Hence, this plant has been excluded from the overall analysis.
    - Performance-related data has not been shared by LLP "Shakhtinskteploenergo" SHTEC, PAVLODARENERGO JSC CHPP-2, CHPP-3, Karabatan Utility Solutions LLP CCGT, and "OralMunayProm" LLP GPES Zhanaozen.
- For aging analysis:
    - In light of cross-connected boiler and turbine systems, the analysis considers the age of turbo-generator units to ensure consistency across plants.
- For performance analysis:
    - Discrepancies were observed in data submitted by some plants. For instance, in some cases the figure shared for specific fuel consumption was not commensurate with the electricity generation and fuel consumption figures shared separately.
    - In above case, while we have noted the discrepancy, we have considered the input value provided by the plants.

Assumptions and Data Gaps (3/3)

- As part of performance analysis for coal and gas plants, following key parameters were looked into detail:
    - Specific Fuel Consumption for Electrical Energy (kg/kWh)
    - Specific Fuel Consumption for Thermal Energy (kg/Gcal)
- Most of the thermal plants have provided information on these parameters
    - Out of 27 coal plants, 23 have provided information on all these parameters.
    - 21 out of the 23 gas plants have provided data on specific fuel consumption for electrical energy. However, data on specific fuel consumption for heat is only available for 11 plants*.
- Performance analysis for the seven hydro plants has been done on the basis of following parameters:
    - Specific Water Consumption (m^3/kWh); *this was provided by 2 plants*
    - Flow Rate (m^3/s); *provided by 4 plants*
- In addition to above, other available parameters were also considered wherever possible. For instance, data on **auxiliary consumption** was also taken into account for deeper analysis.

**For some gas plants, specific fuel consumption for heat may not be applicable as they only generate electricity.*

Annexure 2 – List of Power Plant Visits

List of Power Plants Covered in the Site Visits (1/5)

Sl. No.	Power plant	Zone	Date of visit	Ownership	Capacity (MW)
1	LLP "Ekibastuz GRES-1 named after B. Nurzhanov"	Northern	5-Dec-2022	Private	3,500
2	JSC "Station Ekibastuz GRES-2"	Northern	6-Dec-2022	Public	1,000
3	JSC "Eurasian Energy Corporation" Aksu State District Plant	Northern	7-Dec-2022	Private	2,475
4	PAVLODARENERGO JSC CHPP-3	Northern	8-Dec-2022	Private	555
5	Stepnogorsk CHPP LLP	Northern	27-Jan-2023	Private	180
6	Ust-Kamenogorsk CHPP LLP	Northern	30-Jan-2023	Private	372.5
7	Karaganda Energocenter LLP CHPP-3	Northern	30-Jan-2023	Private	670
8	Sogrinskaya CHPP LLP	Northern	31-Jan-2023	Private	75
9	Karaganda Energocenter LLP CHPP-1	Northern	31-Jan-2023	Private	24
10	UST-Kamenogorsk HPP LLP	Northern	1-Feb-2023	Public	367.8
11	ARCELORMittal Temirtau JSC CHPP-2	Northern	1-Feb-2023	Private	435
12	JSC "Ridder CHPP"	Northern	2-Feb-2023	Private	59

List of Power Plants Covered in the Site Visits (2/5)

Sl. No.	Power plant	Zone	Date of visit	Ownership	Capacity (MW)
13	ARCELORMittal Temirtau JSC, CHPP-PVS	Northern	2-Feb-2023	Private	192
14	"Kazzinc" LLP Bukhtarma SEC, Bukhtarma HPP	Northern	3-Feb-2023	Public	675
15	TOO "Bassel Group LLS" Karaganda GRES-1	Northern	3-Feb-2023	Private	84
16	LIP "Main Distribution Power Plant Topar"	Northern	3-Feb-2023	Private	643
17	LLP "Shakhtinskteploenergo" SHTEC	Northern	6-Feb-2023	Private	18
18	NPP Shulba HPP LLP	Northern	6-Feb-2023	Public	702
19	"Teplcommunnergo" Semipalatinsk CHPP-1	Northern	7-Feb-2023	Public	24
20	UPNK-PV LLP, coke oven gas power plant	Northern	8-Feb-2023	Private	12
21	Tekelia Energocomplex LLP, Tekeliskaya CHPP-2	Southern	9-Feb-2023	Private	24
22	JSC "Aluminium of Kazakhstan" Pavlodar CHPP-1	Northern	9-Feb-2023	Private	350
23	JSC "Almaty Electric Stations" Kapshagay HPP	Southern	10-Feb-2023	Public	364
24	PAVLODARENERGO JSC CHPP-2	Northern	10-Feb-2023	Private	110

List of Power Plants Covered in the Site Visits (3/5)

Sl. No.	Power plant	Zone	Date of visit	Ownership	Capacity (MW)
25	"Astana-Energy" JSC CHPP-1	Northern	13-Feb-2023	Public	22
26	JSC "Zhaiykteploenergo" Ural CHPP	Southern	13-Feb-2023	Private	48.52
27	JSC "Almaty Power Plants" CHPP-1	Southern	13-Feb-2023	Public	145
28	"Astana-Energy" JSC CHPP-2	Northern	14-Feb-2023	Public	600
29	JSC "Almaty Power Plants" CHPP-3	Southern	14-Feb-2023	Public	173
30	Zhaiykmunai LLP GTPP - 1 & GTPP - 2	Western	14-Feb-2023	Private	36.5
31	JSC "Almaty Electric Stations" CHPP-2	Southern	15-Feb-2023	Public	600
32	Ural GTPP LLP	Western	15-Feb-2023	Private	54
33	Batys Power LLP Ural GTES-200	Western	16-Feb-2023	Private	100
34	JSC "Almaty Power Plants" Cascade HPP	Southern	17-Feb-2023	Public	43.7
35	JSC "Tarazenergocenter" Zhambyl CHPP	Southern	20-Feb-2023	Public	44
36	Kazakhmys Energy LLP Balkhash CHP	Northern	20-Feb-2023	Private	145

List of Power Plants Covered in the Site Visits (4/5)

Sl. No.	Power plant	Zone	Date of visit	Ownership	Capacity (MW)
37	JSC "Zhambyl GRES named after T.I.Baturov"	Southern	21-Feb-2023	Private	1,230
38	JSC "3-Energoortalyk" Shymkent CHPP-3	Southern	22-Feb-2023	Private	160
39	GCE "Kentau Service" Kentau CHPP	Southern	23-Feb-2023	Public	12.5
40	JSC "Atyrau CHPP"	Western	27-Feb-2023	Private	454
41	TOO "SagatEnergy" GPPP	Western	1-Mar-2023	Private	2.4
42	Karabatan Utility Solutions LLP CCGT	Western	2-Mar-2023	Private	310
43	Kazakhmys Energy LLP Zhezkazgan CHPP	Northern	2-Mar-2023	Private	252
44	JSC "Crystal Management" GTPP "Akshabulak"	Southern	3-Mar-2023	Private	87
45	Cpc "Кызылordationplelectrocentric", Kyzylorda CHPP	Southern	6-Mar-2023	Public	71.2
46	MAEK-Kazatomprom LLP CHPP-1	Western	6-Mar-2023	Private	43.9
47	JSC "SEVKAZENERGO" Petropavlovskaya CHPP-2	Northern	7-Mar-2023	Private	541
48	JSC "Moynakskaya HPP U.D. Kantaeva"	Southern	9-Mar-2023	Public	300

List of Power Plants Covered in the Site Visits (5/5)

Sl. No.	Power plant	Zone	Date of visit	Ownership	Capacity (MW)
49	JSC "Shardara HPP"	Southern	9-Mar-2023	Public	126
50	MAEK-Kazatomprom LLP CHPP-2	Western	9-Mar-2023	Private	416.8
51	State Enterprise "Kostanay Fuel and Energy Complex" Kostanay CHPP	Northern	9-Mar-2023	Public	12
52	LLP "Zhanazholskaya GTPP"	Northern	9-Mar-2023	Private	168
53	AKTOBE Rail and Section Plant LLP GPPP	Northern	10-Mar-2023	Private	37.2
54	JSC "Aktobe CHPP"	Northern	10-Mar-2023	Private	118
55	LLP "MAEK-Kazatomprom" TPP	Western	10-Mar-2023	Private	450
56	State Enterprise "Arkalyk Fuel and Energy Complex"	Northern	10-Mar-2023	Public	4

Annexure 3 - Plant-wise detail summary

There are three subsections under Annexure 3, which provide summary of plant-wise information for 56 power plants* across the three zones. Annexure 3.1 covers plants in North Zone; Annexure 3.2 covers plants in South Zone; and Annexure 3.3 covers plants in West Zone.

These annexures summarizes plant performance and concerns. The information presented along with the descriptive points are reflections of the power plants' status and characteristics, which is based on (i) data provided by power plants as response to questionnaire(s) and (ii) points (concerns / issues) put forward by power plant officials during interactions / consultations. This is supplemented further through visual observations made during site visits to the power plants.

**Excluding 1. ARCELORMittal Temirtau JSC, CHPP-PVS (no data provided); and 2. GPES LLP "EPC Industry" (not operational)*

Annexure 3.1 - Summary of North Zone Plants

1. Balkhash CHPP
2. Main Distribution Plant Topar
3. Karaganda GRES-1
4. Aktobe Rail & Section GTPP
5. Zhezkazgan CHPP
6. Petropavloskaya CHPP-2
7. Kostanay CHPP
8. Ekibastuz GRES-2
9. Sogrinskaya CHPP
10. Shakhtinskteploenergo SHTEC
11. Shulba Hydropower Plant
12. Semipalatinsk CHPP-1
13. Aksu Power Plant
14. Ridder CHPP
15. UPNK-PV LLP
16. Karaganda CHPP-1
17. ArcelorMittal CHPP-2
18. Aktobe CHPP
19. Astana Energy CHPP-1
20. Zhanazholskaya GTPP
21. Astana Energy CHPP-2
22. Arkalyk Energy Complex
23. Pavlodar CHPP-3
24. Stepnogorskaya CHPP
25. Pavlodarenergo CHPP-2
26. Karaganda CHPP-3
27. Ust-Kamenogorsk CHPP
28. Pavlodar CHPP-1
29. Ust-Kamenogorsk HPP
30. Bukhtarma HPP
31. ArcelorMittal CHPP-PVS
32. Ekibastuz GRES-1

1. BALKHASH CHPP (1/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	145 MW	4 units	LLP Kazakhmys Energy	Karaganda	Northern

Plant Status and Performance

Theme		Details
Age		• The power plant was initially commissioned in **1937** and extension was done in **1963 (~59 years old)**. The installed capacity is **145 MW,** and the plant was generating 59 MW electricity during the visit. • The power plant has **4 units** comprising of 4 turbine generators and 4 boilers. • **Aging** of the plant is a **key concern** causing poor operating conditions and low efficiency.
Fuel sourcing & management		• The plant uses **coal** of GCV 3,658 kcal/kg. • The coal used by the plant is close to its design values and has an **ash content** of **~45%**. • The plant uses **open yard** for **coal storage** with a storage capacity of ~310,000 tons. • The plant is operating at minimum production due to **shortage of coal** faced due to regular **derailment** of **railway wagons**. • The power plant is planning to install a new system for unloading coal wagons.
Major assets	Boiler	• All 4 boilers were manufactured by **Podolsky Boiler Plant** in **1963** and **1964** with a steam generation capacity of **130 tons per hour**.
	Turbine	• Turbines 1 and 2 of the power plant were manufactured by **Leningradsky Metallichesky Zavod** in **2002** with a rated capacity of **30 MW each**. • Turbine 3 was manufactured by **HTGZ** in **1958** with a rated capacity of **25 MW**. • Turbine 4 was manufactured by **Leningradsky Metallichesky Zavod** in **1962** with a rated capacity of **60 MW**.
	Generator	• Generators 1 and 2 were manufactured by **Elektrosila Leningradsky Zavod** in **1998** with a rated capacity of **50 MW each**. • Generators 3 and 4 were manufactured by **Novosibirsk Plant** in **1958** and **1962** with a rated capacity of **25 MW** and **60 MW,** respectively.
Plant operations		• The power plant produces **67.7% electricity** and **32.3% heat** on an average in a year. • The plant generated **1,065.1 GWh** of electrical energy in **2021** and supplied **912.47 GWh** of electrical energy to the **grid**. It reported an auxiliary consumption of **14.33%** in 2021. • The plant consumed **757,884.3 tons of coal** in 2021 and reported a specific fuel consumption of **0.84 kg of coal / kWh** in 2021. • The plant reported **6 emergency shutdowns** in the last 5 years for a total of 87 hours leading to undersupply of **325.7 MWh** of electricity. • The power plant is facing difficulties due to **shortage of coal supply**.

1. BALKHASH CHPP (2/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	145 MW	4 units	LLP Kazakhmys Energy	Karaganda	Northern

Theme	Details
Operation and maintenance	• The power plant is unable to **retain control room personnel** due to **financial constraints** leading to lack of institutional knowledge. • The last **civil / structural survey** of the plant was completed in **2021**. • Based on site visit observations, the **buildings need modernization and reinforcement.** • Plant equipment is **tested** and **inspected** periodically once every **5 years** and **load tests** are conducted **after** every **maintenance**. • The plant is planning to **overhaul** a **boiler** and **add a new boiler**. There are also **plans** to **add** a new **60 MW turbine**. • There is scope to enhance maintenance as **steam leakages** and **insulation damages** were observed during the site visit.
Control systems	• The plant has **SCADA systems** for all turbines except for one. • The plant has an **ERP system** with modules for finance and purchase/warehousing. • The plant **maintains log** of **daily statistics** in the plant through excel forms.
Emission control and ash management	• The power plant **does not** have a **continuous emission monitoring system.** Installation of the same is under consideration. • The power plant **does not** have a **wastewater recovery and disposal system.** • The plant **does not** have an **electrostatic precipitator** and **uses emulsifiers and wet scrubbers** for pollution control. • The plant does not have its own ash storage. The ash slurry is pumped to nearby copper complex pond for storage.
Water quality	• The plant uses **untreated water** from **Lake Balkhash**. It has a **demineralization plant**. • The plant **does not** have an **online steam and water analysis.**

Note: The site visit team was restricted from photography during the visit.

2. MAIN DISTRIBUTION PLANT TOPAR (1/3)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	643 MW	8 units	LLP Main Distribution Power Station Topar	Karaganda	Northern

Plant Status and Performance

Theme		Details
Age		• Set up in 1955 **(67 years old)** and capacity of **643 MW**. The plant was generating at ~448 MW during the site visit. • The power plant has **8 units** comprising of 8 turbine generators and 16 boilers. Turbine 3 is currently under renovation. • **Aging** of the plant is a **key concern** with most equipment reaching the end of its lifespan. Equipment such as fans, pumps, pipes, and mills require **immediate replacement** due to age.
Fuel sourcing & management		• The plant uses **coal** of GCV 3,792 kcal/kg. • The plant was **designed** for coal from **Karaganda;** however, it sources its coal from **Ekibastuz** and **Barlinskoye** which is **abrasive** and has **high ash content** up to 50%. • The plant has 11 belt conveyors for coal transport and **two open storage yards** with an approximate capacity of 400,000 tons.
Major assets	Boiler	• All the boilers except for boiler 3 was manufactured by **Podolsky Boiler Plant** in different years including 1958, 1961-1967, and 1978 with a steam generation capacity of 130 tons per hour. • Boiler 3 was manufactured by **Taganrog Boiler Plant** in 2016 with a steam generation capacity of 142 tons per hour. • The boiler drums have been running for **400,000+ hours** compared to **design life of 200,000 hours.**
	Turbine	• All the turbines of the power plant were manufactured by **Leningradsky Metallichesky Zavod** with turbines 1 and 2 manufactured in 2009 and 2016, respectively, and the other turbines between 1962 and 1966. • Turbine 1 is rated at 55 MW, turbines 4 and 5 at 100 MW, and turbines 6, 7, and 8 at 86 MW each. • Turbine 2 was initially rated at 50 MW; however, the turbine was renovated in 2016 with the replacement of turbo unit increasing the capacity to 130 MW. Turbine 3 is currently undergoing renovation.
	Generator	• Generators 1 and 2 were manufactured by **OJSC Power Machines** in 2007 and 2016 with rating of 63 MW and 130 MW, respectively. • Generators 4, 6, 7, and 8 were manufactured by **Novosibirsk Turbine Generator Plant** in 1963, 1965, 1965, and 1966, respectively, with a rating of 100 MW each. • Generator 5 was manufactured by **LLP 'Electrosila'** in 1963 with a rating of 100 MW.

2. MAIN DISTRIBUTION PLANT TOPAR (2/3)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	643 MW	8 units	LLP Main Distribution Power Station Topar	Karaganda	Northern

Theme	Details
Plant operations	• The power plant mainly produces electricity with 95% electricity and 5% heat in winters and 97% electricity and 3% heat in summers. • The plant generated **4,277.5 GWh** of electrical energy in **2021** and supplied **3,846.5 GWh** of electrical energy to the **grid**. It reported an auxiliary consumption of **10.08%** in 2021. • The plant consumed **3,609,164.2 tons of coal** in 2021 and reported a specific fuel consumption of **0.94 kg of coal / kWh** in 2021. • The plant reported **2 emergency shutdowns** in the last 5 years. **Turbine 8** was shut down for **934 hours** resulting in undersupply of 159.32 GWh of electrical energy.
Operation and maintenance	• Of the 16 boilers in the plant, **5** were undergoing **routine maintenance** during the time of the site visit. • **Rusting**, **equipment damage,** and **insulation damage** were observed across the plant. • **Boiler tubes** reported major **wear and tear**, particularly in **superheater** and **economizer** as well as the drums. This is due to the **abrasive nature** of the coal used by the power plant which is causing wear and tear. • It was reported that the **size** of the **last stage blade** in the turbines has been **reduced** due to aging which has reduced the power generation. • The plant conducts **capital repairs** once every **4-6 years**. • The power plant had to **scavenge** parts from a **boiler** due to **lack of spare parts**. • The **production** cost of the plant is **higher** than the **revenue** resulting in **losses**. • The plant does **not** have an **approved budget**. **Renovation** and **scheduled maintenance** is **affected** due to **lack** of **financial** sources. • The last **civil / structural survey** of the plant was completed in **2022**. • Based on site visit observations, the **buildings need modernization and reinforcement.**
Control systems	• The plant has **SCADA systems for boiler 3 and turbine 3.** Every other equipment is **manually controlled** through obsolete knobs. • The plant has an **ERP system** with modules for finance and purchase/warehousing. • The plant **maintains log** of **daily statistics** in the plant through excel forms.
Emission control and ash management	• The power plant **does not** have a **continuous emission monitoring system.** • The power plant **does not** have a **wastewater recovery and disposal system.** • The plant does **not** have an **electrostatic precipitator** and **uses wet scrubbers** for pollution control. • Ash-water slurry system is used to pump ash to disposal area. The **4th ash dump is almost full,** and a 5th dump is being planned for storage.
Water quality	• The plant uses **anion and cation resin softening system** and does not have demineralizing system in the plant. • The plant does **not** have an **online steam and water analysis.** The steam and water is **manually tested every 6 hours.**

2. MAIN DISTRIBUTION PLANT TOPAR (3/3)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	643 MW	8 units	LLP Main Distribution Power Station Topar	Karaganda	Northern

Visual observations[1]

1. Switchyard

2. Turbine generator hall

3. Coal handling yard

4. Transformer

5. Boiler pipings

6. Observed insulation damage

7. Rusting and damage in air compressor

Source: 1. Site Visit.

3. KARAGANDA GRES-1 (1/3)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	84 MW	3 Boilers & 2 Turbines	LLP Bassel Group	Karaganda	Northern

Plant Status and Performance

Theme		Details
Age		• The power plant was **commissioned** in **1942** and used to have 11 boilers and 9 turbines. **Currently 3 boilers** (including 1 reserve) and **2 turbines** in **cross-linked** configuration are in operation. • **Residual life assessment** was carried out in **2022**. It was estimated that **47.56%** of the main equipment is **depreciated**. • **Aging** of the plant is a **key concern** with most equipment reaching the end of its lifespan. • The **drums** of the boilers have already **exceeded** their projected **lifespan;** however, it is still in operation and the **turbines** were last **overhauled** in **1991** (~31 years ago).
Fuel sourcing & management		• The plant uses **coal** of GCV 3,987 kcal/kg. • The coal used is **sourced** from **Ekibastuz** with ash content less than 42%. • The plant is facing **issues** with **coal supply** with only 8 of last 12 orders being supplied. Coal is supplied through train and unloaded manually. • The plant has **open storage yards** for coal storage with an approximate capacity of 180,000 tons.
Major assets	Boiler	• The 3 boilers of the plant (boilers 9, 10, and 11) were manufactured by **State Machine Building Plant Podoslk** with steam generation capacity of 170 tons per hour each. • Boiler 9 was commissioned in **1953**, boiler 10 in **1954,** and boiler 11 in **1955**. • **Service life extension** has been conducted on all boilers; however, it was reported that **boiler drums** have **exceeded** their **lifespan**.
	Turbine	• The 2 turbines of the plant (turbine 8 and turbine 9) were manufactured by **Leningrad Metal Works** in **1990** and **1991,** respectively, with capacity of 42 MW each. • The power plant has had **no renovation or modernization** activity done for the turbines **since 1991**.
	Generator	• The 2 generators of the plant (generator 8 and generator 9) were manufactured in **1978** and **1955,** respectively, with a rated capacity of 63 MW and 50 MW, respectively. • **No renovation or modernization** activity has been done on the generator.

3. KARAGANDA GRES-1 (2/3)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	84 MW	3 Boilers & 2 Turbines	LLP Bassel Group	Karaganda	Northern

Theme	Details
Plant operations	• The power plant **mainly produces electricity** with 90% electricity and 10% heat in winters and 100% electricity in summers. • The plant generated **556.27 GWh** of electrical energy in **2021** and supplied **463.68 GWh** of electrical energy to the **grid**. It reported an auxiliary consumption of **16.64%** in 2021 which is significantly high. • The plant consumed **489,009 tons of coal** in 2021 and reported a specific fuel consumption of **0.61 kg of coal /kWh** of energy.
Operation and maintenance	• **Maintenance** of the equipment is done **annually. Major** maintenance is done every **5 years** by subcontractors. • The power plant does **not** have **long-term contracts** for **spares**. • The plant uses **manual planning** methodologies for shift and maintenance planning. • There were **minor spillages** noticed in the coal pulverizer and crusher area as well as **coal dust** in the boiler area. • Some **pipe damage**, **insulation damage**, **radiating heat,** etc., were observed in various parts of the plant. • The last **civil / structural survey** of the plant was completed in **2022**. **No visible damage** was observed in the **chimneys**. • Based on site visit observations, the **buildings need modernization and reinforcement.**
Control systems	• The plant has **SCADA systems** for semiautomatic control of equipment. • The plant does not have an **ERP system**. • The plant **maintains log** of **daily statistics** in the plant which are **generated electronically**.
Emission control and ash management	• The power plant **does not** have a **continuous emission monitoring system.** • The power plant **does not** have a **wastewater recovery and disposal system.** • The plant does **not** have an **electrostatic precipitator** for pollution control. • The **current ash storage** of the plant is estimated to have **capacity** for the next **5-6 years**.
Water quality	• The plant does **not use demineralized water**. It uses **reverse osmosis** for water **softening** and to improve the quality of the water. • The plant does **not** have an **online steam and water analysis.**

3. KARAGANDA GRES-1 (3/3)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	84 MW	3 Boilers & 2 Turbines	LLP Bassel Group	Karaganda	Northern

Visual observations[1]

1. Karaganda GRES-1

2. Electrical control room

3. Boiler floor

4. Storage tank damage

5. Boiler area

6. Coal dust in boiler floor

7. Coal unloading station

8. Boiler/turbine control room

Source: 1. Site Visit.

4. AKTOBE RAIL AND SECTION PLANT GTPP (1/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Gas	Electricity	37.2 MW	4 units	Transport Technologies LLP	Aktobe	Northern

Plant Status and Performance

Theme		Details
Age		• Set up in 2015 (**7 years old**) with rated capacity of 38.92 MW. • The power plant is relatively new having been **commissioned in 2015.** It reported that it is not facing any major issues. • The **major equipment** was **observed** to be **new** or in very **good condition** of operational life without need for any immediate reinvestment.
Fuel sourcing & management		• The plant uses **natural gas** of GCV ranging from 11,320.78 to 12,553.53 kcal/m^3. • The plant is supplied with gas through a pipeline from **Quaztrans Gas Company**.
Major assets	Turbine	• Comprises of 4 turbines manufactured by **Wartsila Finland**, in **2013** with rated power of **9.73 MW** each. • Each **turbine** is of **single cycle** type • **No renovation and modernization activity** has been undertaken for the gas turbine as the equipment is relatively new.
	Generator	• Comprises of 4 generators manufactured by **Cummins Generators** in **2013** with rated power of **9.73 MW** each. • **No renovation and modernization activity** has been undertaken for the generator as the equipment is relatively new.
Plant operations		• The plant generated **264,665 MWh** of electrical energy in **2021** and supplied **260,603 MWh** of electrical energy to the **grid / wagon factory**. It reported an auxiliary consumption of **~1.5%** in 2021. • Approximately **7 MW** of the electricity generated is used for **inhouse manufacturing** of rail coaches. **Balance** is supplied to **grid**. • The plant consumed **61,946,910 m^3 of gas** in 2021. It reported a specific fuel consumption of **0.17 m^3 of gas / kWh** in 2021. • The plant reported **3** instances of **first degree failures** and **3** instances of **second degree failures** in the last 5 years.
Operation and maintenance		• **Maintenance** of the equipment is done as per the **OEM recommendations** based on **run hours**. • **Minor maintenance** is done by **power plant** personnel. **Major** repairs and **maintenance** activities are done by the **equipment manufacturer**. • The plant has a long-term **spares** supply **agreement** for all equipment in the plant. • The plant is **neat**, **clean,** and **well maintained**. It was also seen to be **well illuminated**. • The **equipment noise level** in the power plant is **excessive**. • The last **civil / structural survey** of the plant was completed in **2022**.

4. AKTOBE RAIL AND SECTION PLANT GTPP (2/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Gas	Electricity	37.2 MW	4 units	Transport Technologies LLP	Aktobe	Northern

Theme	Details
Control systems	• The plant has **SCADA systems** and **ASCUE** for fully automatic control and monitoring of the equipment. • The generators have **numerical relays** (ABB make) for generator **protection**. • The plant has a **fully automated system** for **maintaining gas** pressures, temperatures, and other **parameters**. • The plant does not have an **ERP system**. • The plant **maintains log** of **daily statistics** in the plant.
Emission control	• The power plant does **not have** a **continuous emission monitoring system**. Flue gas **monitoring** is done by **third party once in a month.** • The power plant does **not have** a **wastewater recovery and disposal system.**

Visual observations[1]

1. Turbine generator unit

2. Numerical relays for generation protection

3. Switchyard

4. Generator human machine interface (HMI)

Source: 1. Site Visit.

5. ZHEZKAZGAN CHPP (1/3)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	252 MW	5 units	LLP Kazakhmys Energy	Karaganda	Northern

Plant Status and Performance

Theme		Details
Age		• Set up in 1959 (**63 years old**) with operating capacity of **252 MW**. It was generating at ~120 MW during the site visit. • The power plant has **5 units** comprising of 5 operating turbine generators and 7 boilers. 3 turbines were decommissioned previously. 4 boilers are not in use. • **Aging** of the plant is a **key concern** with most equipment reaching the end of its lifespan.
Fuel sourcing & management		• The plant uses **coal** of GCV 3,743 kcal/kg. • The coal is **procured** from **Udabarly**, 100 km from Karaganda. The coal is **supplied** through **rail** and unloaded through wagon tipplers. • The plant has **open storage yards** for coal storage with an approximate capacity of 217,440 tons. • The plant reported that it is facing issues with coal supply shortage.
Major assets	Boiler	• Boilers 4 to 9 were manufactured by **Taganrog Boiler Plant** with boilers 4 to 7 between **1959** and **1962** and boilers 8 and 9 in **1970** and **1971,** with a steam generation capacity of **140 tons per hour** each. • Boiler 11 was manufactured by **Barnaul Boiler Plant** in **1993** with a steam generation capacity of **155 tons per hour**. • The plant reported that **inspection** of the **metal surface** of **boiler 8** revealed **severe corrosion** wear and complete **replacement** was **recommended.** • The plant reported that **ultrasonic inspection** of **boiler 10** revealed **excess wear and tear** and **was declared** to be in **emergency** condition.
	Turbine	• Turbines 4 and 8 were manufactured by **Kaluga Turbine Plant** in **2015** and **2018,** respectively, with a capacity of **50 MW** each. • Turbines 5, 6, and 7 were manufactured by **Leningradsky Metallichesky Zavod** in **1960**, **1963,** and **1969,** respectively. • Turbines 5, 6, and 7 have rated capacity of **40 MW**, **50 MW,** and **60 MW** respectively. • Turbines 4 and 8 were **upgraded** in 2014 and 2016, respectively, to **increase efficiency** of production and install **DCS system**. • Turbines 5 and 6 are **working** to lower **capacity** due to **removal** of several **rotor stages** and **issues** with **coupling**. • **Contamination** of the **condensers** was seen with **mechanical** and **biological pollutants** due to ineffective grille and inlet water filtering system.
	Generator	• Generators 4 and 8 were manufactured by **Elektrosila Leningradsky Zavod** in **2012** with rating of **63 MW each**. • Generators 5, 6, and 7 were manufactured by **Novosibirsk Plant** in 1976, 1986, and 1969, respectively. • Generators 5 and 6 have rated capacity of **63 MW** and generator 7 has a rated capacity of **60 MW**. • The plant has not faced any significant problems with the generators.

5. ZHEZKAZGAN CHPP (2/3)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	252 MW	5 units	LLP Kazakhmys Energy	Karaganda	Northern

Theme	Details
Plant operations	• The plant produces electricity and heat with 56% electricity and 44% heat in winters and 81% electricity and 19% heat in summers on average. • The plant generated **1,258.68 GWh** of electrical energy in **2021** and supplied **1,065.34 GWh** of electrical energy to the **grid**. It reported an auxiliary consumption of **15.36%** in 2021. • The plant consumed **982,699.5 tons of coal** in 2021. It reported a specific fuel consumption of **0.94 kg of coal / kWh** in 2021. • The plant reported **9 emergency shutdowns** in the last 5 years. Total shutdown was for **34 hours** with **undersupply** of **~951 MWh.**
Operation and maintenance	• Two boilers (boilers 7 and 10) were **inspected** and found to be **dangerous** for continued use due to advanced wear and tear. • The **operating condition** of the plant was observed to be **poor** and running with **low efficiency**. • **Rusting**, **equipment damage,** and **insulation damage** were observed throughout the plant. • **Coal dust**, **oil spillage,** as well as **steam leakages** were also observed around the plant. • The plant conducts **capital repairs** once every **4-6 years**. • The last **civil / structural survey** of the plant was completed in **2022**. **Significant damage** was observed in **civil structures** around the plant. • Based on site visit observations, the **buildings need modernization and reinforcement.** • The **power transformers** in the plant do **not** have **firefighting systems.** • The plant has **3 instant boiling evaporator** housings which has **insufficient performance** due to **rapid contamination of heating surfaces.**
Control systems	• The plant has **DCS systems for turbines 4 and 8 and boiler 11.** During the site visit it was observed that the centralized control room is manual and obsolete. • The power plant uses both manual alarms as well as microprocessor-based alarms for the equipment. • Many of the **protection systems** in the plant are **electro-mechanical relays**. • The plant has an **ERP system** with modules for finance and purchase/warehousing. • The plant **maintains log** of **daily statistics** in the plant through excel forms.
Emission control and ash management	• The power plant **does not** have a **continuous emission monitoring system.** Currently emissions are calculated based on fuel consumed. • The power plant **does not** have a **wastewater recovery and disposal system.** • The plant does **not** have an **electrostatic precipitator** and **uses emulsifiers** for pollution control. • The plant does **not** have **ash storage** facility. The **ash slurry** is **pumped** to nearby **factories** and water is reclaimed. • The current **ash pipeline** has seen **rapid wear** requiring reconstruction.

5. ZHEZKAZGAN CHPP (3/3)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	252 MW	5 units	LLP Kazakhmys Energy	Karaganda	Northern

Theme	Details
Water quality	• The plant has a **demineralization plant** in the premises. The water is sourced from **Kengir lake** and fed to boiler after treatment. • The plant does **not** have an **online steam and water analysis.**

Visual observations[1]

1. Control room

2. Transformer

3. Insulation damage

4. Steam leakages

5. Structure damage

6. Civil damage

7. Insulation damage on outdoor pipes

8. Chimneys

Source: 1. Site Visit.

6. KOSTANAY CHPP (1/3)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Gas	Electricity & Heat	12 MW	2 units	Kostanay Akimat	Kostanay	Northern

Plant Status and Performance

Theme		Details
Age		• Set up in 1957 (**~65 years old**) and has **installed capacity** of **12 MW.** • **Aging** of the equipment is a **key concern. Residual assessment** done in 2022 indicated overall **depreciation** of **54.19%** of the plant. • **Renovation and modernization** activity has been done on turbines 1 and 2.
Fuel sourcing & management		• The plant uses **natural gas** of GCV 8,085 kcal/m^3.
Major assets	Boiler	• The plant has 8 boilers. All the boilers were manufactured by **Belgorod Boiler Plant** between 1959 and 1968. • Boilers 1, 2, 5, and 6 have steam generation capacity of 35 tons per hour. Boilers 3 and 7 have steam generation capacity of 65 tons per hour. • Boilers 4 and 8 have steam generation capacity of 75 tons per hour.
	Turbine	• Turbine 1 was manufactured by **Kaluga Turbine Plant** in 1959. It has a rated capacity of 6 MW. • Turbine 2 was manufactured by **Nevsky Machine Building** Plant in 1955. It has a rated capacity of 6 MW. • **R&M** was done on the **turbines** to **simplify** the **control system** and has **high ease of use** and **high maintainability**.
	Generator	• Generator 1 was manufactured by **Lysva Turbine Generator Building** in 1959 and is rated 6 MW. • Generator 2 was manufactured by **Saxenwerk Dresden** in 1955 and is rated 6 MW.
Plant operations		• The plant generated **69 MWh** of electrical energy in **2021** and supplied **30 MWh** of electrical energy to the **grid**. It reported an auxiliary consumption of **~56%** in 2021 which is extremely high. • The plant consumed **4,740,000 m^3 of gas** in 2021. It reported a specific fuel consumption of **0.17 m^3 of gas / kWh** in 2021. • The plant had **19 emergency shutdowns** in the last 5 years.
Operation and maintenance		• Company is unable to invest in latest technology due to **financial constraints.** • Turbine generator units do not have enclosures. • The **insulation** for the boilers and turbine is **damaged.** • The plant has a **well-maintained water testing lab**.

6. KOSTANAY CHPP (2/3)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Gas	Electricity & Heat	12 MW	2 units	Kostanay Akimat	Kostanay	Northern

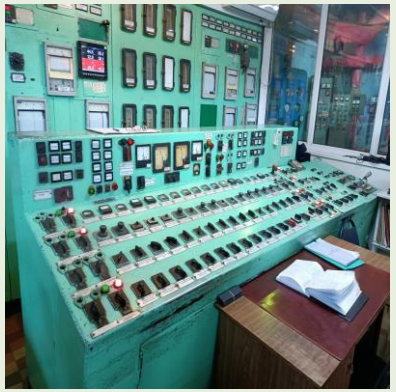
Theme	Details
Control systems	• The plant does not have **SCADA systems.** • The plant does not have an **ERP system**. • The plant reported that it **maintains log** of **daily statistics.** • **Control systems are manual and semiautomatic.**
Emission control	• The plant does **not** have a **continuous emission monitoring system.** Emission control is through **fuel combustion control**. • The plant reported that it does not have a wastewater recovery and disposal system.

Visual observations[1]

1. Turbine generator

2. Steam leakage in the pipes

3. Water analysis area



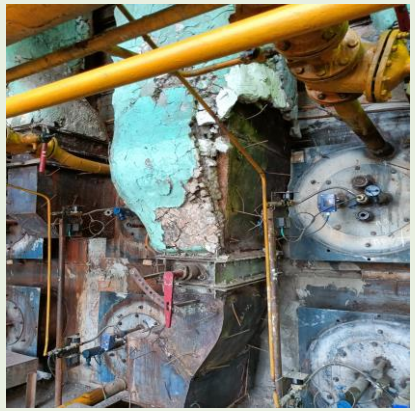
4. Boiler control room

Source: 1. Site Visit.

6. KOSTANAY CHPP (3/3)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Gas	Electricity & Heat	12 MW	2 units	Kostanay Akimat	Kostanay	Northern

Visual observations[1]



5. Damaged insulation in boiler-turbine

6. Flooring damaged

8. Debris accumulated on turbine floor

7. Oil leakage from turbines

9. Mechanical relay panel

Source: 1. Site Visit

7. PETROPAVLOSKAYA CHPP-2 (1/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	541 MW	7 units	CAEPCO	Petropavlsk	Northern

Plant Status and Performance

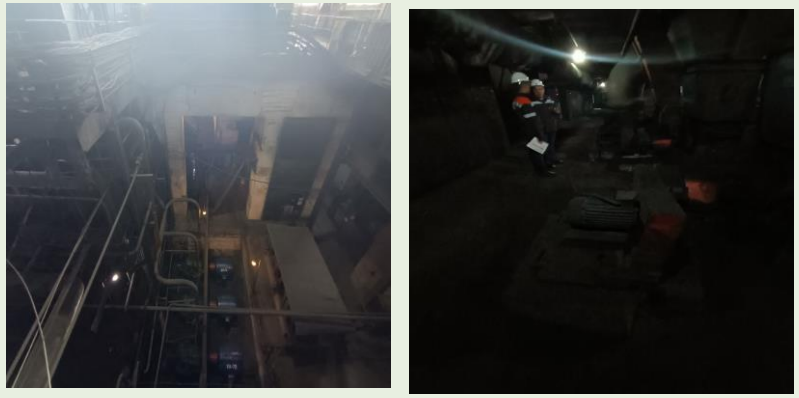
Theme		Details
Age		• The plant was commissioned in 1961 with installed electrical capacity of 541 MW • The plant has been in operation for **60+ years**.
Fuel sourcing & management		• Plant uses **medium grade coal** with GCV 3,860 kcal/kg. • The station uses an open warehouse (200,000 tons of storage capacity).
Major assets	Boiler	• Boilers 1, 2, 3, and 4 manufactured by "**Taganrog boiler plant**" and boilers 7, 8, 9, 10, 11, and 12 manufactured by "**Barnaul cat.**" • Boilers 1, 2, 3, and 4 have reached the limit and require renovation.
	Turbine	• Turbines 2, 3, 6, and 7 manufactured by "LMZ Leningrad" and turbines 1, 4, and 5 manufactured by "CJSC UTZ". • Turbines 3, 6, and 7 have reached the operational life limit, while turbines 1, 4, and 5 have been renovated.
	Generator	• Generators 1, 4, and 5 manufactured by "OJSC".
Plant operations		• The plant **primarily supplies heat** during the winter. • The plant **utilization factor** is **low.** • The plant reported **auxiliary consumption of ~12%.**
Operation and maintenance		• O&M carried out annually by a third party (Sredazenergomontazh Petropavlovsk LLP, contract for routine maintenance of the main and auxiliary equipment of PCHP-2).
Control systems		• The plant has **manual, knob operations** for boiler control. • The plant has both SCADA and DCS system for control in the plant. • The plant also has an ERP system for logging various production data.
Emission control		• Emissions monitoring by an instrumental method through an accredited laboratory (own and third party). • Power plant does not have an electrostatic precipitator. • Fly ash disposal - 99.5% captured in emulsifiers and 0.5% dissipated through 2 chimneys. • No zero liquid discharge system and flue gas desulfurization (FGD) system in the plant.

7. PETROPAVLOSKAYA CHPP-2 (2/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	541 MW	7 units	CAEPCO	Petropavlsk	Northern

Visual observations[1]

1. Coal dust accumulation over lube oil tank



2. Low illumination in the pump house area

3. Fly ash covered the boiler floor

4. Cover plates not aligned properly

5. Control room manual knob operations

6. Damaged insulation

Source: 1. Site Visit.

8. EKIBASTUZ GRES-2 (1/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	1,000 MW	2 Units	Samruk-Energo JSC	Ekibastuz	Northern

Plant Status and Performance

Theme		Details
Age		• Set up in 1990 (**32 years old**) with installed capacity of 1 GW. • Age of the units is **over 30 years** since commissioning. • The **residual life assessment** was conducted for the block 1 and block 2 in 2007 and 2010, respectively. It was found that **80%** of the **pipes** near **heating surfaces** were **worn** out.
Fuel sourcing & management		• The plant uses **medium grade coal** with calorific value (3,972.55 kcal/kg) as primary fuel for energy generation.
Major assets	Boiler	• Boilers 1 and 2 manufactured by "**Ordzho-Nikidze Plant**" in 1990 and 1993, respectively. • Both boilers have a maximum allowable nominal pressure of 255 atm and steam generation rate of 900 tons per hour at maximum continuous rating.
	Turbine	• The plant has 2 turbine units manufactured by "**Leningradsky Metallichesky Zavod**". • The maximum continuous power rating of each turbine is **525 MW**. • **No R&M** has been conducted in the turbine units.
	Generator	• Generator 1 was manufactured by "**LPEO Electrosila**" in 1986. • Generator 2 was manufactured by "**JSC(ELSIB) Novosibirsk**" in 1990.
Plant operations		• The plant generated **6,433.36 GWh** of electrical energy in **2021** and supplied **6,083.7 GWh** of electrical energy to the **grid**. It reported an auxiliary consumption of **~5.43%** in 2021. • The plant consumed **3,913,823 tons of coal** in 2021. It reported a specific fuel consumption of **0.61 kg / kWh** in 2021. • The plant had a total of **56 emergency shutdowns** with **27 shutdowns for block 1** and **29 shutdowns for block 2** in the last 5 years.
Operation and maintenance		• Several LP **turbines** and **generators** had **significant vibrations** and metal **plates** were placed on the **end bearing** to **attenuate** the vibrations. • There are instances of **coal dust accumulation** on the equipment, flooring, control panels, and junction boxes. • The equipment were all **well painted** and **regularly cleaned**, indicating that they were well maintained.

8. EKIBASTUZ GRES-2 (2/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	1,000 MW	2 Units	Samruk-Energo JSC	Ekibastuz	Northern

Theme	Details
Control systems	• The control room has **semiautomatic controls** with analog meters and manual operating knobs. • The plant does **not** have **ERP system** but is equipped with **SCADA/DCS system.**
Emission control and ash management	• Power plant is equipped with **electrostatic precipitator**. • **Gas analyzers** Polar and DAG-500 are used to measure emissions of harmful substances. • The plant used the **gravity hydraulic transportation** to move ash and slag to ash dump. • **No zero liquid discharge system**, no wastewater recovery and disposal system.
Structural vulnerabilities	• Last structural survey was conducted in September 2021. • There are observed **gaps and openings** in the floorings. • The plant has **safety equipment** and systems like **fire extinguishing systems** installed in the BTG halls.

Visual observations [1]

1. Coal dust accumulation was observed in the maintenance bay area

2. Cracks on floors and structures.

3. Damaged flooring risk of trip and fall accidents

Source: 1. Site Visit.

9. SOGRINSKAYA CHPP (1/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	75 MW	2 Units	Sogra energy GmbH	Ust-Kamenogorsk	Northern

Plant Status and Performance

Theme		Details
Age		• The plant was commissioned in **1962** and has been in **operation** for **61 years**. • **Block 1** turbine generator unit was **recommissioned** in **December 2012** • The **three boilers** employed at the plant are **considerably aged** (~57 years). A new boiler is being planned for installation.
Fuel sourcing & management		• **Designed** for **Russian coal** (~5,800 kcal/kg) but it is now using **Karaganda coal** (~4,600 kcal/kg), **impacting performance.** • The **coal storage** is **outdoor open type.**
Major assets	Boiler	• Manufactured by "**Barnul boiler plant**" between 1959 and 1966. Steam generation rate is 95 tons per hour. • Several **repair work** has been done on the **boilers** to **increase service life** and **ensure reliability**.
	Turbine	• Turbine 1 was manufactured by "**PRC, Wuhan Turbine Plant**" and turbine 2 was manufactured by "**Ural Turbo Engine Plant.**" • Turbine 1 was replaced in **2012**, turbine 2 has **368,809** hours of **operating time** left.
	Generator	• Generator 1 is manufactured by "**PRC, Wuhan Turbine Plant**" and generator 2 is manufactured by "**Novosibirsk Turbine Generator Plant.**"
Plant operations		• The plant generated **391,985 MWh** of electrical energy in **2021** and supplied **335,050 MWh** of electrical energy to the **grid**. It reported an auxiliary consumption of **~14.52%** in 2021. • The plant consumed **218,753.5 tons of coal** in 2021. It reported a specific fuel consumption of **0.44 kg / kWh** in 2021. • **Three boilers** shared by the two turbine generator units are **nearing** the **completion** of their potential available operational **life.**
Operation and maintenance		• **Coal dust** was **observed throughout** the plant - accumulated on the floor and on the equipment. • **Leakages** observed in the **cooling water systems** and **steam piping** area below the STG hall. • **High oxygen percent** was observed in **flue** gas (~6-9%).
Water quality		• Temperature difference was observed in the boiler feed water of boilers 1 and 3, which **can lead** to **corrosion** in the deaerator.

9. SOGRINSKAYA CHPP (2/2)

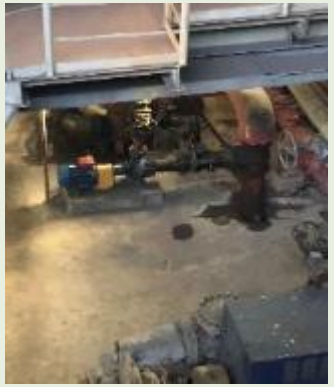
Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	75 MW	2 Units	Sogra energy GmbH	Ust-Kamenogorsk	Northern

Theme	Details
Control systems	• The power plant has **manual switches** and **control knobs** in control room. • The plant has a **SCADA/DCS** system. • The plant does **not** have **any ERP** system.
Emission control and ash management	• The plant does **not** have an **electrostatic precipitator**. • The plant does **not** have a **continuous emission monitoring system.** • **Fly ash** is **removed** through **hydraulic** ash **removal channel**. • The **bottom ash** residue is **transferred** to an ash **dump.**
Structural vulnerabilities	• **Civil damage** such as cracks, breakages, and gaps were observed in the **power plant** floorings, cable trays, and other supporting structures. • **Rusting** and **corrosion** were observed in the expansion joints and pipes. • The **structures** were relatively **new** and **maintained.**

Visual observations [1]

1. Open coal storage yard – coal is exposed to snow and ambient conditions

2. Cracks on floors and structures along with coal dust deposit.



3. Low illumination and leakages

Source: 1. Site Visit.

10. SHAKHTINSK SHTEC (1/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	18 MW	3 Units	Akimat of Shakhtinsk	Karaganda	Northern

Plant Status and Performance

Theme		Details
Age		• Set up in 1961 (**62 yrs old**) with operating capacity at **18 MW**. • The 3 **turbines** of the power plant were **installed** and commissioned in **1961** and **1962**. • The turbines were **renovated** in **2021** and **2022** making them **relatively new.**
Fuel sourcing & management		• **Coal** with GCV 3,324 kcal/kg is the **primary source** for energy generation. • The power plant has **open type** coal storage **yard**.
Major assets	Boiler	• Manufactured by "**Barnaul boiler plant**" between **1961** and **1971** and with steam generation capacity of 40 tons per hour. • The boilers are **more** than **52 years** old. • **Service life extension** of boilers was **conducted** in **2021** and **2022** - boilers 3 and 4 extended till 2024 and boiler 1 extended to 2025.
	Turbine	• Manufactured by "**Kaluga Turbine Plant**" between 1961 and 1962. • The rated capacity of each turbine is **6 MW**. • The turbines are more than **60 years old**. However, the turbines were **renovated** in **2021 / 2022**.
	Generator	• Manufactured by "**Lysvensky Turbine Works**" between 1961 and 1962. Each generator is rated at 6 MW each. • The generators are more than 60 years old.
Structural vulnerabilities		• **Cracks** and **gaps** were **observed** in the structure of the power plant. • The **buildings** need **modernization and reinforcement.** • Two **chimneys** 60 m and 100 m in **pre-emergency and emergency state**; recommended to **dismantle** chimney with height 100 m. • Buildings have **physically exhausted** their **resource** and pose a safety risk.
Plant operations		• The power plant's systems are **old** and have **low efficiency**, leading to an **increase** in **outage time** and **higher maintenance**. • The plant operates on a **heat demand basis**, mostly from October to April. The power plant generates **97% of heat** and 3% **of electricity.** • The power plant reported that it is operating at **30% less manpower** than required for efficient operations.

10. SHAKHTINSK SHTEC (2/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	18 MW	3 Units	Akimat of Shakhtinsk	Karaganda	Northern

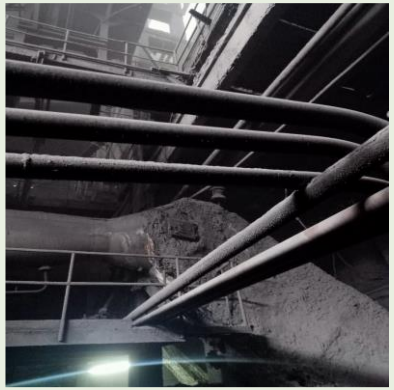
Theme	Details
Operation and maintenance	• **Coal dust** was **observed throughout** the plant. • **Extensive damage** in the **insulation** of various **pipes** was also observed. • Power plant is **unable** to **retain control room personnel** due to financial constraints leading to lack of institutional knowledge. • The power plant needs to **refurbish coal mills** and the **piping system.** • During the **summer** months, the plant is kept off to carry out **maintenance** work.
Control systems	• The power plant has **manual operation of boilers and steam turbine** from control room. • The plant has **SCADA/DCS system.**
Emission control and ash management	• The power plant does **not** have a **continuous emission monitoring system.** • The power plant does **not** have an **electrostatic precipitator**.

Visual observations

1. Poor condition of chimneys[2]

2. Control room [1]

3. Poor maintenance of the boiler room [1]



4. Poor maintenance of the boiler piping structures [1]

Source: 1- As per report no – NeKZ40VEK00012525; 2 – Technical report.

11. SHULBA HPP (1/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Hydro	Electricity	702 MW	6 units	Samruk Energo	Semipalatinsk City	Northern

Plant Status and Performance

Theme		Details
Age		• The plant was commissioned in **1987** and has been in operation for **36 years**. • All the **turbines** were **overhauled** and **upgraded ~ 5 years ago.**
Major assets	Turbine	• Manufactured by “"**Turboatom Kharkiv**” between 1983 and 1989. • Each turbine has a rated capacity of 120 MW.
	Generator	• Manufactured by “"**Elektrosila St. Petersburg**” between 1986 and 1990. • Each generator has a rated capacity of 117 MW.
	Reservoir	• The **maximum capacity** of the reservoir is **2,390,000,000** m^3. • **Post R&M,** the **flow rate increased** from 552 m^3/s to 554 m^3/s for each block.
Structural vulnerabilities		• Last **structural survey** was conducted in November **2021**. The plant conducts annual multifactor survey of the hydraulic structures, periodic technical and visual inspections of power equipment, technological systems, buildings, and structures. • The **structures were in good condition**. • Annually, the plant checks the **readiness** of the **facilities** of HPP for the passage of **environmental protection** of this spring flood. • There were **no fire barrier walls** and **oil water separator** pits near the transformers to prevent fire or explosion from spreading.
Plant operations		• The plant reported an **auxiliary consumption** of **~1.38% in** 2021. • Water **flow** in the plant has **increased** since **2014** due to work related to **filtration**, elimination of **seal defects**, **grouting,** etc.
Operation and maintenance		• The plant was **well maintained** with housekeeping and color coding as per standards. • **Fire suppression** like high pressure sprinkler or eco- and human-friendly gas system was **not available** in the generator hall. • **Battery bank room** was **well maintained** with proper ventilation system and explosive proof electrical fittings. • **Detailed schedule** for **maintenance activities** available.
Environment management		• Removal of **polluted air** during **welding** is carried out by **local suction** in the form of a flexible exhaust device, followed by cleaning in an electrostatic filter

11. SHULBA HPP (2/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Hydro	Electricity	702 MW	6 units	Samruk Energo	Semipalatinsk City	Northern

Theme	Details
Control systems	• The **control system** of the HPP was well maintained with **DCS** displaying the status of the breakers / running status and all other important key parameters. • The local **electric** and **electronic control panels** are **manual**, knob operated. • The plant has **stand-alone vibration modules** and sensors display, which are **absent** in the **central control room** for operator's view or monitoring. • The plant has an **ERP system**. Some elements of ERP have been introduced as part of the 1C: TOIR software product. The transition from 1C: UPP to 1C: ERP UPP is under way.

Visual observations [1]

1. Control room was well equipped with DCS but had manual knob operations

2. Turbine halls were well maintained

3. DC battery bank room was clean and well maintained

Source: 1. Site Visit.

12. SEMIPALATINSK CHPP-1 (1/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	24 MW	2 units	Department of Energy, Abay Region	Semipalatinsk	Northern

Plant Status and Performance

Theme		Details
Age		• The plant was commissioned in **1991** and has been in operation for **32 years**. • The turbine generator **block 2** was **overhauled** and upgraded ~**12 years ago.** • Construction of new **CHPP** of **360 MW** is **planned** (budget approved).
Fuel sourcing & management		• The plant uses coal from the **Karazhyra deposit** (D/DV hard coal). • **Dust suppression** and **fire fighting** system is **not operational** in the coal **yard.**
Major assets	Boiler	• Manufactured by "**Biysk boiler plant**" between 2013 and 2019. • The boilers have a steam generation capacity of 30 tons per hour each.
	Turbine	• Turbines 1 and 2 manufactured by **JSC "Kaluga Turbine Plant"** in 1991 and 2011, respectively. • Rated capacity of each turbine is 12 MW.
	Generator	• Generators 1 and 2 manufactured by **HC JSC "Privod"** in 1992 and 2011, respectively. • Rated capacity of each generator is 12 MW.
Plant operations		• The plant generated **60,181 MWh** of electrical energy in **2021** and supplied **31,734 MWh** of electrical energy to the **grid**. It reported an auxiliary consumption of **~47.27%** in 2021. • The plant consumed **140,887.2 tons of coal** in 2021. It reported a specific fuel consumption of **0.18 kg / kWh** in 2021. • The plant reported that the **tariff** is **low** for both **heat** and **electricity.**
Operation and maintenance		• **Unburned carbon**/coal wastage is a major issue as reported by the plant. • The plant does **not** have a **battery backup** or **DG system** for emergency. • **Coal dust** was **observed throughout** the plant - accumulated on the floor and on the equipment. • **Oil** and **water leakage** as well as **accumulation** was **observed** in multiple locations in the plant.
Water quality		• The plant has a **demineralization plant** to provide demineralized water. • Water quality **testing** is done **manually** in the lab. • The plant does **not** have an **online steam water analysis system.**

12. SEMIPALATINSK CHPP-1 (2/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	24 MW	2 units	Department of Energy, Abay Region	Semipalatinsk	Northern

Theme	Details
Control systems	• The power plant has **old** and **obsolete control system** with **manual operation** of boilers and steam turbine from control room. • The plant does **not have DCS system** for turbine generator **block 1.**
Emission control and ash management system	• The plant is equipped with **electrostatic precipitator**, but the current **filter systems** are **not working** resulting in **higher emissions.** • The plant has been **penalized** for **noncompliance** to the emission norms. • The plant does **not** have a **continuous emission monitoring system.** • Plant has **pneumatic ash removal** scheme from electrostatic precipitators to existing tanks. • **Bottom ash removal** is **manual** and is carried out during the boiler **shutdowns**.
Structural vulnerabilities	• Last **structural survey** was conducted in **September 2022**. • Buildings need **renovation** and **reinforcement**. • **Firefighting system** is **not operational**.

Visual observations [1]

1. Fine ash and coal dust

2. Leakages and spills from pipe structures

3. Rusting of equipment

4. Control room had manual knob operations

Source: 1. Site Visit.

13. AKSU POWER PLANT (1/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	2475 MW	8	Eurasian Energy Corporation JSC	Pavlodar	Northern

Plant Status and Performance

Theme		Details
Age		• Set up in 1968 **(47 yrs old).** • **Blocks 1 to 6 underwent renovation and modernization between 2001 and 2020.** • Block 8 has not undergone any renovation and modernization. • **Block 7 is currently undergoing reconstruction.**
Fuel sourcing & management		• The plant obtains its coal from **Vostochny Open Pit Coal Mine.** • Fuel efficiency in 2021 was 1.725 kWh / kg that is ~3% greater than 2020.
Major assets	Boiler	• Manufactured by PJSC "**Podolsk Machine-Building Plant**". • **A residual life assessment and service life extension was carried out for the boiler unit of blocks 1, 3, 4, and 8.**
	Turbine	• Manufactured by "**JSC Turboatom**" for all blocks. • At maximum continuous rating, the rated capacity of blocks 1, 3, 4, 7, and 8 is 300 MW and for the remaining blocks it is 325 MW.
	Generator	• Manufactured by "**Electrotyazhmash**" for all blocks.
Plant operations		• The utilization factor of all the blocks except blocks 5 and 6 is in the range of **55-84%** (less compared to a standard of 85%). • The plant reported **lower auxiliary consumption of ~4.8%.** • The plant has highlighted that only **three of the eight blocks were shut down** for a total of 2,472 hours (~103 equivalent days) in 2017 and 2020.
Operation and maintenance		• **Fine coal dust** was found on top of the insulation sheets as well as the structural elements of various supports and the flooring. • **Civil damage such as cracks** were observed in the floors and pathways. • **Water leakages** were observed from pipes/equipment and from the roofing of the BTG hall due to leakages during rain.
Control systems		• The power plant has **manual knob operations** of boilers and steam turbine from control room. • The plant has **SCADA system**. It has no DDCS and PLC automation systems.

13. AKSU POWER PLANT (2/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	2475 MW	8	Eurasian Energy Corporation JSC	Pavlodar	Northern

Theme	Details
Emission control and ash management	• The plant has **electrostatic precipitator system** with a design efficiency of 99.1%. • The plant **plans to install automatic monitoring systems** for emissions control in the chimneys. • The plant uses **hydraulic ash removal system** to send the generated ash and slag to the ash dump. • The plant has a **geo membrane bottom ash pond** put to operation in 2015. Other ash ponds abandoned with impermeable ash pond flooring.

Visual observations[1]

1. Coal dust deposit accumulation and suspension in the atmosphere

2. Cracks on floors and pathways

3. Water leakages

4. Oil vapors fumes in the valves and controls

5. Manual knob control operations

Source: 1. Site Visit

14. RIDDER CHPP (1/3)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	59 MW	5 units	JSC Ridder CHPP	Ridder City	Northern

Plant Status and Performance

Theme		Details
Age		• The plant was commissioned in 1956 and is over **65 years.** • **Boilers 1, 2, and 5 have depreciated fully.** • In 1990, it has revamped boilers for improving the efficiency to 90 TPH to meet the winter heat demand.
Fuel sourcing & management		• The plant has a higher storage of low-grade coal and lower storage for high-grade coal. It uses high-quality coal in the winters for economical operations when the plant produces heat.
Major assets	Boiler	• Boilers 1-3 from Godwald, Brno, Czechoslovakia; boilers 4-6 from Podolsk boiler plant. • **All the boiler units are over 50 years old.**
	Turbine	• Turbines 1 and 2 - Kaluga Turbine Plant, turbines 4 and 5 - Sverdlovsk Turbo Engine Plant. • Units 1 and 2 were recommissioned in 2004 and 2008, respectively (~15-19 years ago). • At maximum continuous rating, the rated capacity of blocks 1 and 2 turbine generators is 12 MW, block 4 is 5 MW, and block 5 is 30 MW.
	Generator	• Generators 1 and 2 from Lisovsky Turbine Plant, generator 4 from Electrosila, generator 5 from Novosibirsk Turbine Generator Plant.
Plant operations		• The plant was not producing electricity during the visit. It was informed that plant was buying from grid for its consumption. • **28 emergency shutdowns in 5 years** (accidents - 2, failures of the first degree - 2, failures of the second degree - 24).
Operation and maintenance		• **The plant reported that lack of budget and expertise** affects the plant and equipment maintenance. Hence, the daily O&M has been contracted to a third party which is an expensive exercise. • Running maintenance once in a year and capital maintenance is being done once in 2 or 4 years as per approval. • All the gauges and transmitters lack enclosures. • **Lack of housekeeping and cleaning** observed as there were lot of dust accumulation and debris. • **Spares were unorganized** and disassembled parts were found scattered in the BTG hall. • **Inadequate fire fighting system** across the plant - there was a fire accident near coal conveyor system in January 2023.

14. RIDDER CHPP (2/3)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	59 MW	5 units	JSC Ridder CHPP	Ridder City	Northern

Theme	Details
Control systems	• The power plant has **manual knob operation** of boilers and steam turbine from control room. • As a 1950s plant, it has all **old mechanical and manual operated valves** with advanced operating mechanism - cause delays and inaccurate operation. • The plant has an **ERP system.**
Emission control and ash management	• **No electrostatic precipitator**. • The plant does not have a continuous emission monitoring system.

Visual observations[1]

1. Damaged and unlevelled flooring in STG hall

2. Maintenance bay: Dust accumulation and no fire extinguishers

3. Steam pipelines: External surface rusted

4. Governing valves: Damaged insulation and glass wools

5. STG hall: Inadequate maintenance of wires, pathways, and fire hydrant system

Source: 1. Site Visit.

14. RIDDER CHPP (3/3)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	59 MW	5 units	JSC Ridder CHPP	Ridder City	Northern

Visual observations[1]

6. Boiler floor area: Grease and coal dust accumulation on equipment

7. STG hall : Flooring plates are removed - no caution sign or fencing

8. Boiler floor area: Combustion air duct refractory damaged

9. Outside of BTG house : wasted coal and metal debris dumped

10. Switchyard: Well maintained and colour coded

11. Chimney area: Continuous blow down vessel of boiler not insulated

Source: 1. Site Visit

15. UPNK-PV LLP (1/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Petcoke	Electricity	12 MW	4	UPNK PV LLP	Pavlodar	Northern

Plant Status and Performance

Theme		Details
Age		• Set up in 2016 **(~ 7 yrs old).** • Operates at a power output range of 7.5 to 8 MW. • New plant - **no R&M** carried out.
Fuel sourcing & management		• Sources petroleum coke from three different sources: **Russia, China, and the local region.** • Has a **good fuel handling capacity** of 205,000 tons of petroleum coke per year, but it typically consumes 180,000 tons per year. • Has both open and close storage yard. • The petroleum coke contains only 0.6% ash.
Major assets	Boiler	• Manufactured by Zhengzhou Boiler Co., Ltd (China). • Has a capacity to produce **35 tons of steam per hour**, at a temperature of 400°C and pressure of 24.5 bar.
	Turbine	• Manufactured by Luoyang Zhongchong Generating Equipment Co., Ltd. (China). • The steam inlet parameters for each turbine: 35 tons per hour of steam, 24.5 bar pressure, and a temperature of 400°C.
	Generator	• Manufactured by Luoyang Zhongchong Generating Equipment Co., Ltd. (China). • Has **two emergency generators**, which are used to control the boiler and boiler inlet flaps during emergency situations.
Plant operations		• The power plant generates significantly **less power compared to the regional demand.** • Does not require any external fuel for its boilers – it is a waste heat steam generator (HRSG) that uses heat from the coking process. • Has an **auxiliary consumption of < 40%.**
Operation and maintenance		• Uses anion and cation resin softening followed by mixed bed filters for demineralization of water. • **Maintenance works** for the STG (steam turbine generator) and boilers are performed by **third party** (turbines - either TOO Gqrent Service or TOO Turboenergomash and boilers - TOO IrtiyshProekt Energostory) • **No long-term supply agreement for spare parts** - spares procured from KNR and delivered six months before the scheduled maintenance work.

15. UPNK-PV LLP (2/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Petcoke	Electricity	12 MW	4	UPNK PV LLP	Pavlodar	Northern

Theme	Details
Control systems	• The control systems have a **SCADA/DCS systems.** • **No ERP system.**
Emission control and ash management	• **No ESP** (electrostatic precipitator). • **Use bag filters** - capture dust **and wet scrubbers** - remove the acid component in flue gas. • Does not produce any wastewater or slurry - there is no need for a disposal pond. • Continuous emissions monitoring system (CEMS) installed.

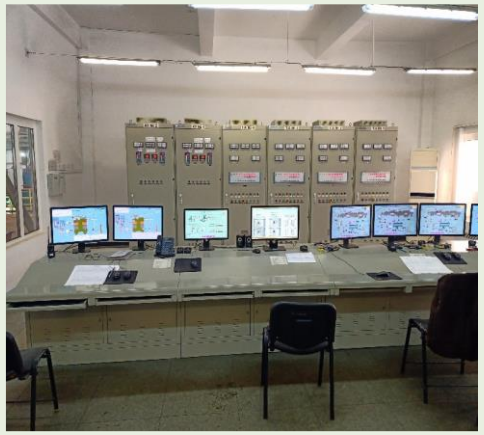
Visual observations[1]

1. Coal storage and conveyor belt

2. Coke oven

3. Chimney with wet scrubbers

4. Steam turbine 4



5. Control room

Source: 1. Site Visit.

16. KARAGANDA ENERGOCENTER CHPP-1 (1/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	24 MW	4	Kazakhstan Utilities Systems	Karaganda	Northern

Plant Status and Performance

Theme		Details
Age		• Had 5 generating blocks and block 1 was decommissioned. • Has 4 operating turbines with 2 installed in 1963 (~60 yrs), 1 installed in 1966 (~57 yrs), and 1 was renovated in 2016 (~7 yrs). • Has 8 boilers (5 power boilers and 3 hot water boilers) which are at least ~54 years old.
Fuel sourcing & management		• An **open-air storage system** for coal storage - subjecting coal to snow and contamination. • Open air storage can result in carbon loss during long storage times.
Major assets	Boiler	• Boilers 1 and 2 manufactured by Barnaul Plant and boilers 3-5 manufactured by Biysk Plant. • Total of 5 boilers in the power plant - one is used for heating purposes, while the remaining four are used for the turbines.
	Turbine	• Four turbines - all manufactured by Kaluga Plant.
	Generator	• Four generators - all manufactured by Lysva. • **Volt-Amps reactive system has been renewed**.
Plant operations		• Operates only between October and April for supply of heating and electricity. • Has had multiple outages due to poor maintenance. • **Auxiliary consumption of the plant is high** at ~30%.
Structural vulnerabilities		• Last civil / structural survey was conducted in 2022. • **Cracks and gaps** were observed in the structure of the power plant. • Civil structures and buildings need modernization and reinforcement.

16. KARAGANDA ENERGOCENTER CHPP-1 (2/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	24 MW	4	Kazakhstan Utilities Systems	Karaganda	Northern

Theme	Details
Operation and maintenance	• **Not generating enough profits-** hinders their maintenance and renovation planning • Power plant is unable to retain control room personnel due to financial constraints leading to lack of institutional knowledge • **Coal dust accumulation and insulation damage** on the pipes were observed
Control systems	• **No DCS system**
Emission control and ash management	• **No Continuous Emission Monitoring System (CEMS)** • No Electrostatic Precipitator- **use wet scrubbing system** to control emissions • Employs an **ash-water slurry system** to transport ash from the plant to the disposal area

Visual observations[1]

1. Water leakage from the boilers

2. Oil leakage

3. Poor pipe insulation

4. Old manual knob control systems

Source: 1. Site Visit

17. ARCELORMITTAL CHPP-2 (1/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity& Heat	435 MW	4	JSC ArcelorMittal Temirtau	Karaganda	Northern

Plant Status and Performance

Theme		Details
Age		• Total of 4 turbines with 3 turbines commissioned between 1973 and 1975 **(~50 years)** and the 4th turbine commissioned in 1982 **(~41 years).** • The power plant has 6 boiler units commissioned between 1973 and 1982 **(>41 years).** • **No renovation and modernization** activity has been done in the plant and has been functional for ~50 years.
Fuel sourcing & management		• The plant is using **low-quality coal from Ekibastuz.** • The **ash content in the coal is high** and coal is **abrasive in nature.**
Major assets	Boiler	• All 6 boilers manufactured by Factory Krasny Kotelshchik.
	Turbine	• All 4 turbines manufactured by Ural Turbine Works, City of Yekaterinburg. • At maximum continuous rating, the rated capacity of turbines 1 to 3 is 100 MW and for turbine 4 it is 135 MW.
	Generator	• All 4 generators manufactured by NGTZ Novosibirsk.
Plant operations		• Significantly **old plant** and **operates with very low efficiency**. • The plant has **multiple outages** due to poor maintenance. • Auxiliary consumption of the plant is **~14%.**
Structural vulnerabilities		• Civil / **structural inspections** are done **twice a year.** • **Cracks and gaps** were observed in the structure of the power plant. • The buildings **need modernization** and reinforcement.
Operation and maintenance		• Facing issues due to equipment age - replacement of parts is difficult. • High amount of coal dust - **no coal dust suppression system.** • High generation of ash due to **higher ash content in the coal from Ekibastuz.** • **Financial constraint affects hiring of expertise** for operations and maintenance.

17. ARCELORMITTAL CHPP-2 (2/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity& Heat	435 MW	4	JSC ArcelorMittal Temirtau	Karaganda	Northern

Theme	Details
Control systems	• **Manual operation and control** of boilers and steam turbine from control room. • **No DCS system.**
Emission control and ash management	• No continuous emission monitoring system (CEMS). • Uses both **electrostatic precipitators** as well as **wet scrubbers** for capturing ash from the flue gas.

Visual observations[1]

1. Dust accumulation

2. Oil leakage and spillage

3. Oil leakage from transformer

4. Old manual knob control systems

Source: 1. Site Visit.

18. AKTOBE CHPP (1/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Gas	Electricity & Heat	118 MW	6	Aktobe CHPP	Aktobe	Northern

Plant Status and Performance

Theme		Details
Age		• Blocks 5 and 6 are ~60 years old. Rest are at least 20 years old. • Block 3 underwent renovation and recommissioning ~7 years ago.
Fuel sourcing & management		• **No inhouse storage for gas;** they get gas from 2 separate pipelines - one is a backup just in case the other pipeline is down. • Initially, coal was used as a fuel. Subsequently, the plant shifted to mazut and now to gas.
Major assets	Boiler	• Of the 8 boilers - boilers 1 and 2 were manufactured in USA, boilers 3 and 4 by TKZ, and rest by BKZ. • The power plant has **separate boiler for power generation and heat provision** (8 boilers for electricity, 5 for heat).
	Turbine	• Of the 6 turbines - turbine 3 was manufactured by Ekaterinburg, rest by KTZ. • At maximum continuous rating, turbines 1 and 2 have a rated power capacity of 6 MW, turbine 3 of 30 MW, turbine 4 of 29 MW, turbine 5 of 22 MW, and turbine 6 of 25 MW.
	Generator	• Of the 6 generators, 1 and 2 are modelled T-12-2У3 ЛГТ3, 3 is DDAX-7290ERH, 4 is ТФП-25-2У3, 5 and 6 are ТВС-30 ХЭТМ. • Average in summer is 100 MW, average in winter is 135 MW.
Plant operations		• **Auxiliary consumption is around 15%** for electricity generation and 0.3% for heat generation. • Pipe structures are **poorly insulated.** • Plant has **outstanding debt** of **KZT 1.2 bn** to gas supplier KazTransGas Aimak and **receivables** of **KZT 3 bn** by Aktobe Su Energy Group. • The plant is **dependent** on **payments from receivables** to **service outstanding debt** to gas supplier.
Operation and maintenance		• **Plant reported that low tariff charge** leads to insufficient profits; unable to secure funds for maintenance and renovations or invite experienced personnel. • The **boiler drum and pipes need replacement** - are old and inefficient.

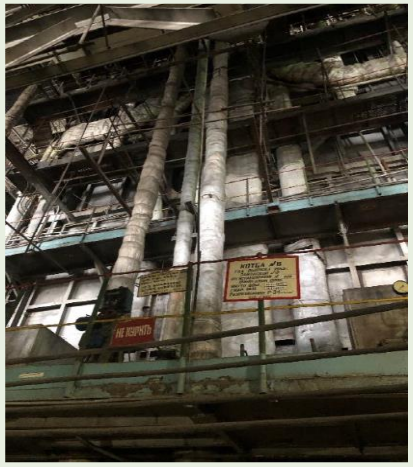
18. AKTOBE CHPP (2/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Gas	Electricity & Heat	118 MW	6	Aktobe CHPP	Aktobe	Northern

Theme	Details
Control systems	• Power plant use ASUTEPE and ASCUE - **Automated system of commercial electricity metering.** • **Automated process control system available.**
Emission control and ash management	• **No filters** as they do not use coal/oil. • **Monitors for flue gas compounds**, after every 40 minutes.

Visual observations[1]

1. Power plant chimney



2. Poor pipe insulation

3. Boiler unit

4.Water treatment plant

Source: 1. Site Visit

19. ASTANA ENERGY CHPP-1 (1/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	22 MW	3	Akimat of Astana	Astana	Northern

Plant Status and Performance

Theme		Details
Age		• The plant was commissioned in **1961** and has been in operation for **62 years**. • **Main equipment** of the plant **underwent** or is **undergoing reconstruction**.
Fuel sourcing & management		• The design capacity of the **coal warehouse** is **100,000 tons**. Currently, the coal reserve is 43,670 tons. The standard reserve agreed with the Ministry of Energy is 31,500 tons. • **Modernization** of the **dust suppression system** at the unloading units was done for warehouse 1 in 2019.
Major assets	Boiler	• 10 boilers were reconstructed in 2020-2022 • **7 are hot water boilers** - 4 manufactured by Sibenergomash, 1 by Dorogobuzh boiler plant, and 2 by Belgorod boiler plant. • Rest **3 boilers are power boilers** manufactured by Sibenergomash.
	Turbine	• Manufactured by **Kaluga Turbine Plant.** • **Turbine 3 is under reconstruction.**
	Generator	• 3 generators - 2 manufactured by **Lysva Turbine Generator Plant** and 1 by **Electrotyazhmash-Privod.** • Generator 3 is under reconstruction • Power generators 1 and 2 are old (**<40 years**).
Plant operations		• All the blocks have **negligible utilization from May to August.**
Operations and maintenance		• **Diesel generator** and **rechargeable battery available** in case of loss of electrical own needs. • **Replacement of the chimney No. 1** planned based on the results of the survey for the implementation period of the fourth quarter of 2024 • Chimney 3 was overhauled in 2021.

19. ASTANA ENERGY CHPP-1 (2/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	22 MW	3	Akimat of Astana	Astana	Northern

Theme	Details
Control systems	• Use **manually operated knob systems** with analog meters for controlling operations from the local control rooms. • **SCADA system available** for visualizing data on the main parameters of turbogenerators - thermomechanical values, vibration, etc.
Emission control and ash management	• **Ash dump No. 1 is filled up to 95-98%.** • Construction of ash dump No. 2 is under way.

Visual observations[1]

1. Chimney

2. Chimney No. 1 reconstruction plan

3. Plant related information available in display board

Source: 1. Site Visit.

20. ZHANAZHOLSKAYA GTPP (1/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Gas	Electricity	168 MW	11	JSC "AMF GROUP"	Aktobe	Northern

Plant Status and Performance

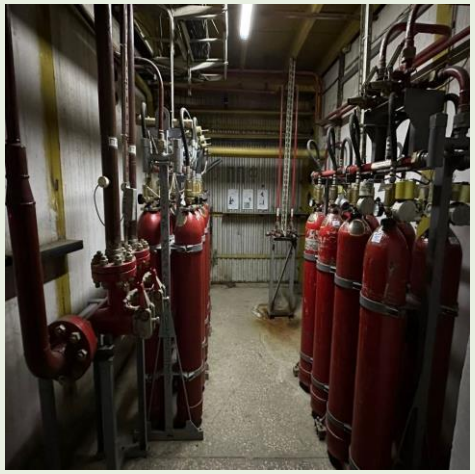
Theme		Details
Age		• Commissioned in 1999 **(<24 years).** • All of the units except 3 and 4 have been **recommissioned in 2004-2021.** • All equipment is either **new or in excellent condition** with a long operational lifespan.
Fuel sourcing & management		• Kaztrans gas, Aimak : approx. 800 m from plant. • No local storage of gas in plant. • **Insufficient fuel gas supply.**
Major assets	Turbine	• 11 turbines manufactured by SE "NPKG "ZORIA-MASHPROEKT", Ukraine.
	Generator	• 11 generators manufactured by OJSC "Electrotyazhmash-Privod", Russia. • Generators 1, 2, 5, 6, 7, 8, 9, 10, and 11 have generation voltage - 10.5 kV. • Generators 3 and 4 have generation voltage - 6.3 kV. • **EDG/ emergency generator available** for each unit.
Plant operations		• **Low power generation** - almost half of its installed capacity due to less fuel supply. • **Auxiliary consumption reported as ~1%.**
Operations and maintenance		• Relatively new plant and is **well maintained.** • Conducts **performance guarantee test on a yearly basis.** • Daily **operation** and **minor maintenance** done by **plant** personnel. • **Major maintenance done by BM company** (third party from Russia). • Yearly spares supply by BM company.
Control systems		• The power plant has a **fully automatic control system**.
Emission control and ash management		• The plant indicated that it **monitors the content** of flue gases.

20. ZHANAZHOLSKAYA GTPP (2/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Gas	Electricity	168 MW	11	JSC "AMF GROUP"	Aktobe	Northern

Visual observations[1]

1. Gas turbine



2. Fire suppression system

3. Power transformer

4. Switchyard

Source: 1. Site Visit

21. ASTANA ENERGY CHPP-2 (1/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	600 MW	6	Akimat of Astana	Astana	Northern

Plant Status and Performance

Theme		Details
Age		• The plant was commissioned in 1979 and has been in operation for **44 years**. • **Most equipment are worn out** and **plant structures are damaged**.
Fuel sourcing & management		• The plant uses coal from **Ekibastuz** coal basin which is abrasive in nature.
Major assets	Boiler	• 14 boilers manufactured by **Sibenergomash.** • **8 are power boilers, 6 are hot water boilers.**
	Turbine	• 6 turbines - 3 manufactured by **Leningrad Machine Plant** and rest 3 by **Ural Turbine Works.** • Turbines 1-3 have more than 85% wear and have worked out their park resource (mechanical wear of the nozzle blades, reg. stage).
	Generator	• 6 generators - 3 manufactured by **Leningrad Machine Plant** and rest 3 by **Ural Turbine Works.**
Plant operations		• **Relatively high specific fuel consumption** (average: ~386 g/kWh). • **High auxiliary consumption** (~18%).
Operations and maintenance		• Equipped with **emergency diesel generator** sets. • Coal dust accumulation observed in TG hall. • **Excess steam water loss** observed - leakages damage the building and metal structures in the main building. • **Damaged structures** like ribbed floor slabs, wall panels, window frames in the boiler room, turbine, deaerator department.
Control systems		• Use **manually operated knob systems** with analog meters for controlling operations from the local control rooms. • **SCADA system (ASKUTE and AMR) available** for visualizing data on the main parameters of turbo-generators - thermomechanical values, vibration, etc.
Emission control and ash management		• Ash dump No. 1 is filled by 95-98%. • **Construction of ash dump No. 2 is under way.** • **Electrostatic precipitators installed** at boilers 7 and 8, operating at an efficiency 99.6% and 99.7%, respectively.

21. ASTANA ENERGY CHPP-2 (2/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	600 MW	6	Akimat of Astana	Astana	Northern

Visual observations[1]

1. Turbine room: coal dust accumulation over equipment

2. Old and damaged walls in the plant

3. Clogged exhaust

4. Ash dump 1: 95-98% exhausted

5. Ash dump 2: under construction

6. Control room: manual knob operation

Source: 1. Site Visit.

22. ARKALYK FUEL AND ENERGY COMPLEX (1/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Gas (& coal)	Electricity & Heat	4 MW	1	Akimat of Arkalyk	Kostanay	Northern

Plant Status and Performance

Theme		Details
Age		• The plant was set up in 1963 (**~60 years old).** • **No R&M** carried out in the existing units.
Fuel sourcing & management		• The old unit uses natural gas of GCV 9,590 kcal/m^3. • The plant has also started using coal as an alternate fuel - three new coal-based boilers have been installed.
Major assets	Boiler	• Manufactured by Belgorodsky KZ. • At maximum continuous rating, the steam generation capacity of the boiler is 35 ton/hour.
	Turbine	• Manufactured by Kaluga TZ. • It has new steam turbine units installed which are yet to be commissioned.
Plant operations		• The plant highlights that there has been **no emergency shutdown** in last 5 years. • The plant produces heat when the demand is high.
Operations and maintenance		• Last energy audit was carried in 2016. • The plant undertakes annual scheduled maintenance. • **Insulation damages were** observed in the boilers and steam pipelines. • **Rusting** of pumps and pipe joints observed. • There were instances of **oil leakages** near pumps.
Control systems		• **No ERP system** for resource management. • **No automated control system.** • **No SCADA/DCS system** available for the old units. • The new boiler turbine control units are equipped with DCS.
Emission control and ash management		• **No electrostatic precipitator (ESP)** installed for particulate matter control. • **Fly ash emissions** are discharged through a 120-meter-high chimney. • Bottom ash is transferred by a third party for dumping.

Source: 1. Site Visit

22. ARKALYK FUEL AND ENERGY COMPLEX (2/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Gas (& coal)	Electricity& Heat	4 MW	1	Akimat of Arkalyk	Kostanay	Northern

Visual observations[1]

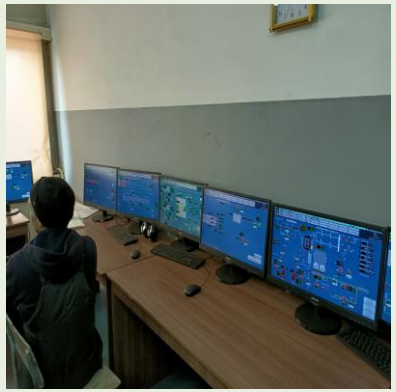
1. Hot water heaters - insulation damaged

2. Steam line insulation damaged

3. Coal dust near new boiler units

4. Damage to building structures

5. Bottom ash collection



6. New boiler control room with DCS

7. Open coal storage yard

8. Water and chemical leakage in water treatment plant

Source: 1. Site Visit

23. PAVLODAR CHPP-3 (1/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	555 MW	6 Units	CAEPCO	Pavlodar City	Northern

Plant Status and Performance

Theme		Details
Age		• Set up in 1972 (**45 yrs old**) and operating at 555 MW. • The blocks were **overhauled** and **upgraded** in last **4 years**.
Fuel sourcing & management		• The plant uses **coal** of calorific value of 3,968 kcal/kg.
Major assets	Boiler	• Manufactured by "**Barnaul Boiler Plant**". • Steam generation rate capacity of 270 tons/hour by each boiler. • Boiler of **blocks 2 to 6** may have **potentially completed** the available **operational life.** • Boiler of block 1 seems to have the **increased residual life** due to **R&M** done in 2011.
	Turbine	• Manufactured by "**Ural Turbine Works**" for blocks 1, 2, 4, 5, and 6, and "**Leningradsky Metallichesky Zavod (LMZ)"** for block 3. • The **turbine for block 3 may have completed its available potential operational life**.
	Generator	• Manufactured by "**NTGZ**" for block 3 and "**NPO "ELSIB" JSC**" for remaining blocks. • The **generator for block 3 may have completed its available potential operational life**.
Structural vulnerabilities		• The plant has conducted **building/structural survey** in **2021**. • **Cracks** and **gaps** were **observed** in the pathway and flooring throughout the plant.
Operation and maintenance		• **Coal dust** was observed in the **BTG Hall** accumulated on the floor and equipment. • **Civil damage** such as **deformations** in the **ducts** carrying coal dust as well as **patching works** from the previous repairs. • **Rusting** observed in the **pipe infrastructure**, the iron handrails, insulation dents, and other structures. • **Waterlogging** was observed on the flooring and pathways.
Control systems		• The power plant has **semiautomated control systems**. • The plant has a **DCS** system for monitoring the plant performance. • The control room also has a **few manually operated knobs** and outdated switchgear and relays.
Emission control and ash management		• The plant **does not have an electrostatic precipitator** system in place to capture dust from the flue gas. • The plant has planned to **install automated monitoring system (ACM**) to monitor gas emissions.

23. PAVLODAR CHPP-3 (2/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	555 MW	6 Units	CAEPCO	Pavlodar City	Northern

Visual Observations [1]

1. Damage on civil structures

2. Rusting of pipes and equipment

3. Water accumulation and seepages

4. Coal dust accumulation on equipment

5. Manual / semiautomatic control center.

Source: 1. Site Visit.

24. STEPNOGORSKAYA CHPP (1/3)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	180 MW	5 Units	Stepnogorskaya CHP LLP	Stepnogorsk City	Northern

Plant Status and Performance

Theme		Details
Age		• Commissioned in **1966** and has been in **operation for 50+ years**. • **All** the 9 **boilers** are **over 37 years** old. • **All** the **turbine** units **except turbine 12** were **commissioned 54-72 years ago**. • **Turbine 12** was **recommissioned** in **2014**.
Fuel sourcing & management		• The plant uses a **medium-grade coal** with GCV ~ 3,972+ kcal/kg. • **Open coal storage yard**, which makes the **coal** susceptible to **contamination** due to snow and moisture.
Major assets	Boiler	• Manufactured by "**Barnaul Boiler Plant.**" • Steam generation rate is '160 tons/hour' for boilers 1-3 and '220 tons/hour' for boilers 4-6. • The **boilers** have **not** been **renovated**. Boiler 1 is in need of replacement.
	Turbine	• Manufactured by "**Ural Turbo Generator Plant**" for Units 1 and 2, "**Kaluga Turbo - generator Plant**" for Units 3 and 4, and "**Leningrad Turbo - generator Plant**" for Unit 5. • The rated capacity is 35 MW for Units 1 and 2, 25 MW for Units 3 and 4, and 60 MW for Unit 5. • **Turbines 1 and 2** have **undergone R&M** in 2017 and 2021, respectively.
	Generator	• Manufactured by "**Lysven Turbo -generator Plant**" for Units 1 and 4, "**Ukrainian Soviet Socialist Republic Lenin Plant El.Tyazh. Mash.**" for Units 2 and 3, "**Factory Kharkiv**" for Unit 4, and "**Siberian El.Tyazh. Mash**" for Unit 5.
Structural vulnerabilities		• **Cracks** and **open pit** in **pathways** and **misplaced metal plates** in the floorings.

24. STEPNOGORSKAYA CHPP (2/3)

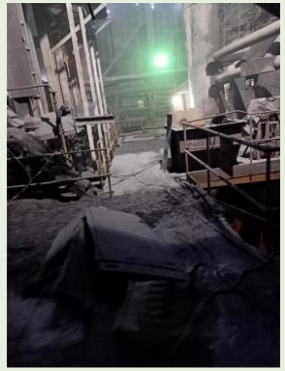
Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	180 MW	5 Units	Stepnogorskaya CHP LLP	Stepnogorsk City	Northern

Theme	Details
Plant operations	• The plant generated **1,057.5 GWh** of electrical energy in **2021** and supplied **853 GWh** of electrical energy to the **grid**. It reported an auxiliary consumption of **~19.34%** in 2021. • The plant consumed **684,529.53 tons of coal** in 2021. It reported a specific fuel consumption of **0.65 kg / kWh** in 2021. • The plant has **poor operational parameter** and **lower running efficiency** of plant. • The plant is facing **multiple outages** due to poor maintenance.
Operation and maintenance	• The power plant reported that it is **unable** to **retain control room personnel** due to **financial constraints** leading to lack of institutional knowledge. • Coal dust **accumulation** was **observed throughout** the plant. • **Extensive damage** in the **insulation** of various **pipes** was also observed.
Control systems	• **Manual operation** of boilers and steam turbine from control room. • The plant does not have a DCS system.
Emission control and ash management	• The plant does **not** have a **continuous emission monitoring system (CEMS).** • The plant does **not** have an **electrostatic precipitator.** • The plant **uses wet scrubbers** to capture ash.

24. STEPNOGORSKAYA CHPP (3/3)

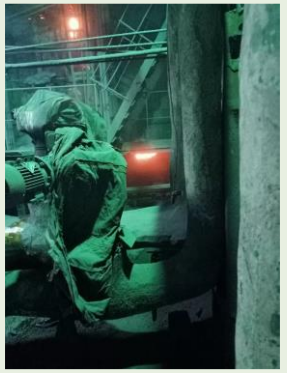
Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	180 MW	5 Units	Stepnogorskaya CHP LLP	Stepnogorsk City	Northern

Visual observations[1]




1. Coal dust accumulation





2. Leakages



3. Poor equipment maintenance

4. Power plant control room

5. Coal handling

6. BTG hall

Source: 1. Site Visit

25. PAVLODARENERGO CHPP-2 (1/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	110 MW	3 Units	CAEPCO	Pavlodar City	Northern

Plant Status and Performance

Theme		Details
Age		• The plant was commissioned in **1961** and has been **operational for 60+ years**. • All the boilers of the plant were commissioned between 1959 and 1968. • The turbines of the power plant were commissioned between 1959 and 1960. • The **average age** of the **equipment** is **60+ years**.
Fuel sourcing & management		• The plant uses a **medium-grade coal** with **GCV** (~ 3,980 kcal/kg). • **Open** coal storage **yard**, which makes the **coal susceptible** to **contamination** due to snow and moisture.
Major assets	Boiler	• Manufactured by "**Barnaul Plant**" for all the boilers between 1959 and 1960. • All of the boilers produce steam at a pressure of 125 bar. • The plant has **not undertaken** any other **R&M**.
	Turbine	• Manufactured by "**UMTZ**" for turbines 1 and 2 and "**LMZ**" for turbine 3. • The rated capacity is 25 MW for turbines 1 and 2 and 60 MW for turbine 3. • **No renovation** has been **done** on the main equipment of the plant.
	Generator	• Manufactured by "**NTGZ**" for all 3 generators. • All the **generators** were manufactured between **1959** and **1962** with rated capacity of 2 x 30 MW and 1 x 60 MW.
Structural vulnerabilities		• The last **civil / structural survey** was done in **2022**. • The plant **buildings** need **modernization** and **reinforcement** • The power plant had a **chimney inspection** undertaken in August **2021**.

25. PAVLODARENERGO CHPP-2 (2/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	110 MW	3 Units	CAEPCO	Pavlodar City	Northern

Theme	Details
Plant operations	• The power plant is **significantly old** and **operates with** very **low efficiency**. • Due to the **age of the plant** and **low efficiency**, the **plant** is facing increased **O&M costs**.
Operation and maintenance	• Considering the **age** of the **main equipment** and the plant, the plant is in **dire need for renovation** and modernization. • The plant has **undertaken residual life assessments** for the various equipment and **extended** the **life** to **around 2025** for most equipment. • The power plant is **unable** to **retain control room personnel** due to financial constraints leading to lack of institutional knowledge.
Control systems	• The power plant has an **ASDU MIR** that performs **SCADA** functions.
Emission control and ash management	• The power plant does **not** have a **continuous emission monitoring system** • The power plant does **not** have an **electrostatic precipitator**.

Note: The site visit team was restricted from photography during the visit.

26. KARAGANDA ENERGOCENTER CHPP-3 (1/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	670 MW	8 Units	Kazakhstan Utility Systems	Karaganda City	Northern

Plant Status and Performance

Theme		Details
Age		• Commissioned in **1947** and has been **operational** for **40+ years**. • **Turbines** 1 to 4 were commissioned in **1977-1990** and is **~40 years old**. Turbines 5 and 6 were commissioned in **2012** and **2016**. • The power plant has **8 boilers**. The boilers were installed between **1977 and 1995** except boiler 8 which was installed in 2016.
Fuel sourcing & management		• The plant uses a **medium-grade coal** with **GCV** of ~ 3,998 kcal/kg, and **ash content** in the coal was significantly **low**. • **Open** coal **storage yard**, which makes the coal **susceptible** to **contamination** due to snow and moisture.
Major assets	Boiler	• Manufactured by "**Barnaul Boiler Plant**" for boilers 1-7 and "**Harbin Plant**" for boiler 8. • All of the boilers produce steam at a pressure of 140 bar. • The plant has **not undertaken** any other **R&M**.
	Turbine	• Manufactured by "**UMTZ**" for turbines 1-4, "**LMZ**" for turbine 5, and "**Harbin Plant**" for turbine 6. • The rated capacity is 120 MW for turbines 1–4, '152 MW' for turbine 5, '110 MW' for Turbine 6.
	Generator	• Manufactured by "**Novosibirsk Plant**" for all 6 generators. • Generators 1 to 4 were manufactured between 1977 and 1990, generators 5 and 6 in 2011 and 2016.
Structural vulnerabilities		• **Cracks** and **gaps** were **observed** in the structure of the power plant. • The **buildings need modernization** and **reinforcement**.
Plant operations		• The plant generated **4,316.3 GWh** of electrical energy in **2021** and supplied **3,791.7 GWh** of electrical energy to the **grid**. It reported an auxiliary consumption of **~12.15%** in 2021. • The plant consumed **3,323,404 tons of coal** in 2021. It reported a specific fuel consumption of **0.37 kg / kWh** in 2021. • **Poor operating parameter** and **low** plant running **efficiency is a concern.** • The plant has **multiple outages** due to **poor maintenance**.
Operation and maintenance		• **Coal dust accumulation** was observed **throughout** the plant. • **Extensive damage** in the **insulation** of various pipe.

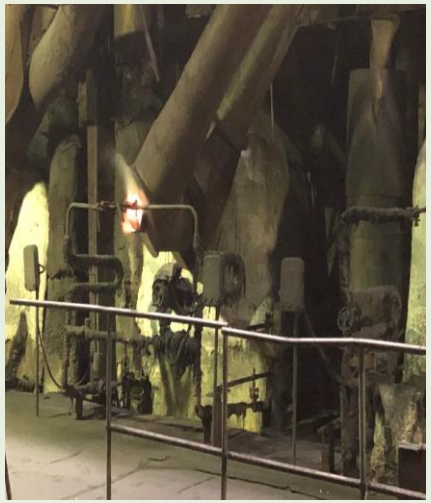
26. KARAGANDA ENERGOCENTER CHPP-3 (2/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	670 MW	8 Units	Kazakhstan Utility Systems	Karaganda City	Northern

Theme	Details
Control systems	• **Manual operation of boilers** and **steam turbine** from control room. • The plant does **not** have a **DCS system**
Emission control and ash management	• The plant does **not** have a **continuous emission monitoring system (CEMS).** • For CEMS installation, **new chimneys** and/or **additional stairs/platforms** are **needed** to access the equipment.

Visual Observations [1]

1. Poor equipment maintenance



2. Leakages

3. Control room

Source: 1. Site Visit.

27. UST-KAMENOGORSK CHPP (1/3)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	372.5 MW	8 Units	Kazakhstan Utilities Systems	Ust- Kamenogorsk City	Northern

Plant Status and Performance

Theme		Details
Age		• Commissioned in **1947** and has been in operation for **75 years**. • All the **9 boilers** are **over 37 years** old. • **All** the **turbine** units except turbine 12 were commissioned **54-72 years ago**. Turbine **12** was recommissioned in **2014**.
Fuel sourcing & management		• The plant uses a **good quality coal** with **GCV** of ~ 4,500+ kcal/kg, and **ash content** in the coal was significantly **low**. • **Open** coal **storage yard**, which makes the **coal** susceptible to **contamination** due to snow and moisture.
Major assets	Boiler	• Manufactured by "**Central Boiler and Turbine Institute (CKTI)"** for boilers 1-4, "**BKZ**" for boilers 5-8, and "**Taganrog Krasny Kotelshchik (TKZ)"** for boiler9. • All **boilers were upgraded and repaired** in 2022 except boilers 10 and 14. **Repair activities** of boiler 10 are 30% completed and that of boiler 14 are 10% completed. • The maximum nominal pressure for the boilers is 33 atm and 140 atm for boilers 1-4 and boilers 5-9, respectively.
	Turbine	• Manufactured by "**Kaluga Turbine Plant**" for unit 1, "**Kirov Turbine Works**" for units 4-7, and "**Dongfan**" for unit 8. • The rated capacity of the turbines varies significantly from 3.5 MW for the turbine of unit 1 to 120 MW for the turbine of units 7-8.
	Generator	• Manufactured by "**Plant Lysva**" for unit 1; "**Elektrosila Leningrad**" for units 2, 3, and 5; "**Factory Kharkiv**" for unit 4; "Novosibirsk city" for units 6-7; and "**China Dongfang**" for unit 8.
Plant operations		• The plant generated **2,168.2 GWh** of electrical energy in **2021** and supplied **1,843.5 GWh** of electrical energy to the **grid**. It reported an auxiliary consumption of **~15%** in 2021. • The plant consumed **862,666.9 tons of coal** in 2021. It reported a specific fuel consumption of **0.40 kg / kWh** in 2021. • All the **units** have **less** than **85% utilization factor** for electricity generation. • **High auxiliary consumption** of ~15% for electricity and ~5% for heat generated.
Operation and maintenance		• There is **unsafe condition** due to **cables** running and **water spillages** around the crusher. • **Water leakages** in the **boiler area** were observed. • **Red hot spots** were **observed** in the **coal** fine **feed piping.** • **Cracks** and **open pit** in **pathways** and **misplaced metal plates** in the floorings.

27. UST-KAMENOGORSK CHPP (2/3)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	372.5 MW	8 Units	Kazakhstan Utilities Systems	Ust- Kamenogorsk City	Northern

Theme	Details
Control systems	• **Not all** boiler and turbine generator units are equipped with a **SCADA/ distributed control system**. • **Semiautomatic control room** with analog meters and manual operating knobs. • **No fire detection** and **suppression system** like smoke detectors and fire alarm panel in the central **control room**.
Emission control and ash management	• **No electrostatic precipitator**. **Periodic** instrumental **measurements** at source of emissions (gas ducts in front of the pipe) are conducted. • Planned the **installation** of an **automated system for monitoring** (ASM) emissions in **2023**. • Has a **circulating service water supply system** with a **cooling tower** as well as a circulating hydraulic ash removal system. • The collected **ash** is disposed in the **ash dump**.
Water	• **Steam / water chemistry** testing is done **manually** in the lab. • **No online steam** water **analysis** system.

Visual observations[1]

1. No dust and fire suppression system

2. Cables and water spillage around crusher

3. Low Illumination, water and oil spillage, rusting

Source: 1. Site Visit.

27. UST-KAMENOGORSK CHPP (3/3)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	372.5 MW	8 Units	Kazakhstan Utilities Systems	Ust- Kamenogorsk City	Northern

Visual observations[1]

4. Suspended coal dust and damaged insulation

5. Water testing area

6. Transformers: lack enough fire fighting system

7. No proper tagging, oil leakage, steam leakage, no fire fighting system

8. Pit hole in pathways

Source: 1. Site Visit

28. PAVLODAR CHPP-1 (1/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	350 MW	6 Units	Eurasian Resources Group	Pavlodar Region	Northern

Plant Status and Performance

Theme		Details
Age		• Commissioned in **1964** and has been in operation for **50+ years**. • The power plant comprises of **6 turbines and 8 boilers**. • 2 turbines of the power plant were commissioned in 1964, 2 in 1966, 1 in 2008, 1 in 1982, and 1 in 2009. • The **average age** of the **turbines** is **~29 years**. • 5 **boilers** were **commissioned** between **1962 and 1967**, 1 in **1975**, 1 in **1983,** and 1 in **1987**.
Fuel sourcing & management		• The plant uses a **medium-grade coal** with **GCV** of ~ 3,982 kcal/kg. • **Ash content** in the **coal** used in the power plant is **greater** than **43**%. • **Open** coal **storage yard**, which makes the **coal** susceptible to **contamination** due to snow and moisture.
Major assets	Boiler	• Manufactured by "**Barnaul Boiler Plant**" for all 8 boilers. • The steam generation rate for boilers 1 and 2 is 230 tons/hour and for boilers 3-8 is 250 tons/hour. • 2 boilers have been renovated in 2004 and 2006.
	Turbine	• Manufactured by "**Leningrad Metal Plant**" for units 1-4, "**Ural Turbine Plant**" for unit 5, and "**Leningrad Metal Plant**" for unit 6. • The rated capacity of the turbines 1 and 2 is 60 MW and 50 MW for other turbines. • **R&M** has been conducted in **turbines 1, 2, 3, 4, and 5.**
	Generator	• Manufactured by "ELSIB" for units 1, 2, 4, 5, 6 and "HC JSC "Drive"" for unit 3.
Plant operations		• The plant generated **1,951.1 GWh** of electrical energy in **2021** and supplied **1,669.3 GWh** of electrical energy to the **grid**. It reported an auxiliary consumption of **~14.5%** in 2021. • The plant consumed **735,520 tons of coal** in 2021. It reported a specific fuel consumption of **0.38 kg / kWh** in 2021. • The power plant is **significantly old** and **operates** with very **low efficiency**. • The plant has **multiple outages** due to the **age** of the equipment.

28. PAVLODAR CHPP-1 (2/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	350 MW	6 Units	Eurasian Resources Group	Pavlodar Region	Northern

Theme	Details
Operation and maintenance	• The power plant is **old**. Although some **components** have been **renovated**, the power plant **still needs investments** to replace old components. • The power plant is **facing issues** due to **equipment age**. **Replacement** of parts is **difficult** due to **financial** constraints. • The power plant is **unable to retain control room personnel** due to **financial constraints** leading to lack of institutional knowledge. • The plant also reported **difficulties** in **adjusting heat-electricity production** in and out of the heating season.
Control systems	• **Not all** boiler and turbine generator units are equipped with a **SCADA/ distributed control system**. • **Semiautomatic control room** with analog meters and manual operating knobs. • **No fire detection** and **suppression system** like smoke detectors and fire alarm panel in the **central control room**.
Emission control and ash management	• The plant has **an electrostatic precipitator.** • The power plant does **not** have **continuous emission monitoring system.**

Note: The site visit team was restricted from photography during the visit.

29. UST – KAMENOGORSK HPP (1/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Hydro	Electricity	367.8 MW	4 Units	Samruk Energo	Ust-Kamenogorsk City	Northern

Plant Status and Performance

Theme		Details
Age		• **Commissioned** in **1952** and has been in operation for **71 years**. • 3 **turbines** were **overhauled and reconstructed** ~ 7 years ago. • The **stator** of generator 4 was **replaced** 12 years ago.
Major Assets	Turbine	• Manufactured by "**PJSC Power Machines, St. Petersburg**" for unit 1, "**OJSC Power Machines, St. Petersburg**" for units 2 and 3, and ""**Leningrad Metal Works", Leningrad**" for unit 4. • The rated capacity is 95 MW for units 1-3 and 85 MW for unit 4. • **All turbines** have undergone **R&M** between 2015 and 2021. • **RLA** carried out for **block 1 and 4**.
	Generator	• Manufactured by "**NPO "ELSIB" PJSC Novosibirsk**" for units 1-3 and "**Sibelektrotyazhmash, Novosibirsk**" for unit 4.
	Reservoir	• The plant uses the kinetic energy of flowing water to rotate a turbine generator which produces electricity. • The water capacity of **UST-Kamenogorsk** Hydropower Plant is **650,000,000** m^3.
Structural vulnerabilities		• No **dyke walls** to **contain oil spills** in the step-up **transformer** yard. • **Damages** in **flooring tiles** in the turbine hall. • **No** adequate **caution tagging** for underground steep stairways.
Plant operations		• The plant has a **reservoir** of **650 million cubic meter** capacity. • There has been **20% increase** in flow rate since the time of **commissioning** after **reconstruction** of the three turbine units. • There has been **no change** in the **flow rate** in **turbine 4.** • Since November 2021, the plant has been connected to the **automatic frequency and power control (ARChM) system**.
Operation and maintenance		• The plant is **clean** and **well maintained.** • **Maintenance** is carried out **twice a year**. • **Capital repairs** are conducted **once** in last **7 years.** • The **maintenance bay** has **stored spares** and other **equipment required** for **maintenance.** • The **plant** follows **lock-out tag-out system** for worker safety.

29. UST – KAMENOGORSK HPP (2/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Hydro	Electricity	367.8 MW	4 Units	Samruk Energo	Ust-Kamenogorsk City	Northern

Theme	Details
Control systems	• **PTK GRARM** software and hardware complex are used for **group control of active and reactive power**. • The plant has **SCADA/DCS system**. • The control system is **well maintained** showing gross MW, water flow rate, generator frequency, time, date, etc., with proper tagging. However, these **parameters** are **not reflecting** in the **DCS**.
Emission control and ash management	• **Emission** volumes **calculation** are performed **quarterly**. • The plant has **wastewater recovery and disposal system**.

Visual observations[1]

1. No vibration parameter in DCS screen

2. No fire barrier wall

3. Missing pathway markings and floor tiles damaged

30. BUKHTARMA HPP (1/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Hydro	Electricity	675 MW	9 Units	Samruk Energo JSC	East Kazakhstan Region	Northern

Plant Status and Performance

Theme		Details
Age		• The plant was **commissioned** in **1960** and has been in **operation for 57 years**. • The turbines were **overhauled** and **upgraded ~20 years ago**. • The plant had also **undertaken stator replacement activities** in 4 of the 9 generators – completed for 3 generators and 1 is in progress.
Major assets	Turbine	• Turbines of all 9 blocks are manufactured by "**Leningrad Metal Works (LMZ)**" and are "**Francis Turbine (Radial-axial)**" type. • The rated capacity of each turbine is 79 MW except for block 7 which has a rated capacity of 82 MW.
	Generator	• The generators for the 9 blocks of the hydropower plant are manufactured by "**NTGZ**". • Each generator has a power rating of 75 MW.
	Water reservoir	• The plant uses the kinetic energy of flowing water to rotate a turbine generator which produces electricity. • The **water source** for Bukhtarma Hydropower Plant is the **Bukhtarma reservoir** with a capacity of **54,633,000,000** m^3. • The plant reported a **specific water consumption** of **6.58 m^3/kWh.**
Structural vulnerabilities		• One of the three **power transformers** and the **gas insulated switchyard** rooms were **not equipped** with a **fire suppression** sprinkler system. • There was **no fire walls** separating the **transformers.** • **Pipes** did **not** have **piping supports** which could lead to damages and leakages. • The piping **systems ran low** obstructing the pathways of the workers.
Plant operations		• The **auxiliary consumption** accounts for **~0.97%** of the total electrical energy generated. • The **performance guarantee** test for blocks 2 and 3 was conducted **20 years ago**. • Overall **electricity generation** is **affected** in the **winters** due to ice formation. • **Monthly** capacity **utilization factor** is **above** the overall **yearly** plant capacity **utilization** factor in the **summer months** of April to October • The power plant is conducting **maintenance activities** on a **block-by-block basis**.

30. BUKHTARMA HPP (2/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Hydro	Electricity	675 MW	9 Units	Samruk Energo JSC	East Kazakhstan Region	Northern

Theme	Details
Operation and maintenance	• The plant was **well maintained** except a **few instances** of **leakages** observed. • **Dampening** and **staining** of the **false ceiling** of the **central control room** due to water leakages were observed. • **Uninsulated** bare **copper wire strip** that runs across the floor of the GIS room before connecting to the earth grid could lead to dust and debris deposition on the wire.
Control systems	• The control systems for this hydro plant is **fully automatic** with **DCS** as well as electrical control panel. • **Electrical switchyard** operations, circuit breakers, and isolation switches **cannot** be **monitored** and captured in the DCS. • The plant has **two ERP systems** - 1C and SAP.
Emission control and ash management	• A **compliance** certificate for the existing **environment management system** was issued by **TÜV Thüringen** in 2018, which currently stands expired.

Visual observations[1]

1. Low and unsupported piping

2. Stain due to water leakage

3. Bare earthing copper strip

Source: 1. Site Visit.

31. ARCELOR MITTAL CHPP-PVS (1/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	192 MW	4 Units	ArcelorMittal	Karaganda region	Northern

Plant Status and Performance

Theme		Details
Age		• Commissioned in **1959** and has been in **operation for 55+ years**. • The power plant comprises of **4 turbines and 8 boilers**. • Boiler 1 was commissioned in 1956 and is under renovation.
Fuel sourcing & management		• The plant uses **Ekibastuz** coal, which has **high ash** and **low kcal content.** • The coal is **stored** in an **open-air storage area** with a capacity of 35,000 tons. • The power plant **faces issues** with **coal supply** from various sources, creating challenges in controlling the burning process and fuel mixtures.
Major assets	Boiler	• The boiler operates at 3 different pressure patterns - 35, 13, and 8 bar. • **Boiler 1 is under renovation**.
	Turbine	• The rated capacity of the turbines 1 is 12 MW and 60 MW for other turbines. • Turbine 2 was observed to be under maintenance during the site visit.
	Generator	• The power plant has a total of four generators. • During the inspection visit, the current electricity generation was observed to be 74 MW (38.5% less than rated).
Plant operations		• There has been a considerable increase in outage time, maintenance cost, and profit loss. • The power plant is **not generating** sufficient **profits** by selling **electricity to utility**.
Operation and maintenance		• The **pressure parts** of the boiler and related equipment have **reached their amortization limit** and require renovation. • **Controlling** the **burning process** has become **difficult** due to the use of coal from different sources. • **Significant amount** of **ash production** is causing problems, which can only be resolved by using high-grade coal and implementing an appropriate flue gas handling method. • **Maintenance** is carried out **based on assigned tasks** and is measured in terms of time taken, quality, and completion.

31. ARCELOR MITTAL CHPP-PVS (2/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	192 MW	4 Units	ArcelorMittal	Karaganda region	Northern

Theme	Details
Control systems	• The power plant is **operated** through **manual control** using knobs in its control system. • There are **manual knobs for controlling STGs** and heating in addition to a SCADA system. • **No ERP system**. However, SAP is used for managing spares and procurement as well as for creating and tracking work orders.
Emission control and ash management	• **No electrostatic precipitator (ESP)** at plant. • It uses a **wet scrubbing** method for air pollution control. • The **ash-water slurry system** is pumped to the **disposal** area.
Water	• No **resin** or **electrical demineralizing system** at plant. • **No online water-steam analyzers** at the plant.

Visual observations[1]

1. Dust accumulation

2. Steam leakages

3. Open coal storage yard

4. Fire fighting system

Source: 1. Site Visit

32. EKIBASTUZ GRES 1 (1/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	4,000 MW	8 Units	Samruk Energo JSC	Pavlodar	North

Plant Status and Performance

Theme		Details
Age		• Set up in 1980 (**43 yrs old**) operating at ~3.5GW. • **All power blocks are >38 yrs** since commissioning, except block 2 which was recommissioned in December 2014.
Fuel sourcing & management		• The plant uses bituminous coal from **Ekibastuz coal basin.** • The coal comes in trailers and is stored in two **open coal storage yards**
Major assets	Boiler	• Manufactured by OJSC "Podolsky Machine-Building Plant". • **Boilers of blocks 3, 5, and 7 may have potentially completed the available operational life**, whereas boilers of blocks 6 and 8 seem to have a residual life till end of year 2027 and mid-2024, respectively.
	Turbine	• Manufactured by “Kharkov Turbine Plant” for blocks 2 and 3 and “Leningrad Metal Plant” for blocks 4-8. The rated capacity of each turbine is 500 MW. • The **turbine for block 7 may have completed its available potential operational life**. The remaining life for all the blocks except blocks 1, 2, and 4 are between 2024 and 2027.
	Generator	• Manufactured by “OJSC Power Machines” for block 2, “Electrotyazhmash" for blocks 3-4, and “LMZ Electrosila“ for blocks 5-8.
Plant operations		• The plant reported moderate **auxiliary consumption of ~4.96%.** Block 2 has the lowest auxiliary consumption of 4.2%, and block 6 has the highest with 6.2%. • Block 6 had service life extension done in May 2022. It was reported that the **highest proportion of emergency shutdowns was in block 6** in the last 5 years, having reported 33 instances which is 20% of the overall shutdowns in the last 5 years, followed by block 3 (25 times) and block 5 (23 times). • The **station heat rate for block 2 is lower than the design heat rate** indicating efficient operations. Other blocks have higher station heat rate compared to the design specification, with **highest being block 6.** • Block 2 is the most efficient in terms of electricity generation for every kg of fuel burnt, whereas **block 6 has the lowest fuel efficiency.**

32. EKIBASTUZ GRES 1 (2/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	4,000 MW	8 Units	Samruk Energo JSC	Pavlodar	North

Theme	Details
Operation and maintenance	• The burners were observed to be **without IR and high temperature protective glass**. • Lack of **efficient coal dust management** as widespread amount of coal dust was observed around the power plant.
Control systems	• The power plant has **manual operation of boilers and steam turbine** from control room. • The plant has a **SCADA and DCS** system for monitoring the plant performance; however, there is **no ERP system.**
Emission control and ash management	• The **chimneys are equipped with an electrostatic precipitator system.** • The plant has signed an agreement for the development of an '**automated system for monitoring emissions** into the environment' system. • There is no alternate use for the **fly and bottom ash, and it is dumped in an ash pond** which is ~5 km from the plant.

Visual observations[1]

1. High amount of coal dust deposit and debris accumulation seen

2. Cracks on floors and structures, and corrosion

3. Steam and water leakages

4. Control rooms for units with manual knob operations

Source: 1. Site Visit.

Annexure 3.2 - South Zone Plants

South Zone Plants

1. GTES Akshabulak
2. Almaty CHPP-3
3. Shymkent CHPP-3
4. Zhambyl CHPP
5. Kentau CHPP
6. Moynakskaya Hydropower Plant
7. Almaty Kapshagay Hydropower Plant
8. Shardara Hydropower Plant
9. Zhambyl GRES
10. Almaty Cascade Hydropower Plant
11. Almaty CHPP-1
12. Tekeliskaya CHPP-2
13. Almaty CHPP-2
14. Kyzylorda CHPP
15. Zhaiykteploenergo Ural CHPP

1. GTES AKSHABULAK (1/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Gas	Electricity	87 MW	3 units	JSC Crystal Management	Kyzylorda	Southern

Plant Status and Performance

Theme		Details
Age		• Set up in 2012 (**10 years old**) and operating at ~87 MW. It was generating at 86 MW during the site visit. • The power plant is relatively new, having been **commissioned in 2012.** It reported that it is not facing any major issues. • The **major equipment** was **observed** to be **new** or in very **good condition** of operational life.
Fuel sourcing & management		• The plant uses **natural gas** of GCV 9,500 kcal/m^3. • The plant is supplied with gas from the **Akshabulak** field of JV "KazGerMunai", 3 km away from the plant.
Major assets	Turbine	• Manufactured by **Hitachi Limited**, in **2011** with rated power of **29 MW** each. • Each **turbine** is of **single shaft**, **single cycle** type. • **No renovation and modernization activity** has been undertaken for the gas turbine as the equipment is relatively new. • Each **turbine** has **10 combustion chambers** and the plant is **not** facing any **problems** related to the turbine.
	Generator	• Manufactured by **Brush HMA, Netherlands** in **2011** with rated power of **29 MW** each. • The generator had a capacity of 86 MW at 11 kV during the time of the visit. • **No renovation and modernization activity** has been undertaken for the generator as the equipment is relatively new.
Plant operations		• The plant generated **652,990 MWh** of electrical energy in **2021** and supplied **648,076 MWh** of electrical energy to the **grid**. It reported an auxiliary consumption of **~0.75%** in 2021. • The plant consumed **177,075,781 m^3 of natural gas** in 2021. It reported a specific fuel consumption of **0.27 m^3 of gas / kWh** in 2021. • The plant reported **71 instances** of **emergency shutdowns** in the last **5 years** with 34 in block 1, 16 in block 2, and 21 in block 3. • **Input gas preparation** such as filtration, pressure, and heating is done in a **separate plant**. • **Firefighting building** is also **outside** the plant **premises**.

1. GTES AKSHABULAK (2/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Gas	Electricity	87 MW	3 units	JSC Crystal Management	Kyzylorda	Southern

Theme	Details
Operation and maintenance	• **Maintenance** of the equipment is done **twice in a year**. • **Minor maintenance** is done by **power plant** personnel. **Major** repairs and **maintenance** activities are done by the **equipment manufacturer**. • The power plant is in **possession** of adequate **spares** for all **critical equipment**. • The plant is **neat, clean,** and **well maintained**. • The last **civil / structural survey** of the plant was completed in **2022**. • The plant conducts **monthly maintenance** and **service** of the **existing fire fighting equipment**.
Control systems	• The plant has **SCADA systems** and has fully automated control system for control of equipment. • The plant does not have an **ERP system**. • The power plant has **consolidated measurement** screen for **gas supply** which highlights any abnormalities / deviations. • The plant **maintains log** of **daily statistics** in the plant which are maintained in Excel spreadsheets.
Emission control	• The power plant **has** a **continuous emission monitoring system (MRU SWG 300-1)** for continuous automatic analysis of flue gas. • The continuous emission monitoring system is **independently verified** by an **accredited lab** on a quarterly basis. • The power plant **has** a **wastewater recovery and disposal system.**

Visual observations[1]

1. Air cooled heat exchanger

2. Transformer

3. Piping and clear flue gas from chimney

4. Gas filtering and pressurizing station

5. Switchyard

Source: 1. Site Visit.

2. ALMATY CHPP-3 (1/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	173 MW	4 Units	Samruk-Energo JSC	Almaty	Southern

Plant Status and Performance

Theme		Details
Age		• Set up in 1964 (**59 yrs old**) and operating at 173 MW. • The turbines were **overhauled** and **upgraded** ~40 years ago. • The plant had to **shut down** a **boiler** for repairs **~4 times a month** due to abrasive coal.
Fuel sourcing & management		• The plant uses **low-quality abrasive coal** from **Ekibastuz** coal basin. • **Abrasive** coal **soot** is causing **damage** to **boiler** heat exchange surfaces. Average **time between shutdowns** of **boilers** is **200 hours** due to effect of coal.
Major assets	Boiler	• Manufactured by "**Barnul boiler plant**“ between 1962 and 1967. • Steam generation rate is 160 tons per hour.
	Turbine-Generator	• Manufactured by “**Leningrad Metal Plant**” between 1980 and 1989. • The rated capacity of one turbine is 50 MW and other turbine is 41 MW. No R&M done on the equipment yet.
Plant operations		• The plant generated **1,085.3 GWh** of electrical energy in **2021** and supplied **923.7 GWh** of electrical energy to the **grid**. It reported an auxiliary consumption of **~14.9%** in 2021. • The plant consumed **531,682 tons of coal** in 2021. It reported a specific fuel consumption of **0.49 kg / kWh** in 2021. • The station is **partly open** type with **boilers** partly exposed to atmosphere.
Operation and maintenance		• **Coal dust** was observed **throughout** the plant - accumulated on the floor and on the equipment. • Civil **damage** such as **cracks** in the structure as well as **insulation damage** was observed in the piping. • **Oil** and **water leakage** as well as accumulation was observed in multiple locations in the plant.
Water quality		• The plant has a **demineralization plant** to provide demineralized process water. • **Water quality testing** is done **manually** in the lab and the plant does not have an online steam water analysis system.

2. ALMATY CHPP-3 (2/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	173 MW	4 Units	Samruk-Energo JSC	Almaty	Southern

Theme	Details
Control systems	• The power plant has **manual operation** of **boilers** and **steam turbine** from control room. • The plant has **SCADA/DCS** system for monitoring.
Emission control and ash management	• The power plant does **not** have an **electrostatic precipitator**. **Wet scrubbers** are used to capture ash; however, **ash** and **soot deposits** were observed in the **snow outside** the **plant**. • The plant does **not** have a **continuous emission monitoring** system. • **Ash** is **stored outside** the **territory** of the power plants. It reported that ash storage is **reaching** its **capacity.** • There is **no demand** for the **generated ash** leaving plants with no option to discard the ash. • No water recycling systems. **Wastewater disposal** is into Almaty city **sewer** networks.
Structural vulnerabilities	• Last structural survey **recommended strengthening** of **chimneys**. Work has been **deferred** due to lack of **competence**, **financial** constraints, as well as expected **transition to gas.** • **Cracks** were also observed in the **chimney.**

Visual observations [1]

1. Coal dust

2. Cracks on floors and structures.

3. Water leakage

Source: 1. Site Visit.

3. SHYMKENT CHPP-3 (1/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Gas	Electricity & Heat	160 MW	3 Boilers & 2 Turbines	Eurasian Resources Group	Shymkent	Southern

Plant Status and Performance

Theme		Details
Age		• The plant was commissioned in **1978** and has been in operation for **40 years**. • The plant has **3 boilers** installed between 1978 and 1980 and **2 turbines** installed in 1978 and 1979. • The plant has **only** done **capital repairs** on the main equipment. **No renovation and modernization** activity done so far.
Fuel sourcing & management		• The plant uses **gas** with a GCV value of 8,220 kcal/m^3. • Agreement from JSC **KTGA** for the **consumption** of 330 million m^3 / year of **natural gas.**
Major assets	Boiler	• Manufactured by **"TKZ (Taganrog Boiler Plant "Krasny Kotelshchik")** between 1978 and 1980. • Boilers have steam generation capacity of 200 / 500 tons per hour.
	Turbine	• Manufactured by "**LMZ (Leningrad Metal Works)**" between 1978 and 1979. • Turbines have a rated capacity of 80 MW. No R&M done yet.
	Generator	• Manufactured by "**Novosibirsk plant Electrotyazhmash**" between 1978 and 1979.
Plant operations		• The plant generated **1,151 GWh** of electrical energy in **2021** and supplied **1,026 MWh** of electrical energy to the **grid**. It reported an auxiliary consumption of **~10.86%** in 2021. • The plant consumed **238,906,000 m^3 of gas** in 2021. It reported a specific fuel consumption of **0.37 m^3 / kWh** in 2021. • The plant **primarily supplies heat** in the **winter months** and **electricity** in the **summer** months. • The power plant reported that it **cannot run** at installed **capacity** due to **high ambient temperatures** and **gas deficit**. It is understood that while all gas turbines are ambient machines, if high ambient temperature is a concern, plant may adopt intake air cooler technologies like evaporative cooling/ chillers or fogging, etc.
Operation and maintenance		• There was extensive **oil leakage** and **fumes** observed in the **air compressor room.** • **Dust accumulation**, **improper illumination**, oil/water **leakage,** and **accumulation** were observed in various parts of the plant. • There was visible **flue gas leakage** in the **boiler burners** leading to inefficient burning • Extensive **insulation damage** and **steam leakage** was observed in various parts of the plant

3. SHYMKENT CHPP-3 (2/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Gas	Electricity & Heat	160 MW	3 Boilers & 2 Turbines	JSC "3-Energoortalyk"	Shymkent	Southern

Theme	Details
Water quality	• The plant has a **demineralization and water treatment plant.** • The plant does **not test** for **pH** of the **process steam** and does not have online steam water analysis system. • No zero liquid discharge, wastewater recovery, and disposal system available.
Control systems	• The power plant has **manual operation of boilers** and **steam turbine from control room**. • Many of the **parameter sensors** were found to be **not working** in the control room.
Emission control	• The power plant has a **continuous emission monitoring** system that is currently being **commissioned.**
Structural vulnerabilities	• No adverse findings in the last structural survey; however, **cracks**, **gaps,** etc., were **observed** in the civil structure. • During the visit, **no cracks** were observed in the **chimneys.**

Visual observations [1]

1. Damages and leaks (water + steam)

2. Control room

Source: 1. Site Visit

4. ZHAMBYL CHPP (1/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Gas	Electricity & Heat	44 MW	3 Boilers & 2 Turbines	Akimat of Zhambyl	Taraz	Southern

Plant Status and Performance

Theme		Details
Age		• The plant was commissioned in **1963** and has been in operation for **~60 years**. • The plant has **3 boilers** installed in 1961, 1962, and 1963, respectively. It also has **2 turbines** installed in 1963. • There has **no R&M** on the **turbines**. It had **increased** the **vacuum** of the steam turbines in the 1980s to increase output. • The **boilers** were **upgraded** for higher steam capacity in the **1980s.**
Fuel sourcing & management		• The plant uses **gas** with a GCV value of 8,429 kcal/m^3.
Major assets	Boiler	• Manufactured by "**Barnaul boiler plant**" between 1961 and 1963. • Boilers have steam generation capacity of 50 tons per hour.
	Turbine	• Manufactured by "**UTMZ**" in 1963. • Rated capacity of turbines is at 30 MW.
	Generator	• Manufactured by "**Novosibirsk Turbine Generator Plant**". • Rated capacity of generators is at 30 MW.
Plant operations		• The plant **primarily supplies heat** during the **winter** and conducts **maintenance** in the **summer**. • In 2021, the plant generated **128,863 MWh** of electrical energy in **2021** and supplied **93,666 MWh** of electrical energy to the **grid**. • The plant consumed **16,553,000 m^3 of gas** in 2021. It reported a specific fuel consumption of **0.154 m^3 / kWh** in 2021.
Operation and maintenance		• The plant was **generally well maintained;** however, **dust accumulation** was observed in some places. • **Cracks**, **gaps,** and **water leakages** were observed outside the turbine hall. • **Rust** was also observed in the equipment in the demineralization plant.

4. ZHAMBYL CHPP (2/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Gas	Electricity & Heat	44 MW	3 Boilers & 2 Turbines	Akimat of Zhambyl	Taraz	Southern

Theme	Details
Control systems	• The power plant has **manual operation of boilers and steam turbine** from control room. • The plant does **not** have a **DCS system**
Emission control	• The plant does **not** have a **continuous emission monitoring system** • Emissions are measured **weekly** using **portable gas analyzers**
Structural vulnerabilities	• **Structural survey** was last conducted in **2022** and was rated **satisfactory** for all except **one chimney.** • The **defects** in the **chimney** were **resolved** by the plant.

Visual observations [1]

1. Water and oil leakages

2. Control Room

3. Boiler flash tan leakage

4. Battery bank - no safety sensors

Source: 1. Site Visit

5. KENTAU CHP (1/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	12.5 MW	1 unit (operational)	City of Kentau	Turkestan	Southern

Plant Status and Performance

Theme		Details
Age		• The plant currently **has 5 turbines** of which **2** were **decommissioned**, **1** is **non-usable**, **1** is scheduled for **capital repairs,** and only 1 is functional. **Several modifications** were done on the **turbines** including **reduction** of **vacuum** and **change** to **backpressure** type. • The plant currently has **6 boilers** that are **operational**. **No R&M activity** has been done on the boilers. • The plant is **extremely old**. There is **visible cracks and damages** observed in the **building** and **structures**.
Fuel sourcing & management		• The plant is using **low-quality coal** from **Ekibastuz**. The **ash content** is very **high** and coal is **abrasive** in nature. • Abrasive **coal soot** is causing **damage** to **boiler heat exchange** surfaces.
Major assets	Boiler	• Manufactured by **"Taganrog boiler plant Krasny Kotelshik."** • Steam generation capacity of the boilers varies between 20 and 30 tons per hour.
	Turbine	• Manufactured by **"Bryansk Machine-Building Plant."** • Turbines are rated with various capacities ranging between 6 MW and 12.5 MW.
Plant operations		• The plant **only supplies heat** and does not supply electricity to the grid. One turbine generates 5.5 MW for auxiliary use. • The plant consumed **7,700,000 tons of coal** in 2021.
Operation and maintenance		• Coal **dust** was **observed throughout** the plant - accumulated on the floor and on the equipment. **Leakage** of **coal fines** from **pulverizer** was observed in the boiler room. • **Extensive damage** in the **insulation** of various pipes was also observed. • The power plant is **unable to retain control room personnel** due to seasonal nature of production and financial constraints leading to lack of institutional knowledge.
Water quality		• The plant does **manual testing** of water and steam chemistry. • The plant does **not** have an **online steam water analysis system.**

5. KENTAU CHP (2/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	12.5 MW	1 unit (operational)	City of Kentau	Turkestan	Southern

Theme	Details
Control systems	• The power plant has **manual operation of boilers** and **steam turbine** from control room. • The plant does **not** have **DCS system.**
Emission control and ash management system	• The power plant does **not** have an **electrostatic precipitator**. It uses **cyclone scrubbers** to capture ash. • **Thick black smoke** was observed from the **chimneys, which may** indicate ineffectiveness of ash capturing system, incomplete combustion or poor combustion dynamics, ineffective separation of fly ash filtration system, etc. • **Ash** is **stored outside** the **territory** of the power plants. The plant reported that **ash storage is reaching its capacity.** • There is **no demand** for the generated **ash** leaving plants with no option to discard the ash.
Structural vulnerabilities	• Last **structural survey** of the plant was done in **2021. Minor issues found** were rectified. • During the site visit, civil damage including **cracks and gaps** was observed throughout the plant.

Visual observations [1]


1. Water and coal dust leakage


2. Coal dust


3. Damages and cracks

Source: 1. Site Visit

6. MOYNAKSKAYA HPP (1/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Hydro	Electricity	300 MW	2 units	Samruk Energo	Almaty	Southern

Plant Status and Performance

Theme		Details
Age		• The plant was commissioned in **2011** with installed electrical capacity of **300 MW.** • The plant consists of 2 blocks each of 150 MW each. • The plant has been in operation for 10+ years.
Major assets	Turbine	• Manufactured by "**Harbin Electromechanical Plant**" in 2010. • Turbine has rated capacity of 153.5 MW.
	Generator	• Manufactured by "**Harbin Electromechanical Plant**" in 2010. • Generator has a rated capacity of 150 MW.
Plant operations		• Both turbines 1 and 2 were commissioned in 2011. The turbine is of **Pelton type** and **mounted vertically**. • The power plant indicated that both the turbines have **~16,060** hours of **service life left**. • The auxiliary consumption of the plant is **less than 1%.**
Operation and maintenance		• The plant has had **6 failures** of the second degree in the past 5 years. In **2014** the plant had to **shut down** due to **foreign body** in the nozzle. • The plant also reported that **single turbine shutdown** occurs **1–2 times a year** due to spontaneous deviation of speed controlling magnet sensor. • Scheduled **maintenance** and **current repairs** in the plant are done on an **annual** basis. • Although plant is **well maintained**, some **rust** and **scratched paint** was observed in the piping. • The last plant shutdown was in 2014. • The power plant also indicated that it faces **ball valves (gate) failures** every **2 years**.

6. MOYNAKSKAYA HPP (2/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Hydro	Electricity	300 MW	2 units	Samruk Energo	Almaty	Southern

Theme	Details
Control systems	• The plant has both **SCADA and DCS system** for control in the plant. • The power plant control room is **automatic**. • The various protection **relays** used in the power plant are of **numerical type**. • The plant also has an **ERP system** for logging various production data.
Emission control and monitoring	• The power plant does **not** have a **wastewater recovery** and disposal system. • The power plant has an **oil water separator** to ensure only clean water flows out of the plant.
Structural vulnerabilities	• The plant is relatively **new** having been set up in 2010. • The last **structural survey** done in the plant was in 2019. There were **no significant findings**. • The turbine hall is **well maintained**. There are **no cracks / gaps** or leaks observed.

Visual observations [1]

1. Main hall

2. Hydro turbine

3. Switchgear and auxiliary transformers

4. Control room

Source: 1. Site Visit.

7. KAPSHAGAY HPP (1/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Hydro	Electricity	364 MW	4 Units	Samruk Energo JSC	Kapshagay	Southern

Plant Status and Performance

Theme		Details
Age		• Commissioned in 1952 **(~ 71 years)** • **3 turbines** were overhauled and **reconstructed ~ 7 years** ago. • The stator of generator 4 was replaced 12 years ago.
Major assets	Turbine-generator	• The power generator unit for all the blocks is **manufactured by "Syzran Turbine Plant".** • The plant uses **Kaplan type of turbines**, which **are governed electro-hydraulically.**
	Water reservoir	• Planned **water level of 485 m** and **capacity of 28.14 billion m^3**. • On the day of visit the level of water was 479 m. • There are **sensors in place to measure the height of water** in the reservoir. • Has a spillway in case of overflow from the dam.
Plant operations		• Electricity generation and supply is **high for the peak summer months** of May to August and then dips in the winter months of October to April. • **Water inlet structure is not free of debris** - there are minute particles in the water inlet. • **Leakage was observed in the main inlet valve of penstock** of the plant. However, no damage/accident has happened to the penstock.
Operation and maintenance		• **Scheduled maintenance** of the turbine generators is conducted **annually** (last conducted in September 2022). • According to the plant operators, the equipment in the plant are physically depreciated. • The plant independently carries out the O&M with overhaul once every 4 years. • **Does not have any long-term spares supply agreement in place.** The supply of spares for all power plants under ALES is carried through ALES (Almaty JSC) central office.

7. KAPSHAGAY HPP (2/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Hydro	Electricity	364 MW	4 Units	Samruk Energo JSC	Kapshagay	Southern

Theme	Details
Control systems	• The plant has a **SCADA and DCS** system for monitoring the plant performance. • There is an **enterprise content management (ECM)** system instead of an ERP system to manage, store, and organize business documents in real time.
Environment Management	• The plant has a biological treatment station "STOK" for a **wastewater recovery and disposal system.** • Emissions are well within the permits for exposure.

Visual observations[1]

1. Maintenance routine: personnel used PPEs and maintenance bay was relatively clean.

2. Main busbar: MARKS and dents observed

3. Fire fighting system: well maintained with no observed leakages or cracks in the structures.

Source: 1. Site Visit.

8. SHARDARA HPP (1/3)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Hydro	Electricity	126 MW	1	Samruk Energo	Turkestan	Southern

Plant Status and Performance

Theme		Details
Age		• Commissioned in 1965 **(~58 years).** • **R&M done** in **2019** - all systems (including turbines) were replaced . • **Post R&M**, installed **capacity increased** from 100 MW to 126 MW.
Major assets	Turbine-generator	• The turbine generators were recommissioned in 2019-2020 **(~3 years).** • **Kaplan type turbines** - mounted vertically.
	Water reservoir	• The plant is a conventional **dam type** HPP. • The plant faces low water levels in summer. • Maximum volume of the reservoir is 5,200 million m^3. • Amount of energy the existing volume allows to generate cannot be determined due to **electricity output dependency on committee** on water resources orders.
Structural vulnerabilities		• **Relatively new,** having been set up in 2019. • Is due for an inspection of the civil structures as per regulations. • The turbine hall is **well maintained** - no cracks / gaps or leaks observed.
Plant operations		• The power plant comprises of 4 turbines rated at 31.5 MW each. • After modernization **efficiency rose from 86% to 93%.** • The auxiliary consumption of the plant is **~1.1%.**
Operation and maintenance		• **Debris was observed in the trash racks.** • Estimated operational time without need for capital repairs is **20 years.** • As the reservoir is primarily for irrigation, **electricity generation** is a **secondary focus** for the plant.

8. SHARDARA HPP (2/3)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Hydro	Electricity	126 MW	1	Samruk Energo	Turkestan	Southern

Theme	Details
Control systems	• Both **SCADA and DCS system available** for control in the plant. • **Fully automated control room.** • **Numerical protection relays** used • **ERP system available** for logging various production data
Environment management	• Have a **wastewater recovery and disposal system.** • Have an **oil–water separator system** as well as **sewage cleaning system.**

Visual observations[1]

1. Main hall: well maintained and proper safety measures like rails and demarcations provided

2. Fire extinguishing system in TG floor

3. Control room: fully automatic control systems

Source: 1. Site Visit

8. SHARDARA HPP (3/3)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Hydro	Electricity	126 MW	1	Samruk Energo	Turkestan	Southern

Visual observations[1]

4. Turbine floor

5. Switchgear for auxiliary transformers

6. Battery room

7. Ventilation unit

8. Crane for maintenance of sluice gates

9. Fire extinguishing system in main transformer unit : seepage of water observed

Source: 1. Site Visit.

9. ZHAMBYL GRES (1/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Gas	Electricity	1230 MW	6 Units	Zhambyl GRES	Zhambyl Region	Southern

Plant Status and Performance

Theme		Details
Age		• **Commissioned** in **3 stages** – block 1 in 1967, blocks 2 and 3 in 1971, and blocks 4 and 5 in 1976. • 3 turbines and boiler commissioned by 1971 and 3 by 1976.
Fuel sourcing & management		• The plant uses **natural gas** with **high GCV** (~ 8,440 kcal/kg). • **Gas transportation** and **storage** carried out by **gas transportation organization**.
Major assets	Boiler	• Manufactured by "**Podolsky machine-building plant**." for blocks 1–3; and "**Taganrog boiler plant**" for blocks 4–6. • Steam generation rate is 640 tons/hour for boilers 1–3; and 670 tons/hour for boilers 4–6. • Residual life of **~20,000–30,000 hours left** for boilers.
	Turbine	• Manufactured by "**Leningrad Metal Plant**" for all the blocks. • The rated capacity are 200 MW for blocks 1–3; and 210 MW for units 4–6. • **Turbines 1–4** have **undergone R&M** in 2020–2021. • **Reconstruction** has been done for **turbines 1–4 in 2021**. The **turbine blades** were **replaced** after metal testing due to **erosion** of the blades.
	Generator	• Manufactured by "Electrotyazhmash, Kharkov" for all blocks.
Structural vulnerabilities		• The power plant is generally **well maintained**; however, **cracks**, **gaps,** and **broken tiles / windows** were observed. • The last structural survey was done in 2019 and **no major issues** were found.

9. ZHAMBYL GRES (2/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Gas	Electricity	1230 MW	6 Units	Zhambyl GRES	Zhambyl Region	Southern

Theme	Details
Plant operations	• The power plant is **unable** to **utilize its installed capacity** due to **low demand**. It was currently running at **utilization at ~50%** and had shutdowns in 2021 due to low demand.
Operation and maintenance	• The power plant reported that they had **replaced** the **turbine blades** for **turbines 1 to 4** in 2021 due to **erosion**. • The plant **replaces** the **heat surfaces** of the **boilers** every 6–7 years. • The plant has **scheduled capital repairs** every **year** • The power plant had **undertaken several major capex** in last 5 years such as replacement of pipes, heat surface of boilers, turbine condenser pipes, hydraulic system, vacuum circuit breakers, CEMS, etc. • The power plant indicated that **all boilers** and **turbines 2, 4, 5, and 6 have residual life left**. Life **extension** was done for **turbines** 1 and 3. • The power plant has had **partial shutdowns** due to **fuel supply**, **equipment failures,** as well as **human errors**.
Control systems	• The power plant has **semiautomatic control center** for control of boilers and turbines. • The plant has a **DCS system**. There is also an **ADCS** system that provides **visibility** on **generation** to the grid operator.
Emission control and ash management	• The power plant has installed a **continuous emission monitoring system (CEMS).** The CEMS is yet to be commissioned. • Currently the plant does **manual measurement** of **emissions** and report monthly to the regulator.
Water	• The main **source** of water is the **Taraz** river used mainly for **turbine cooling**.

Note: The site visit team was restricted from photography during the visit.

10. ALMATY CASCADE HPP (1/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Hydro	Electricity	43.7 MW	13 Units	Samruk Energo	Almaty	Southern

Plant Status and Performance

Theme		Details
Age		• Commissioned in **1948** and has been in **operation** for **70+ years**. • All of the **turbines** were **installed** and **commissioned** between 1943 and 1963.
Plant type and water source		• The plant is a **derivative type hydropower plant**. • **Major source** of water from **Big Almaty** Lake as well as **three** different **rivers** flowing in the region.
Major assets	Turbine & generator	• The system is a **cascade of hydropower plants** stretching across a span of 25 km. • The **turbines** in plants 1 and 2 are **Pelton type**, the other turbines are **Francis type**. • All the **turbines** are of **horizontal configuration** except **plant 5** which was **vertical** turbines. • 3 turbines manufactured by "**f. Ansaldo**"; 3 by "**Ural plant of hydraulic engineering**"; 3 by "**Kirov plant**"; 3 by "**Almaty**"; and 1 by "**Laffel**". • The rated capacity varies from **0.8 MW to 5.2 MW**. • **R & M not yet** carried out.
Structural vulnerabilities		• The last civil / **structural survey** was conducted in 2022 by a third party. The plant was asked to **strengthen** the **dam** in the last survey and the same is **planned** for **May** 2023. • The **buildings** are **old;** however, they are **well maintained**.
Plant operations		• **Lower** plant **utilization** in the **winter months** due to water restrictions and ice formation. • The plant has **annual scheduled repairs** as well as **capital repairs every 5–7 years**. Two turbines are serviced every year. • The **auxiliary consumption** of the plant was **~1.32%** last year.

10. ALMATY CASCADE HPP (2/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Hydro	Electricity	43.7 MW	13 Units	Samruk Energo	Almaty	Southern

Theme	Details
Operation and maintenance	• Generates electricity on the **basis** of **water release authorization** of **Water Resources Ministry** body. • **Generally** well **maintained**; however, **illumination** was **less** in a lot of locations including the turbine floor. • The power plant uses a **150 × 150 m screen** to **remove debris** from the flowing water. • Has an **emergency diesel generator** that is run for 5–10 mins every week to check for reliability.
Control systems	• No ADCS system; however, it is **equipped with DCS**. • The plant mostly **uses electromechanical relays** however a **few numerical relays** for outgoing feeder protection were observed.
Emission control and ash management	• The plant has a **biological treatment station** for wastewater recovery and disposal. • The plant indicated that the **wastewater** from plant 7 is **fed** to the **city sewerage** system.

Visual observations[1]

1. Hydro Turbine

2. Hydro turbine under maintenance

3. Battery room

4. New numerical relays

Source: 1. Site Visit

11. ALMATY CHPP-1 (1/3)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Gas	Electricity & Heat	145 MW	3 Units	Samruk Energo	Almaty	Southern

Plant Status and Performance

Theme		Details
Age		• The plant has **6 boilers** and **3 steam turbines**. • Turbines 1 and 2 were installed in **1970** and **1971,** respectively (**~50+ years).** • Turbine 3 was installed in **1996 (~25+ years).** • All the boilers are over **50+ years.**
Fuel sourcing & management		• The plant uses **natural gas** of GCV 8,322 kcal/kg.
Major assets	Boiler	• All 6 boilers manufactured by "**Barnaul Boiler Plant**" installed between **1960 and 1972**. • Maximum steam generation: 160 tons/hour. • **No R&M activity** has been done on the **boilers.**
	Turbine & Generator	• Manufactured by "**Leningrad Metal Plant LMZ**" for turbines 1 and 2; "**Kharkov Turbine Generator Plant**" for turbine 3. • Rated capacity is 60 MW for turbines 1 and 2; 25 MW for turbine 3. • **No R&M activity** has been done on this equipment.
Structural vulnerabilities		• **No adverse finding** in **structural inspection** conducted in 2022. • During the site visit, **cracks in structure**, **turbine hall**, as well as **gaps**, **insulation damage,** etc., were observed,
Plant operations		• The plant **shuts down** in the **summer months** and serves as a **conduit** for **heat supply** to Almaty from other stations. • The plant reported auxiliary consumption at ~27%.
Operation and maintenance		• **Dust accumulation** as well as **oil and water leakages** throughout the plant. • There was observed **insulation damage** which can lead to process inefficiencies. • **Rusting** and **denting** in the main and auxiliary equipment was observed.

11. ALMATY CHPP-1 (2/3)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Gas	Electricity & Heat	145 MW	3 Units	Samruk Energo	Almaty	Southern

Theme	Details
Control systems	• **Semiautomatic/manual operation of boilers and steam turbine** from control room. • The plant has a **SCADA** system. • **Kcell** is used as **communication network**/telecontrol system.
Emission control and ash management	• No **continuous emission monitoring system** (CEMS); the monitoring is manual.
Water	• The plant has a **demineralization plant** for generating demineralized water. • **Water quality lab** had **outdated practices** including written records of parameters.

Visual observations[1]

1. Low illumination in the plant

2. Dust accumulation in the plant

3. Rusting of piping, equipment

Source: 1. Site visit.

11. ALMATY CHPP-1 (3/3)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Gas	Electricity & Heat	145 MW	3 Units	Samruk Energo	Almaty	Southern

Visual observations[1]

4. Improper/No insulation to the piping and equipment

5. Oil leakage observed in the plant

6. Steam/Water leakage observed in the plant

7. No DCS and analog control systems used in the control room

Source: 1. Site Visit

12. TEKELISKAYA CHPP-2 (1/3)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	24 MW	2 Units	Tekelia Energocomplex	Tekeli City	Southern

Plant Status and Performance

Theme		Details
Age		• Set up in 1959 (**64 years old**) operating at ~24 MW.[1] • The turbines were overhauled and upgraded **~40 years ago**.
Fuel sourcing & management		• The plant uses **good quality coal** of calorific value 4,697 kcal/kg.[1] • **Metal debris and scraps scattered** in the coal storage yard. • Open coal storage **exposes the coal to moisture and snow** affecting its quality.
Major assets	Boiler	• Manufactured by OJSC "**Barnaul boiler plant**". • Steam generation rate of 75 tons/hour at Maximum Continuous Rating conditions. • The boilers are **at least 62 years old** as of 2022.
	Turbine	• Manufactured by "**Bryansk Locomotive Plant**". • Rated capacity of each turbine is 12 MW.[1]
	Generator	• Manufactured by "**State Union Plant of Thermal Equipment Kharkov USSR MES**".
Structural vulnerabilities		• Chimneys were **physically deteriorated (~38%).**[1] • Gas ducts have **accumulated ash deposits**. • **Crack and faulty g**as duct support. • **Rusting** was observed in several metallic surfaces/structures. • Conveyor supporting concrete pillar were **corroded** due to **moisture / oxidation / reaction** with ash.
Plant operations		• Turbine in Block 1 was steam cogeneration and in Block 2 was steam condensation type. • Month-wise heat generation **shows a dip in summer months** when the heat demand is lower. • The plant reported an auxiliary consumption of **11.56%** in 2021. • The plant consumed **757,884.3 tons of coal** in 2021. It reported a specific fuel consumption of **0.84 kg of coal / kWh** in 2021.

Source: 1: TECHNICAL REVIEW #22–46 report

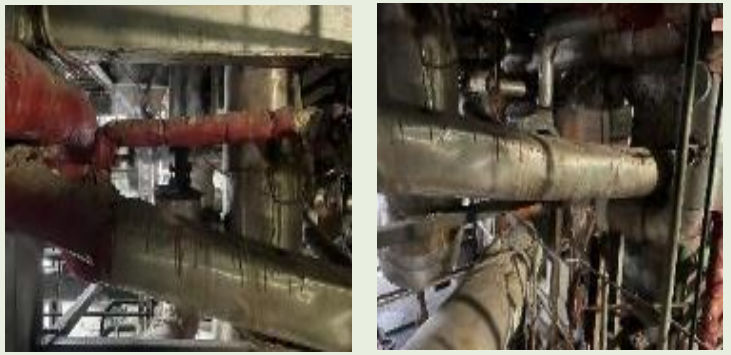
12. TEKELISKAYA CHPP-2 (2/3)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	24 MW	2 Units	Tekelia Energocomplex	Tekeli City	Southern

Theme	Details
Operation and maintenance	• Safety motor **double earthing is not followed**. • **Stained oil and grease fumes** deposits observed on equipment. • **Leakages** from piping system observed.
Control systems	• The power plant has **manually operated knob** systems with analog meters for controlling operations from the local control rooms. • The plant has a SCADA system for visualizing data on the main parameters of generators, boilers, turbine units and power lines.
Emission control and ash management	• **Ineffective fly ash separation system** and combustion systems. • **No continuous emission monitoring system (CEMS)** to check the emission level. • Wastewater quality control is carried out **once every quarter** in compliance with MPC standards. • Hydraulic system used for dumping the ash and slag captured in the storage facility and generated during the combustion. • Ash Dump: No seepage in water outlet only the **surface is covered with vegetation**.
Water	• Water quality testing is done **manually in the lab**. • The plant does **not have online steam water analysis system**.

Visual observations[1]

1. Lacks fire & dust suppression system [2]



2. Extensive damage to the insulation/ missing aluminum cladding [2]

3. Oil stain & deposits and lacks safety system [2]

Source: 1. Site Visit, 2: TECHNICAL REVIEW #22–46 report.

12. TEKELISKAYA CHPP-2 (3/3)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	24 MW	2 Units	Tekelia Energocomplex	Tekeli City	Southern

Visual observations[1]

4. Water spillage & algae grown in pumping area[2]

5. No fire barrier wall between each transformer[2]

6. Destruction to the protective concrete layer[3]

7. Analog metering/ knob type manual operation desk[2]

8. Accumulation and formation of layer of ash deposits inside chimney[3]

Source 1: Site visit observations; 2: TECHNICAL REVIEW #22–46 report; 3: Multifactorial survey report on Ash Dump.

13. ALMATY CHPP-2 (1/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	600 MW	6 Units	Samruk Energo	Almaty	Southern

Plant Status and Performance

Theme		Details
Age		• Commissioned in **1985** and has been in **operation for 30+ years**. • All the **equipment except one boiler** was installed between **1980 and 1989**. The **6th boiler** was installed in **2016.**
Fuel sourcing & management		• .The plant was initially designed for **higher quality Karaganda** coal; however, it was reported by the power plant that it uses **low quality** abrasive **Ekibastuz coal** with **40%** ash content • It was informed by the power plant **that the abrasive coal soot** is causing **damage** to **boiler heat exchange** surfaces and pipes.
Major assets	Boiler	• Manufactured by "**Barnaul boiler plant**" for 7 boilers, "Podolsk boiler plant" for 1 boiler. • Steam generation 420 tons/hour. • The boilers have undergone upgradation where economizer and air pre-heater was installed.
	Turbine & generator	• Manufactured by "**Leningrad Metal Plant LMZ**" for 4 units; and "**Ural Turbomechanical Plant**" for 2 units. • The rated capacity of the turbines are 100 MW for 3 units; 120 MW for 2 units; and 60 MW for 1 unit.
Structural vulnerabilities		• Last structural **survey** was done in **2020** and showed **damage** to **roofing**, **walls**, **windows** as well as **smoke pipes.**
Plant operations		• The plant generated **1,492.2 GWh** of electrical energy in **2021** and supplied **2,108.9 GWh** of electrical energy to the **grid**. It reported an auxiliary consumption of **15.38%** in 2021. • The plant consumed **897,880 tons of coal** in 2021. It reported a specific fuel consumption of **0.36 kg of coal / kWh** in 2021. • The power plant does **manual soot blowing** which causes **accumulation** and **reduces operational efficiency.**
Operation and maintenance		• **Dust accumulation** as well as **oil and water leakages** were observed throughout the plant. • There was observed **insulation damage** which can lead to process inefficiencies. • **Rusting** and **denting** in the main and auxiliary equipment were observed.
Control systems		• The power plant has **semiautomatic control room** for operation of boilers and turbines. • The plant does **not** have **DCS system.**

13. ALMATY CHPP-2 (2/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Coal	Electricity & Heat	600 MW	6 Units	Samruk Energo	Almaty	Southern

Theme	Details
Emission control and ash management	• Power plant does **not** have **an electrostatic precipitator**. **Wet scrubbers** are used to capture ash. • The plant does **not** have a **continuous emission monitoring system.** • **Ash** is **stored outside** the **territory** of the power plants. The plant reported that ash storage has **8 years of capacity left.** • They have been **unable** to **identify new locations** for ash storage.
Water	• **No** water **recycling system in** the plant. • **No wastewater recovery** or disposal system. • Wastewater flushed in city sewerage.

Visual observations[1]

1. Turbine hall

2. Water Accumulation

3. Control Room

Source: 1. Site Visit

14. KYZYLORDA CHPP (1/3)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Gas	Electricity & Heat	113.2 MW	5 Units	Akimat of Kyzylorda	Kyzylorda City	Southern

Plant Status and Performance

Theme		Details
Age		• **Commissioned in 2 stages** – blocks 1–3 in 2005, blocks 4 and 5 in 1989, operation for 34+ years. • Production Year for **blocks 1–3 is 2005**. • Production years for boilers 4 and 5 are **1968** and **1987,** respectively. • Production years for turbines 4 and 5 are **1993** and **1976,** respectively. • **Loud humming** noise was observed from **power transformer** 3 and requires **overhauling.**
Fuel sourcing & management		• The plant uses **natural gas** with **high GCV** (~ 9,297 kcal/m^3). • The plant procures gas from **Kaztransoil**.
Major assets	Boiler	• Manufactured by "**JSC "Yuzhtransenergo", Ukraine**" for boilers 1–3; and "**Barnaul Boiler Plant, Russia**" for boilers 4 and 5. • **Boilers 4 and 5 exceeded** their useful **life**. • **No reconstruction and modernization** performed.
	Turbine	• Manufactured by "**SE NPKG "Zorya-Mashproekt", Ukraine**" for all blocks 1–3; "JSC "**Kaluga Turbine Plant", Russia**" for block 4; and "**Leningrad Metal Works, Russia**" for block 5. • **Overhauling** of **blocks 1, 2, 3** was done in **2020** and **2021**.. • Rated capacities are 15.4 MW for block 1–3; and 25 MW for Block 4; and 42 MW for block 5. • **No reconstruction and modernization** performed.
	Generator	• Manufactured by "**HC JSC "Privod", Russia**" for blocks 1–3; "**OAO NPO ELSIB, Russia**" for block 4; and "**Sibelektrotyazhmash, Russia**" for block 5.
Structural vulnerabilities		• **Leakage** in **steam** is **observed** as some places. • Civil **structure** in **switchyard** is found **damaged**, it will also require **renovation**. • **Earth strips** in **switchyard** found **corrosive**. **Earthing continuity** is to be checked for **safety**. • The **old buildings** require **modernization** and **reinforcement**.

Source 1: Response from Plant

14. KYZYLORDA CHPP (2/3)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Gas	Electricity & Heat	113.2 MW	5 Units	Akimat of Kyzylorda	Kyzylorda City	Southern

Theme	Details
Plant operations	• The power plant **only generating at 54.81 MW** (47% of nameplate capacity). The **auxiliary** consumption is **~5%**. • New **expansion project** upcoming for **240 MW** total generation. • Plant is operating under **poor conditions** due to **aging**. • The **efficiency** of the operation i**s low**. • The plant is **experiencing** a **significant increase** in outage time, **maintenance costs**, and profit losses. • **Vegetation** in **switchyard** and no gravel in transformer / switchyard.
Operation and maintenance	• Boilers **5, 6, and 7** have already been **dismantled** due to their **age** and **require replacement** as they are a prime requirement for the plant. • **Old switchyard** leading to **increase** in difficulty to **obtain spare** parts and service. • Power plant is **experiencing low profits**. • The power plant needs immediate **funds** for **maintenance** and **renovation**, but unable to secure them. • Plant is relying on **portable fire extinguishers** and **sand buckets** for fire fighting which can result in **delayed response**, limited coverage, **increased risk** and potential regulatory non-compliance. • During site visits, it was observed that there was low illumination in few parts and the HRSG area was not insulated properly
Control systems	• **Control and monitoring is old** and manual. • They have **monitoring** and **measurement** of **gas parameters** and component. • The plant does **not** have **SCADA / DCS** system.
Emission control and ash management	• The power plant has **installed** a **continuous emission monitoring System** (CEMS). • Quarterly, a **specialized organization** conducts **industrial environmental control** with measurements of emissions at pollution sources
Water	• Water **source** from **Syr darya river** which is 1 km away from the plant. • **Water treatment plant** treat water before using for boiler and turbine.

14. KYZYLORDA CHPP (3/3)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Gas	Electricity & Heat	113.2 MW	5 Units	Akimat of Kyzylorda	Kyzylorda City	Southern

Visual observations[1]

1. Poor Insulation of piping structures

2. Turbine generator unit

3. Fire fighting system

4. No fire wall for transformers/ CO_2 flooding system

Source: 1. Site Visit

15. ZHAIYKTEPLOENERGO URAL CHPP (1/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Gas	Electricity & Heat	54 MW	4 Units	JSC "Zhaiykteploenergo"	Uralsk City	Western

Plant Status and Performance

Theme		Details
Age		• Commissioned in **1962; aging equipment** is a **problem** faced by the plant. • Power plant has both **gas-fired steam turbine** as well as a **combined cycle gas** turbine power plant. • The plant has **5 steam boilers** supplying 2 steam turbines. The steam boilers were commissioned between 1957 and 1965. • 1 steam turbine was commissioned in 1992 and the other in 1969. • The **combined cycle GTPP** commissioned in **2004** and comprises **gas turbine** and a **HRSG** (Heat recovery steam generator) boiler.
Fuel sourcing & management		• The plant uses **natural gas** with **high GCV** (~ 8,180 kcal/m^3).
Major assets	Boiler	• Manufactured by "**Barnaul Boiler Plant**" for boilers 2–6; and "**Daekyung Machinery & Engineering Co., Ltd,**" for block 1. • Steam generation rate is 25 tons/hour for boilers 2–6.
	Turbine	• Manufactured by "**Kaluga Turbine Plant**" for turbines 1–3; "**Hitachi**" for turbine 4. • The rated capacity varies from 8 MW to 18.5 MW. • **No renovation and modernization** activity has been **undertaken**.
	Generator	• Manufactured by "**Lysva**" for generators 1–3; and "**MEIDEN**" for generator 4.
Structural vulnerabilities		• Significantly **old** and **cracks** and **other damage** were observed. • **Buildings** need **modernization** and **reinforcement.** • The last civil / structural survey was done in 2022.
Plant operations		• The plant is **significantly old**, with an **average age of 37 years** for the equipment. • **Increased O&M** cost due to **low efficiency** and aging. • **Frequent change requests** from the controllers are causing constant **fluctuations** in the generation parameters causing rapid wear and tear. • **Need addition** of another Gas **turbine** and **HRSG** unit to enhance plants flexibility between heat and electricity production to avoid unforeseen rapid changes. • The **auxiliary** consumption of the plant is significantly high at **~19%.**

15. ZHAIYKTEPLOENERGO URAL CHPP (2/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Gas	Electricity & Heat	54 MW	4 Units	JSC "Zhaiykteploenergo"	Uralsk City	Western

Theme	Details
Operation and maintenance	• The existing **fuel reserve system** is **63 years old** and **needs** to **replaced** to increase reliability of operations. • Considering the **age** of the **main equipment** and the plant, the plant is in **dire need** for **renovation** and **modernization.** • Power plant is **unable to retain control room personnel** due to financial constraints leading to lack of institutional knowledge
Control systems	• **Manual operation of boilers** and **turbine** from control room. • The plant does **not** have a **DCS system.** • The **Gas turbine generator** has **SCADA system** for **monitoring.**
Emission control and ash management	• The plant does **not** have **continuous emission monitoring system** (CEMS).

Visual observations[1]

1. Heating boilers constructions and chimneys

2. Switchyard and main transformers

3. STG's hall

4. Natural gas burners

5. Control room - manual knob operations

Source: 1. Site Visit

Annexure 3.3 - West Zone Plants

West Zone Plants

1. Batys Power Ural GTES-200
2. MAEK Kazatomprom CHPP-1
3. MAEK Kazatomprom CHPP-2
4. MAEK Kazatomprom TPP
5. Atyrau CHPP
6. Karabatan Utility Solutions
7. Atyrau GPPP
8. Uralsk GTPP
9. Zhaiykmunai LLP GTPP

1. BATYS POWER URAL GTES-200 (1/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Gas	Electricity	100 MW	1 unit	Batys Power LLP	Uralsk	Western

Plant Status and Performance

Theme		Details
Age		• The power plant is relatively new, having been **commissioned in 2016.** • As per the data provided by the power plant, **the turbine was manufactured in 1993 and is ~29 years old.**
Fuel sourcing & management		• The plant uses **natural gas** of GCV 8,122.74 kcal/m^3. • The plant is supplied with gas from the **Soyuz main gas pipeline** of the Intergas Central Asia JSC. • The plant is facing **trouble with gas supply** causing **20-day shutdown** in January 2023 as well **delaying expansion** plans.
Major assets	Turbine	• Manufactured by **Nuovo Pignone**, a subsidiary of General Electric Corporation in **1993**. • The **rated power** of the turbine is **116.9 MW**. • **No renovation and modernization activity** has been undertaken for the gas turbine. The equipment has already consumed **~110,000 hours** prior to installation in this plant. • One of the combustors of the power plant was replaced.
	Generator	• Manufactured by **Alstom** in **1992.** • Generating at 103 MW during the time of the visit. • **No renovation and modernization activity** has been undertaken for the generator. The equipment has already consumed **~110,000 hours** prior to installation in this plant.
Plant operations		• The plant generated **788,163 MWh** of electrical energy in **2021** and supplied **783,001 MWh** of electrical energy to the **grid**. It reported an auxiliary consumption of **~0.65%** in 2021, which is good. • The plant consumed **272,182,480.00 m^3 of natural gas** in 2021. It reported a specific fuel consumption of **0.35 m^3 of gas / kWh** in 2021. • The plant reported a **shutdown** of **8 days** in **April 2021,** where **19,065 MWh** of energy was undersupplied. The reason for this is not clear. • The plant also had a **shutdown** of **20 days** in **January 2023** due to fuel supply issues. • The plant reported facing issues with **sudden fluctuations** in **consumer load**.

1. BATYS POWER URAL GTES- 200 (2/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Gas	Electricity	100 MW	1 unit	Batys Power LLP	Uralsk	Western

Theme	Details
Operation and maintenance	• Both the turbine and generator of the power plant are secondhand assets put into operation in 1993. • The last **civil / structural survey** of the plant was completed in **2022**. • Based on site visit observations, the **main building** of the plant is **in need of renovation.** • Power plant is unable to **retain control room personnel** due to **financial constraints,** leading to lack of institutional knowledge. • Power plant is facing **operational challenges** due to **lowering** of the **demand** from the plant by the **grid operator**, causing loss of revenue. • **Energy audit** of the plant is carried out every **5 years** - the last in 2019, with several key observations. Of the observations, fuel and electricity consumption metering systems were implemented. • **Performance guarantee** test is conducted by the **grid authority** every **year**. **Scheduled maintenances** are done every **6 months** with **maximum load test** done by the **plant after each maintenance**.
Control systems	• The plant has a **SCADA and DCS** system for monitoring the plant performance; however, there is **no ERP system.** • The plant **maintains log** of **daily statistics**.
Emission control and ash management	• Power plant **does not** have a **continuous emission monitoring system.** • Power plant **does not** have a **wastewater recovery and disposal system.**

Visual observations[1]

1. Gas turbine and generator

2. Oil cooling system

3. Natural gas heating system

4. Natural gas filtering system

Source: 1. Site Visit.

2. MAEK KAZATOMPROM CHPP-1 (1/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Gas	Electricity & Heat	43.9 MW	4 Boilers & 3 Turbines	Ministry of Energy	Aktau	Western

Plant Status and Performance

Theme		Details
Age		• Set up in 1965 **(~57 years old),** has installed capacity of 75 MW. However, currently the operating capacity is 43.9 MW. • **Aging** of the equipment is a **key concern.** It was indicated that the average wear of the equipment is **73.2%.** • Considering the **age,** many of the main **equipment is in critical condition. Replacement** / **renovation** of the same is **necessary**.
Fuel sourcing & management		• The plant uses **natural gas** of GCV 8,235 kcal/m^3.
Major assets	Boiler	• The plant has 4 boilers (boilers 4, 5, 6, and 7). • The boilers were manufactured by **Barnaul Boiler Plant** between 1962 and 1966. Each has a steam generation capacity of 160 tons per hour. • Their **wear** was reported to be between **45.9% and 88.6%,** with boiler 6 the least followed by boiler 5. • All the boilers have **almost exhausted** their residual life. • Boiler 7 has **88.6%** of wear and is in **emergency reserve**. Its **mean time between failure** is **3–4 days** due to wear of heating surfaces.
	Turbine	• The plant has 3 steam turbines (turbines 3, 4, and 5). Each of the turbines has a rated capacity of 25 MW. • Turbines 3 and 4 were manufactured by **Ural Turbine Plant** in 1962–1963. Turbine 5 was manufactured by **Kaluga Turbine Plant** in 1963. • **Service life extension** was done in **turbines 3 and 4**. They have **almost exhausted** their **residual life** and have **high levels** of **wear,** at 93.7% and 92%, respectively.
	Generator	• Generator 3 was manufactured by **SETM Novosibirsk**, and generators 4 and 5 were manufactured by **ETM Kharkov** between the years 1962 and 1963. • Each of the turbines have a rated capacity of 25 MW each. • The **operation** of the **generators** were seen to be **satisfactory**.
Plant operations		• The plant generated **191,306 MWh** of electrical energy in **2021** and supplied **144,152 MWh** of electrical energy to the **grid**. It reported an auxiliary consumption of **~24.65%** in 2021 which is extremely high. • The plant consumed **69,752,000 m^3 of natural gas** in 2021. It reported a specific fuel consumption of **0.5 m^3 of gas / kWh** in 2021. • The plant is forced to observe **load limitation** due to **wear of parts** in the flow path of the turbines • Many **equipment, pipes, steam pipelines,** etc., were **unmarked** which can lead to confusion and **errors** during emergency response.

2. MAEK KAZATOMPROM CHPP-1 (2/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Gas	Electricity & Heat	43.9 MW	4 Boilers & 3 Turbines	Ministry of Energy	Aktau	Western

Theme	Details
Operation and maintenance	• **Maintenance** of the equipment is done **twice a year**. **Capital repairs** of the equipment are done **once** in **4 years**. • **Steam leakages** and **oil** leakages were observed throughout the plant. • Structures such as **maintenance platforms**, **fences**, were seen to be **damaged**. • Significant **insulation damage** and lack of **metal covers** were observed in the piping. • Some **equipment**, **pipelines**, **steam pipes** etc. were found to be without inscriptions or markings. • The last **civil / structural survey** of the plant was completed in **2022**. The building & structure needs reinforcement and modernization. • **Modernization** of boiler 7, and **construction** of a new **water heater** boiler is currently **under consideration**. • The plant reported **24** emergency **shutdowns** / **outages** in the last 5 years.
Control systems	• The plant does not have **SCADA systems.** The control rooms are **manual** / **semiautomatic** type. • The plant does not have an **ERP system**. • The plant does not **maintain log** of **daily statistics**
Emission control	• The power plant does **not** have a **continuous emission monitoring system.** • The plant has 3 **metal smoke chimneys** constructed between 1962 and 1967. • The plant indicated that no wastewater is generated and discharged to the environment.

Visual observations[1]

1. Turbine hall

2. Steam turbine

3. Steam leakage

4. Control room

Source: 1. Site Visit

3. MAEK KAZATOMPROM CHPP-2 (1/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Gas	Electricity & Heat	416.8 MW	13 Boilers & 10 Turbines	Ministry of Energy	Aktau	Western

Plant Status and Performance

Theme		Details
Age		• Set up in 1968 **(~54 years old)** has **installed capacity** of **630 MW** and **available capacity** of **416.8 MW**. • **Aging** of the equipment is a **key concern.** It was indicated that the average wear of the equipment is **79.1%.** • Considering the **age** many of the main **equipment is in critical condition. Replacement** / **renovation** of the same is **necessary**.
Fuel sourcing & management		• The plant uses **natural gas** of GCV 8,235 kcal/m^3.
Major assets	Boiler	• The plant has 13 boilers (boilers 1 to 13). The boilers were manufactured by **Taganrog Boiler Plant** between 1965 and 1980. • The steam generation capacity of boiler 1 is 200 tons per hour (tph), boilers 2 and 3 are 220 tph, boiler 4 is 210 tph, boilers 6 to 9 are 190 tph, boilers 11 and 13 are 480 tph, and boiler 12 is 430 tph. Boilers 5, 9, and 10 have been decommissioned. • **Service life extension** has been conducted on **boilers 1 to 4**. All the boilers have **almost exhausted** their residual life. • Average **wear rate** of boilers is **84.7%,** with 7 units with over 80% wear.
	Turbine	• The plant has 10 turbines (turbines 1 to 10). Turbines 1 to 3 and 8 to 10 were manufactured by **Leningradsky Metallichesky Zavod** and boilers 4 to 7 by **HTZ factory** between 1965 and 1979. • Turbines 1 to 3, 8, and 9 are rated 60 MW each, turbines 5 to 7 are rated 50 MW each, turbine 10 is 80 MW, and turbine 4 at 100 MW. • **Service life extension** has been conducted on **turbines 1 to 3 and 8 to 10. Turbines 1 and 10** have **exceeded** their **service life**. • 6 turbines have wear rate over 90%, with the station **average wear rate** at **89.55%. Turbines 4 and 7** have been **decommissioned.**
	Generator	• Generators 1 to 7 were manufactured by ES Lysva and generators 8 to 10 by SETM Novosibirsk. Generators 1 to 7 (except generator 4) are rated 60 MW, generators 8 and 9 are 63 MW, and generators 4 and 10 are 100 MW each. • The **operation** of the **generators** was seen to be **satisfactory**.
Plant operations		• The plant generated **1,926.1 GWh** of electrical energy in **2021** and supplied **1,658.5 GWh** of electrical energy to the **grid**. It reported an auxiliary consumption of **~13.89%** in 2021. • The plant consumed **599,648,000 m^3 of gas** in 2021. It reported a specific fuel consumption of **0.396 m^3 of gas / kWh** in 2021. • The plant is forced to observe **load limitation** due to **wear of parts** in the flow path of the turbines. • Many **equipment, pipes, steam pipelines.** etc. were **unmarked** which can lead to confusion and **errors** during emergency response.

3. MAEK KAZATOMPROM CHPP-2 (2/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Gas	Electricity & Heat	416.8 MW	13 Boilers & 10 Turbines	Ministry of Energy	Aktau	Western

Theme	Details
Operation and maintenance	• **Maintenance** of the equipment is done **twice in a year**. **Capital repairs** of the equipment are done **once** in **4 years**. • **Steam leakages** and **oil** leakages were observed throughout the plant. • Structures such as **maintenance platforms**, **fences**, were seen to be **damaged**. • Significant **insulation damage**, and lack of **metal covers** were observed in the piping • Some **equipment**, **pipelines**, **steam pipes,** etc. were found to be without inscriptions or markings. • The last **civil / structural survey** of the plant was completed in **2022**. The building and structure needs reinforcement and modernization. • **Construction** of a 139 MW combined cycle **gas turbine** and **modernization** of **boiler 10** and **turbine 7** is **under consideration**. • The plant is planning on **disposing turbines 1, 2, and 3** in stages between **2026 and 2028** due to high wear and tear.
Control systems	• The plant does not have **SCADA systems.** The control rooms are **manual** / **semiautomatic** type. • The plant does not have an **ERP system**. • The plant does not **maintain log** of **daily statistics**
Emission control	• The power plant does **not** have a **continuous emission monitoring system.** • The plant has 4 **reinforced concrete chimneys** commissioned between 1968 and 1981. • The plant indicated that no wastewater is generated and discharged to the environment.

Visual observations[1]

1. Turbine hall

2. Steam turbine

3. Trip and fall hazards

4. Control room

Source: 1. Site Visit

4. MAEK KAZATOMPROM TPP (1/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Gas	Electricity	450 MW	3 units	Ministry of Energy	Aktau	Western

Plant Status and Performance

Theme		Details
Age		• Set up in 1983 **(~39 years old)** has **installed capacity** of **625 MW** and **available capacity** of **450 MW**. • **Aging** of the equipment is a **key concern**. It was indicated that the average wear of the equipment is **90.3%**. • Considering the **age** many of the main **equipment is in critical condition. Replacement** / **renovation** of the same is **necessary**.
Fuel sourcing & management		• The plant uses **natural gas** of GCV 8,235 kcal/m^3.
Major assets	Boiler	• The plant has 3 boilers manufactured by Taganrog Boiler Plant between 1981 and 1987. • The boilers have steam generation capacity of 670 tons per hour. • **Service life extension** has been conducted on **boiler 2.** All the boilers have **almost exhausted** their **residual life except boiler 2**. • **Average wear rate** of boilers are **85.4%** with 2 boilers exceeding 80%.
	Turbine	• The plant has 3 turbines manufactured by **Leningradsky Metallichesky Zavod** between 1981 and 1988. • Turbine 1 is rated at 200 MW, turbine 2 at 210 MW, and turbine 3 at 215 MW. • **Service life extension** has been conducted on **turbine 1. All turbines** have almost **exhausted** their **residual life.** • **Average wear rate** of turbines is **95.7%** with **1 turbine** having **exceeded** its residual **life**.
	Generator	• Generators 1, 2, and 3 were manufactured by ETM Kharkov between 1983 and 1987. • Generators 1 and 2 are rated at 210 MW each and generator 3 is rated 220 MW. • The **operation** of the **generators** were seen to be **satisfactory**.
Plant operations		• The plant generated **2,355.36 GWh** of electrical energy in **2021** and supplied **2,159.76 GWh** of electrical energy to the **grid**. It reported an auxiliary consumption of **~8.30%** in 2021. • The plant consumed **742,542,000 m^3 of gas** in 2021. It reported a specific fuel consumption of **0.42 m^3 of gas / kWh** in 2021. • The plant is forced to observe **load limitation** due to **wear of parts** in the flow path of the turbines • Many **equipment, pipes, steam pipelines,** etc., were **unmarked** which can lead to confusion and **errors** during emergency response.

4. MAEK KAZATOMPROM TPP (2/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Gas	Electricity	450 MW	3 units	Ministry of Energy	Aktau	Western

Theme	Details
Operation and maintenance	• **Maintenance** of the equipment is done **twice a year**. **Capital repairs** of the equipment are done **once** in **4 years**. • **Steam leakages** and **oil** leakages were observed throughout the plant. • Structures such as **maintenance platforms**, **fences**, were seen to be **damaged**. • Significant **insulation damage**, and lack of **metal covers** were observed in the piping • Some **equipment**, **pipelines**, **steam pipes,** etc. were found to be without inscriptions or markings. • The last **civil / structural survey** of the plant was completed in **2022**. The building & structure needs reinforcement and modernization.
Control systems	• The plant does not have **SCADA systems.** The control rooms are **manual** / **semiautomatic** type. • The plant does not have an **ERP system**. • The plant does not **maintain log** of **daily statistics**
Emission control	• The power plant does **not** have a **Continuous emission monitoring system.** • The plant has 1 **reinforced concrete chimney** commissioned in 1983. • The plant indicated that no wastewater is generated and discharged to the environment.

Visual observations[1]

1. Turbine hall

2. Steam leakage

3. Observed damage

4. Control room

Source: 1. Site Visit

5. ATYRAU CHPP (1/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Gas	Electricity & Heat	454 MW	14 Boilers & 12 Turbines	JSC Samruk Kazyna Ondeu	Atyrau	Western

Plant Status and Performance

Theme		Details
Age		• Set up in 1963 **(~59 years old)** has **installed capacity** of **474 MW** and **available capacity** of **339 MW**. • **Aging** of the equipment is a **key concern. Residual assessment** done in 2022 indicated overall **depreciation** of **54.19%** of the plant. • Overall **wear** of **boilers** is **~61.93%** and overall **wear** of **turbines** is **~46.45%.** • **Renovation**, **modernization,** and **service life extension** has been carried out on **boiler 1 and turbines 3, 4, 5, 6, 7, and 8.**
Fuel sourcing & management		• The plant uses **natural gas** of GCV 8,050 kcal/m^3.
Major assets	Boiler	• The plant has 14 boilers of which boilers 1 to 7 and 10 were manufactured by **Barnaul Boiler Plant** between 1963 and 1985 and with steam generation capacity of 50 and 80 tons per hour (tph). • Boilers 8, 9, and 11 to 14 were made by **TKZ Krasny Kotelshchik** in 1975, 1980, and 2011–2015 with steam generation capacity of 110 tph. • Boilers 3 to 10 have **almost exhausted** their **residual life.** Boilers 11 to 14 are **relatively new**. • **Overall wear rate** of boilers is **63.9%** with **8 boilers** having wear ranging from **71.7% to 98.2%.**
	Turbine	• Turbines 1 to 4 and 8 to 10 were manufactured by **Kaluga Turbine Plant** between 1963-1967 and 2010-2012. • Turbines 5–7 and turbine 12 were manufactured by **Leningrad Metal Plant** between 1969-1977 and 2015. • The gas turbine was manufactured by **GEC Gasturbines Ltd. England** in 2019 and is rated at 45 MW. • Turbines 3, 4, 6, and 7 have **almost exhausted** their **residual life**. Turbines 1, 2, 5, and 11 are **relatively new**. • **Overall wear rate** is **48.6%** with **4 turbine generators** having degree of wear between **70% and 99.4%.**
	Generator	• The plant has 11 generators of varying ratings. • Generators 1, 2, and 8 to 11 are relatively new, made after 2010. The other generators were manufactured in the 1960s and 1970s.
Plant operations		• The plant generated **1,913.1 GWh** of electrical energy in **2021** and supplied **1,724.1 GWh** of electrical energy to the **grid**. It reported an auxiliary consumption of **~9.88%** in 2021. • The plant consumed **738,695,770 m^3 of gas** in 2021. It reported a specific fuel consumption of **0.475 m^3 of gas / kWh** in 2021. • The plant is forced to observe **load limitation** due to **wear of parts** in the flow path of the turbines • Many **equipment, pipes, steam pipelines,** etc., were **unmarked** which can lead to confusion and **errors** during emergency response.

5. ATYRAU CHPP (2/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Gas	Electricity & Heat	454 MW	14 Boilers & 12 Turbines	JSC Samruk Kazyna Ondeu	Atyrau	Western

Theme	Details
Operation and maintenance	• **Steam leakages** and **oil** leakages were observed in the plant. Structures such as **maintenance platforms**, **fences**, were seen to be **damaged**. • **Insulation damage**, and lack of **metal covers** were observed in piping. The building and structure needs **reinforcement** and **modernization**. • High **temperature** were observed at **service marks** due to lack of **brickwork**, **insulation** and steam **leakages** causing overheating, corrosion, etc. • The plant had **31 emergency shutdowns** in the last 5 years with an overall **undersupply** of **78.7 MWh** of electricity. • It was observed that plant personnel does **not comply** with **health and safety regulations** such as **PPE**. • The plant is **understaffed** and faces **shortage** of **qualified specialist** due to **low wages**. • **Shallowing** of **Zharyk river** has caused **decreased** in **water intake reducing vacuum** in the condenser and **limiting plant output**. • Equipment **testing**, **tuning** were done **poorly** leading to **lower productivity** and higher fuel consumption. • In the last structural survey, damage was observed in the concrete as well as damage due to corrosion caused by presence of steam.
Control systems	• The plant has **SCADA systems.** The control rooms are **semiautomatic** type. • The plant does not have an **ERP system**. • The plant reported that it **maintains log** of **daily statistics**
Emission control	• The plant does **not** have a **continuous emission monitoring system.** Emissions **monitoring** through **portable gas analyzer** by a **third party**. • The plant reported that it has a wastewater recovery and disposal system.

Visual observations[1]

1. Turbine

2. Observed damage

3. Damaged insulation

4. Control room

Source: 1. Site Visit

6. KARABATAN UTILITY SOLUTIONS CCGT (1/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Gas	Electricity & Heat	310 MW	2	JSC Samruk-Kazyna	Atyrau	Western

Plant Status and Performance

Theme		Details
Age		• The plant was commissioned in 2019 and has been **in operation for 4 years.** • The enterprise has **plans** for the **construction** of **new power plant** of 165 MW by 2027. • The plant structures were comparatively new and in **good condition**.
Fuel sourcing & management		• Major issue for the plant is **lack of volumes** of **commercial gas** from the supplier. • The plant reported that it is **penalized** for **excessive gas consumption** in the amount of 1.5 times the gas tariff during the heating season (HWP) and 1.2 times the tariff for the rest of the season.
Major assets	Boiler	• Manufactured by **Doosan Engineering and Construction.** • There are two boilers in each block.
	Turbine	• There are 6 turbines – 2 manufactured by **Doosan Skoda Power** and 4 by **Siemens Industrial Turbomachinery.** • There are three turbines in each block.
	Generator	• There are 6 generators – 2 manufactured by **Doosan Skoda Power** and 4 by **Siemens Industrial Turbomachinery.** • There are three generators in each block.
Plant operations		• Generated 1.8 TWh of electricity in 2021 and had an **auxiliary consumption < 2%.** • Water quality testing like electrical conductivity is measured automatically- readings are taken every 2 hours. • The plant was **well equipped with the fire fighting system**.
Operation and maintenance		• The plant has a **five-year contract** with Siemens Energy LLP **for technical inspections of gas turbines** by running hours, 24-hour online technical support, supply of a two-year emergency stock of spare parts. • **Fuel filter** of the **turbine** feed changed **atleast once a year**. The **condensate removal** system is **manual**.

6. KARABATAN UTILITY SOLUTIONS CCGT (2/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Gas	Electricity & Heat	310 MW	2	JSC Samruk-Kazyna	Atyrau	Western

Theme	Details
Control systems	• The control systems of the plant are **connected to the DCS** via digital communication channels using IEC 61850 protocol. • There are **no ERP systems**. However, the plant plans to install an ERP system in near future.
Emission control and ash management	• The plant **has continuous emission monitoring system** in the chimney. • All emission sources are equipped with automatic emission monitoring systems (AMS) that determine the actual concentrations of pollutants in real time.

Visual observations[1]

1. Gas turbine

2. Turbine generator arrangement with fire fighting system

3. Pathways - clean and well marked

4. Turbine hall: clean and equipment are new

5. Plant outside - well maintained and regulated

Source: 1. Site visit.

7. ATYRAU GPPP (1/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Gas	Electricity	9 MW	11	Sagat Energy	Atyrau	Western

Plant Status and Performance

Theme		Details
Age		• **No R&M activity** undertaken for the **nine blocks** in this plant. • The plant **plans** to **increase** the **capacity** of the **GPES** by an additional 40 MW through the implementation of the modernization and expansion program by the end of 2024.
Fuel sourcing & management		• The plant gets **high-pressure natural gas** from the **regional gas distribution system** in underground pipes.
Major assets	Gas piston electric unit	• 11 gas piston units are manufactured by **Waukesha**. • Gas pistons 1 and 2 are not operational. • Standard natural gas consumption at full engine power is 242 Nm^3/h. • Electric power rating 1,000 kW efficiency 42.1%.
	Generator	• All 11 generators are manufactured by **Leroy Somer.** • Efficiency is 95.4%, rated power is 1,200 kW / 1,500 kVA.
Structural vulnerabilities		• The plant is **well maintained** and there were **no major structural vulnerabilities**. • The equipment were **well tagged**, and the **safety cautions** were mentioned.
Plant operations		• The plant has a **demineralization plant** to provide demineralized process water. • **Water quality testing** is done **manually** in the lab.
Operation and maintenance		• The plant has **maintenance scheduled once every quarter** for all the blocks. • The plant stated their **concern** regarding the **availability of spare parts** for ongoing repairs in terms of their increased cost and delivery time • 6 of the 9 gas piston units **require maintenance and repair.**

7. ATYRAU GPPP (2/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Gas	Electricity	9 MW	11	Sagat Energy	Atyrau	Western

Theme	Details
Control systems	• The power plant does **not** have an **electrostatic precipitator** or **electric filters** at the exhaust/outlet pipes to reduce emissions. • The plant does **not** have a **continuous emission monitoring system.**
Emission control and ash management	• The power plant has **manual and semiautomatic control systems.** • The plant is **not** equipped with an **automated DCS system.**

Visual observations[1]

1. Pathway leading to main generating station

2. PPEs and LOTO system

3. Controls and monitors

4. Monitoring room: the processes are automated and well monitored.

Source: 1. Site Visit

8. URALSK GTPP (1/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Gas	Electricity & Heat	54 MW	3	JSC "Ural GTPP"	Uralsk	Western

Plant Status and Performance

Theme		Details
Age		• All units of this plant are commissioned in 2011 **(<12 years old**).
Fuel sourcing & management		• Primary fuel for this plant is **gas** of **33.73 MJ/m^3** calorific value is supplied to the plant. • It was reported by the plant that there are challenges with **fluctuating natural gas pressure** which could lead to flame out or abrupt halting of turbines. Plants may consider gas boosting compressor & PRS, or surge tanks, accumulators for distillate fuel, etc., for the same.
Major assets	Boiler	• Two boilers are in operation - manufactured by **JSC "AK" Yuzhtransenergo "Ukraine, Zaporozhye.** • **Third boiler** is **out of service** (organizational problems). • **Boilers** are not for steam but **hot water production** (140–1,500°C).
	Turbine	• The power plant has **three gas turbines** which were installed in 2006 and 2008. • All **turbines** were **upgraded** in 2021 – **replacement of gearbox** gear pair and increase of capacity from 16 to 18 MW. • Manufactured by **JSC "KMPO".**
	Generator	• Manufactured by **OOO "Electrotyazhmash-Privod".** • The plant has three 20 MW generators producing at 10 kV.
Plant operations		• For **winters** (October to April), **20% of production ratio is allocated for heat**, 80% is for electricity. • For **summers** (May to September) **focus** is on **electricity production.** • Supplies heat to **JSC "Zhaiykteploenergo" Ural CHPP** district heating system. • The **auxiliary consumption** of the plant is **~1.5%.** • Conducts test on the **minimum** and **maximum capacity** every three months and adhere to daily production targets.
Operations and maintenance		• **Production challenges** due to **lack** of **availability** of natural **gas** as well as **unstable pressure** in the gas pipeline. • **Difficulty in procuring spare parts** as equipment are of multinational origin. • Difficulty in **retaining control room personnel** due to **financial constraints** leading to lack of institutional knowledge. • Only **major** and **scheduled maintenance activities outsourced** to subcontractors.

8. URALSK GTPP (2/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Gas	Electricity & Heat	60 MW	3	JSC "Ural GTPP"	Uralsk	Western

Theme	Details
Control systems	• The power plant has indicated that **it has a DCS system**.
Emission control	• The power plant does **not** have a **continuous emission monitoring** system. • The power plant data **indicated that emission parameters** for NOx, SOx, Cox, and solids were **within** the **available norms**.

Visual observations[1]

1. Gas turbine generator hall

2. Air filter house

3. Boiler 1 - currently out of service

Source: 1. Site Visit

9. ZHAIYKMUNAI LLP GTPP-1 & GTPP-2 (1/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Gas	Electricity	36.5 MW	4	Nostrum Oil & Gas Corporation	Western Kazakhstan	Western

Plant Status and Performance

Theme		Details
Age		• The plant was recommissioned in 2011 **(~12 years).** • All units of this plant are over 30 years old. • Residual life assessment, conducted in 2022, indicated **availability of residual life.**
Fuel sourcing & management		• It was informed that the fuel is obtained from nearby oil and gas fields, with calorific value of 8,740 kcal/m^3.
Major assets	Turbine	• Zhaiykmunai LLP GTPP-1 and GTPP-2 comprise one main gas turbine unit and three standby gas turbine generator units. • Turbine 1 manufactured by AEG KANIS; turbines 2–4 manufactured by solar turbines. • **4 single cycle gas turbines** which were manufactured between 1990 and 1993. • **Undertaken 2 renovation activities in turbines 1 and 2.** • Replacement of outdated relay protection system in turbine 1 in 2018. • Replacement of starting system for turbine 2 with an electrically operated system in 2016.
	Generator	• The plant has 1 main generator (26 MW, 10.5 kV) manufactured by AEG KANIS. • There are 3 standby generators of 10.5 kV and capacities of 7 MW, 4.2 MW, and 4.2 MW, respectively. • Generator 2 is manufactured by ASEA, generators 3 and 4 are manufactured by GEC Althom Large Machines.
Plant operations		• Part of the production complex and is designed to supply power for industrial production. • The **auxiliary consumption** of the plant is **~2%.** • **No heat recovery systems**- exhaust gas from the turbines is not being utilized.
Operations and maintenance		• The plant is unable to generate at the rated capacity due to **evacuation limitations** of the grid. • Main responsibility of the plant is to fulfil the energy demand of the oil factory. • The plant stated having no objective of selling electricity to the grid due to **low tariffs.** • The plant is **unable to raise money** for maintenance and renovation of the plant. • Financial constraints affects the hiring and retaining of technical expertise.

ZHAIYKMUNAI LLP GTPP-1 & GTPP-2 (2/2)

Plant Type	Purpose	Capacity	No. of units	Owner	Region	Zone
Gas	Electricity	36.5 MW	4	Nostrum Oil & Gas Corporation	Western Kazakhstan	Western

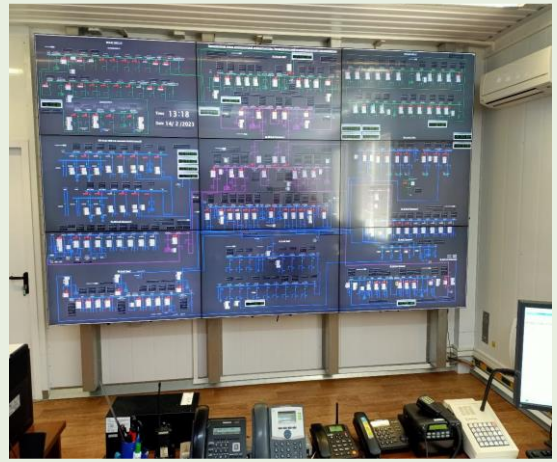
Theme	Details
Control systems	• The plant is equipped with **numerical relay systems** for protection. • The plant control rooms are equipped with a **SCADA/DCS system.** • The plant has **SAP system** for shift directives.
Emission control and ash management	• The plant has a **continuous emission monitoring system** for emission monitoring and control.

Visual observations[1]

1. Chimney

2. Main transformer

3. Back-up turbine generators



4. Electrification control systems

Source: 1. Site Visit

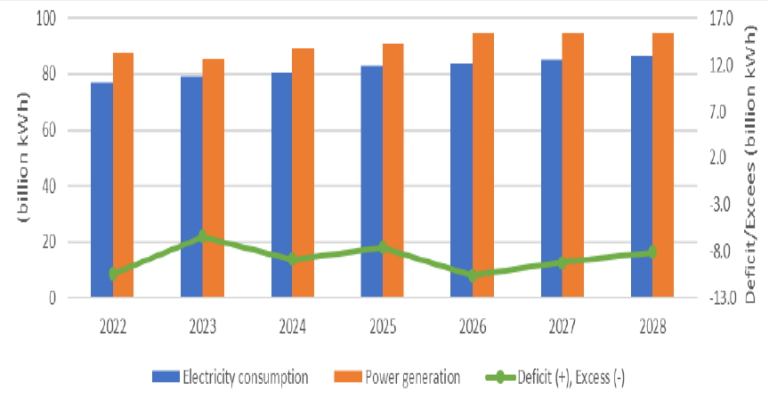
Annexure 4 – Energy Balance till 2028

Energy Balance Studies Indicate Overall Energy Deficit

KEGOC's energy balance forecast shows varying deficit from 2022 to 2028.

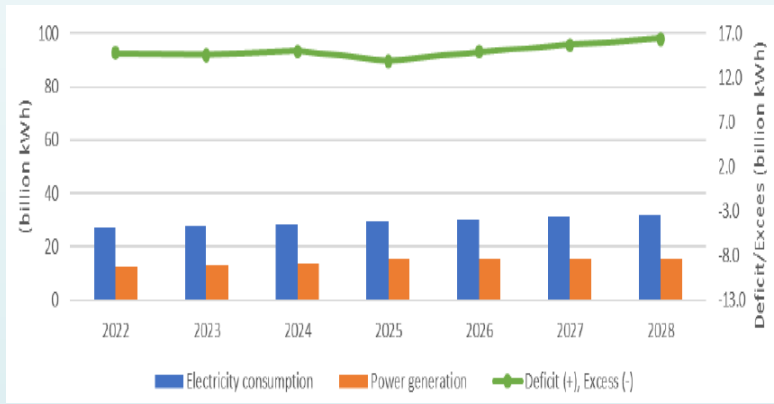
The energy balance indicates overall energy deficit of 5.2 billion kWh in 2028.

North Zone



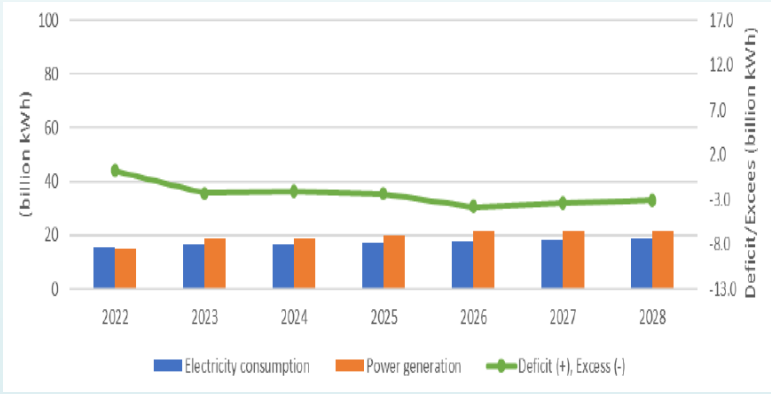
- The North Zone comprises of aging coal generation assets.
- North Zone is forecasted to have excess energy generation across the years from 2022 to 2028.
- North Zone is interconnected with South Zone and supplies excess energy to the South Zone.

South Zone



- The South Zone is forecasted to have excess demand over generation from 2022 to 2028.
- South Zone is interconnected with North Zone and the deficit can be made up by North Zone
- However, considering the age of the assets, unexpected shutdowns / decommissioning of capacity can result in widening deficit.

West Zone



- The West Zone is forecasted to have excess energy from 2023 to 2028 with 200 million units deficit in 2022.
- However, the West Zone is electrically isolated from the North and South Zones.
- Any loss of capacity in the West Zone will lead to blackouts as energy cannot be imported from other zones.