ENERGY EFFICIENCY BOILER IN INDUSTRY – CASE STUDY FOR INDUSTRY

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CONTENT

- Introduction of UNIDO project "Promotion of energy efficient industrial boiler adoption and operating practices in Vietnam"
- Activities have been done to support to project
- Boiler assessment activities.
- Case study 1
- Case study 2
- Case study 3
- Case study 4
- Lessons and experiences in boiler operation process

INTRODUCTION OF UNIDO BOILER PROJECT

- **Project title:** “Promotion of energy efficient industrial boiler adoption and operating practices in Vietnam” (in short “EEBP”)
- **Duration:** 4 years (starting from November 2015 to October 2019)
- **Executing agency:** Ministry of Industry & Trade (MOIT)
- **Implementing agency:** United Nations Industrial Development Organization (UNIDO)
- **Other project partners**: STAMEQ-MOST, MONRE, MOLISA, ECCs, Boiler Manufacturers and Vietinbank
- **Target beneficiaries:**
  - **Industrial enterprises (end-users) in subsectors**: pulp & paper, textile & garment, food processing, chemical & fertilizer, wood-processing, etc.
  - **Boiler manufacturers/providers**

PROJECT BUDGET

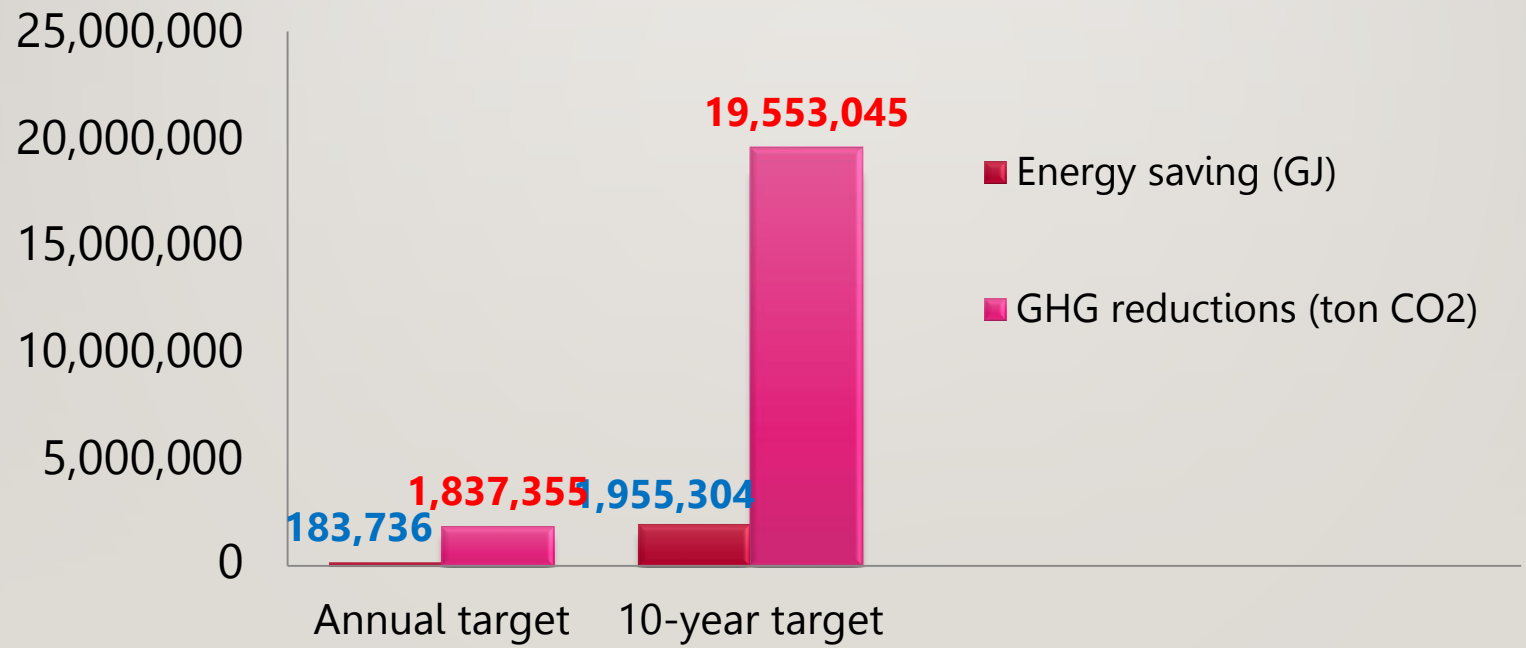
- **Total project Budget: US$ 12,053,000**, of which:
- GEF grant: US$ 1,771,000
- UNIDO inputs: US$ 110,000 (cash and in-kind)
- Total committed co-financing by Vietnamese partners is US$ 10,282,000, of which:
  - MOIT: US$ 1,725,000 (cash and in-kind)
  - ECCs: US$ 535,000 (in-kind)
  - Boiler Manufacturers: US$ 500,000 (in-kind)
  - Vietinbank: US$ 7,412,000 (loan program)

4

Project Objectives

Project Objectives: to reduce energy consumption and GHG emissions through promotion of EE industrial boilers

Indicators	Annual target	10-year target
Measurable energy reductions by industry	1,955,304 GJ	19,553,045 GJ
Calculated GHG emissions reductions	183,736 ton CO2	1,837,355 ton CO2



Project components

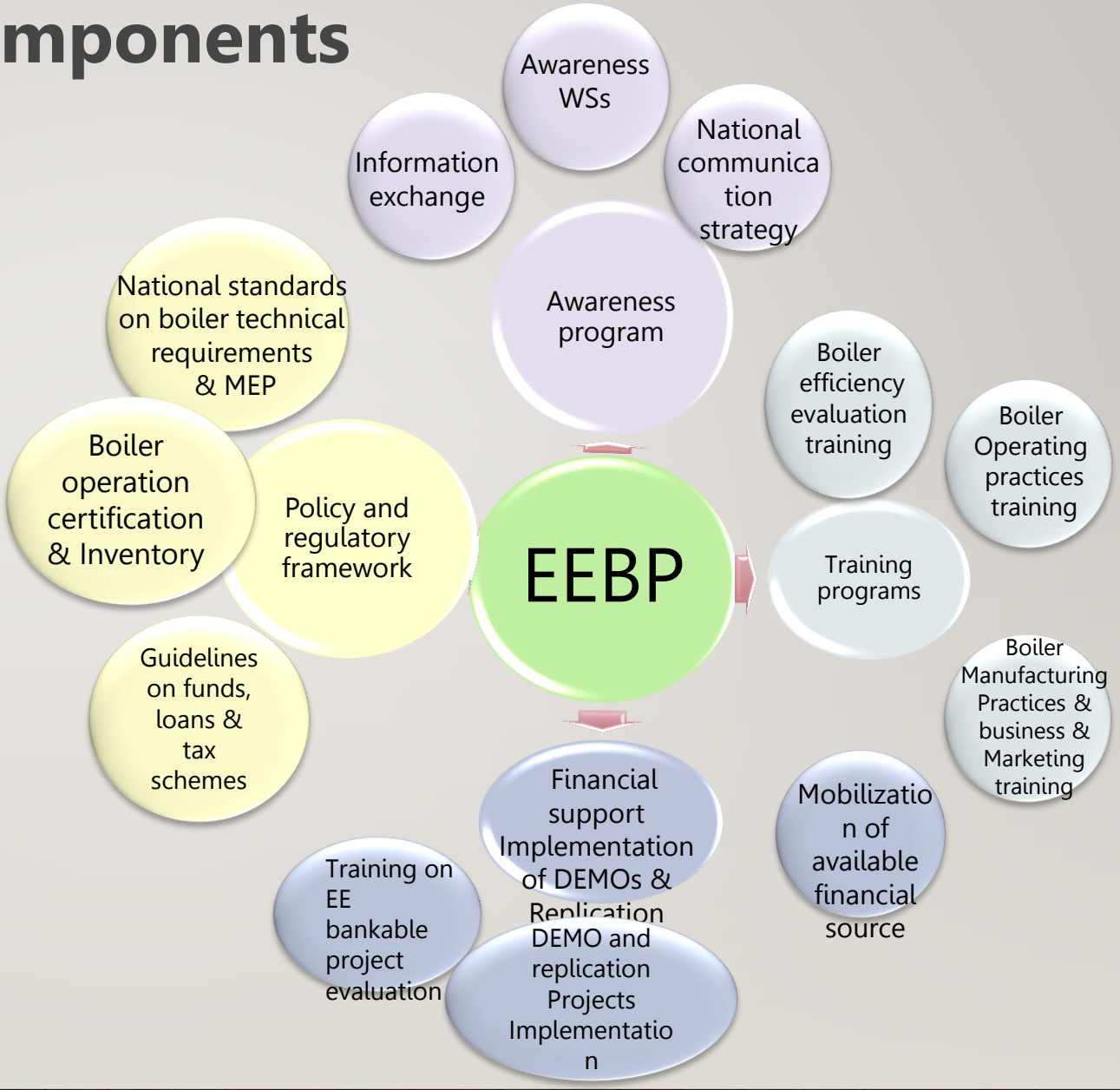
1. About the IEE project

Component 1: Policy and regulatory framework to support the boiler standardization system**.**

Component 2: Awareness, training and capacity building for government agencies, boiler owners, operators, and manufacturers, and other stakeholders.

Component 3: Financing and implementation of energy efficient boiler adoption projects and manufacturing.

The major themes of EEBP project are the improvement of policy & regulatory framework, the capacity building and EE boiler projects implementation.



ACTIVITIES HAVE BEEN DONE TO SUPPORT PROJECT

- Support to evaluate the software used for thermal calculation of boiler design
- Support to prepare training materials for the project training activites
- Support to evaluate the Instruments used for boiler assessment
- Conduct the boiler efficiency measurement training for boiler user and boiler evaluation experts with and without international experts.
- Assessing 29 boilers to evaluate boiler efficiency as well as giving energy conservation opportunities of boiler in 24 factories in Vietnam

BOILER ASSESSMENTS ACTIVITIES

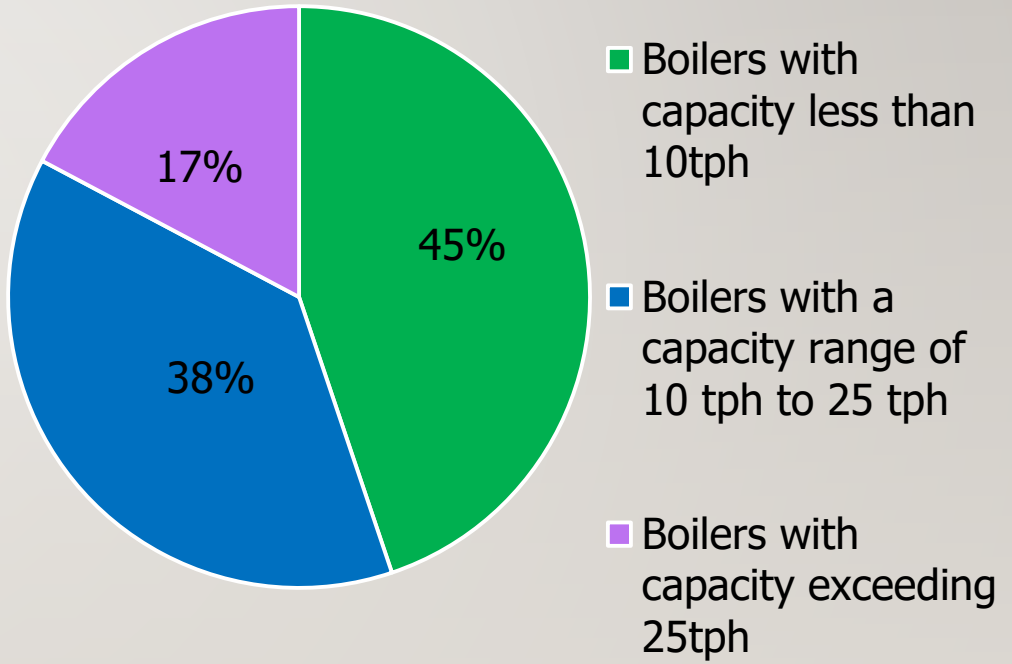
- Assessment and proposing energy saving solutions for boiler/steam supply system performed by experts training in line with UNIDO program are with the following contents:
  - Measuring and assessing boiler efficiency at the plant with standard devices/instrument equipped by UNIDO project;
  - Measurement are carried out in an automatic recording over a long period of a few days to a week, so that the actual boiler working status can be assessed based in load variation. The results is more reliable;
  - The final evaluation report and the proposal of energy saving solutions for the boiler and steam supplying system were sent to the plant at the same time with in-depth consultation on how to carry out;
  - The plants get 3 months to decide and implement the proper energy saving solutions in line with the actual situation of the plant;
  - The experts return to the plant to assess the efficiency of implementing energy saving solutions.

BOILER ASSESSMENTS ACTIVITIES

The number of boiler by capacity classification

STT	Parameters	Unit	Number
1.	**Total evaluated plants**	**Plant**	**24**
2.	**Total assessed boilers**	**Boiler**	**29**
2.1	Boilers with capacity less than 10tph	Boiler	13
2.2	Boilers with a capacity range of 10 tph to 25 tph	Boiler	11
2.3	Boilers with capacity exceeding 25tph	Boiler	5

Chart - Boilers classification by capacity

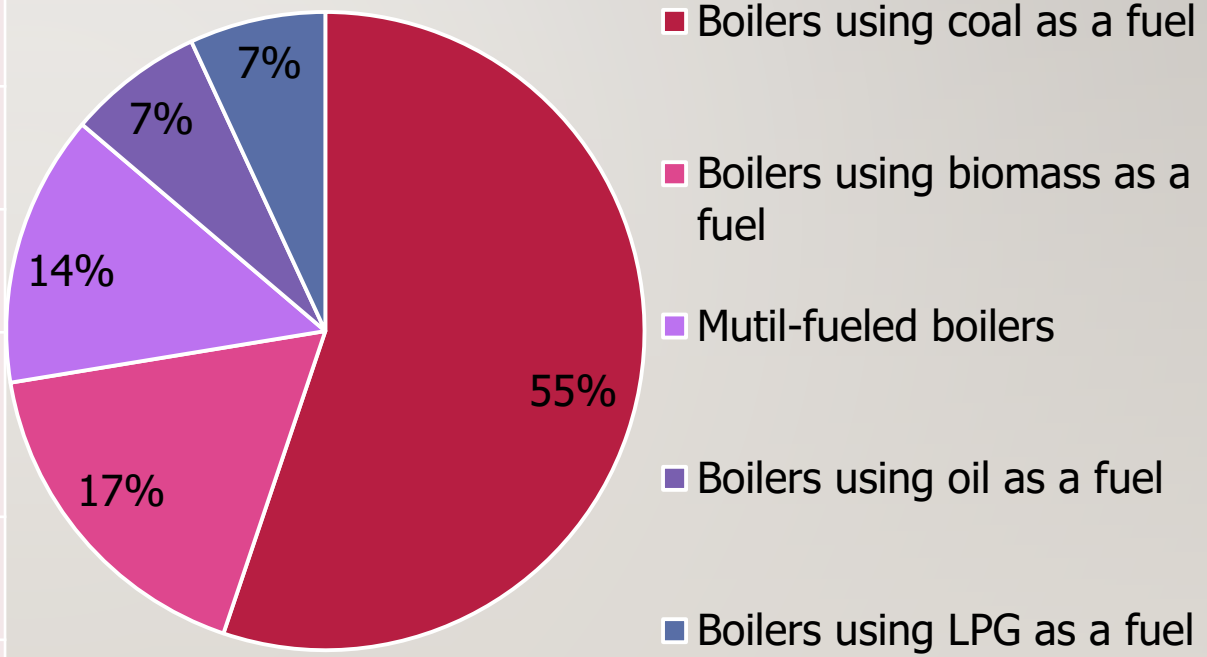


BOILER ASSESSMENT ACTIVITIES

The number of boilers by fuel classification

STT	Parameters	Unit	Number
1.	**Total assessed boilers**	**Boiler**	**29**
1.1	Boilers using coal as a fuel	Boiler	16
1.2	Boilers using biomass as a fuel	Boiler	5
1.3	Multi-fueled Boilers	Boiler	4
1.4	Boilers using oil as a fuel	Boiler	2
1.5	Boilers using LPG as a fuel	Boiler	2

Chart - Boilers classification by fuel

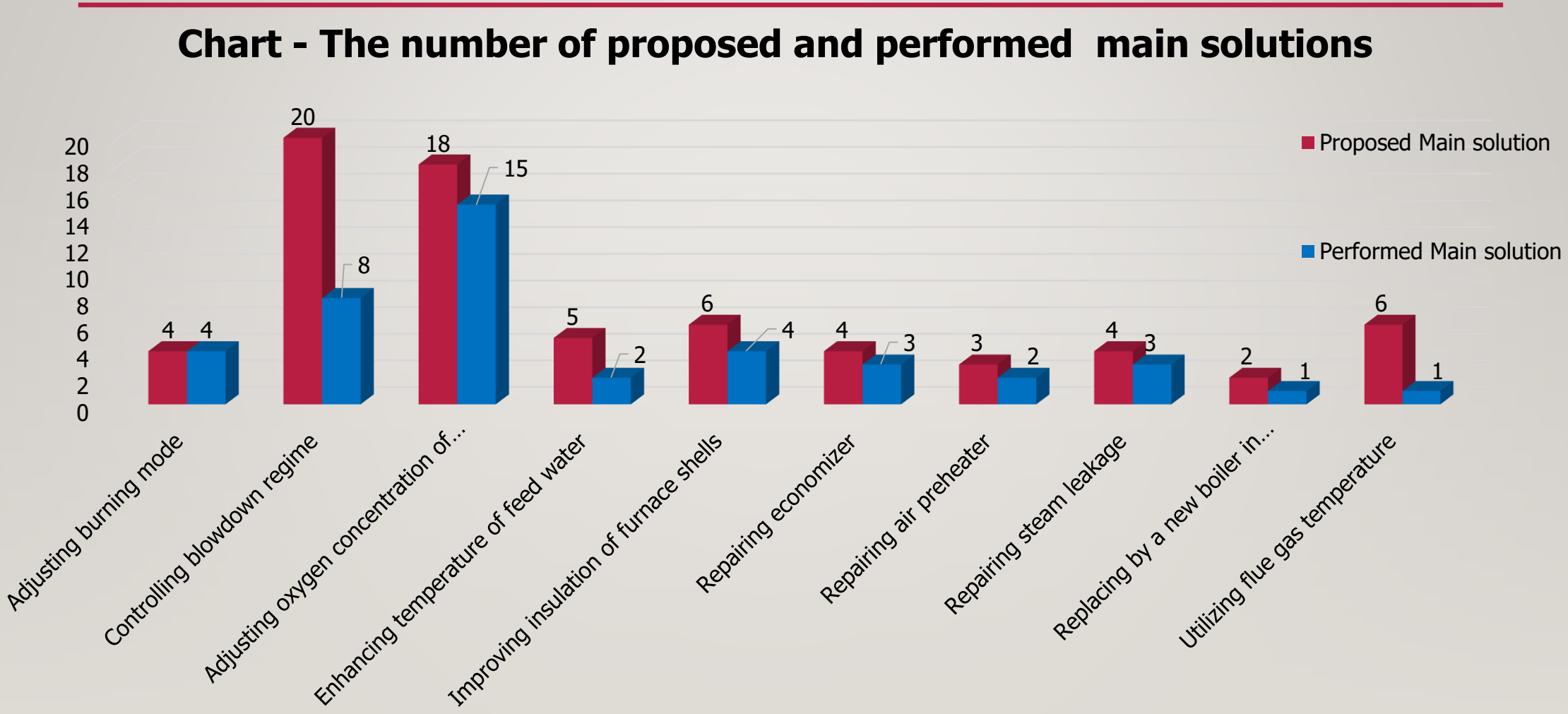


BOILER ASSESSMENT ACTIVITIES

Table 3. List of proposed main solutions

No	Solution title
1	Adjusting combustion mode
2	Controlling blowdown regime
3	Adjusting oxygen concentration of flue gas
4	Increasing temperature of feed water
5	Improving insulation of furnace shells
6	Repairing economizer
7	Repairing air preheater
8	Repairing steam leakage
9	Replacing by a new boiler in accordance with load and operation mode
10	Utilizing flue gas temperature
11	Combining the combustion additive and coal

BOILER ASSESSMENT ACTIVITIES



BOILER ASSESSMENT ACTIVITIES

Results of implemented solutions

No	Fuel type	Unit	Saving
1	Coal	tons/year	19.589
2	Oil	1000 littre/year	115
3	Biomass	tons/year	7.628
4	LPG	tons/year	435

No	Fuel type	CO_2 reduction *(tons CO_2/year)*
1	Coal	49.952
2	Oil	368
3	Biomass	1.275
4	LPG	1.292

BOILER ASSESSMENT ACTIVITIES

GHG emission reduction by the implemented solutions

STT	Implemented solutions	CO_2 Reduction (tCO_2)
1	Adjusting combustion mode	19.733
2	Controlling blowdown regime	6.328
3	Adjusting oxygen concentration of flue gas	9.999
4	Increasing temperature of feed water	1.932
5	Improving insulation of furnace shells	2.560
6	Repairing economizer	6.765
7	Repairing air preheater	4.363
8	Repairing steam leakage	373
9	Replacing by a new boiler in accordance with load and operation mode	370
10	Utilizing flue gas temperature	412
11	Combining the combustion additive and coal	6.765

CASE STUDY 1

HANOI DYEING JOINT STOCK COMPANY

- Name of company: Hanoi Dyeing Joint Stock Company- Hung Yen branch
- Address: Pho Noi B industrial Area, Lieu Xa commune, Yen My district, Hung Yen province
- Main field: Textile products
- Annual operation days: 250 days
- Designed boiler capacity: 6tph
- Fuel: Coal
- Boiler efficiency before implementing energy saving solutions: 70.92%

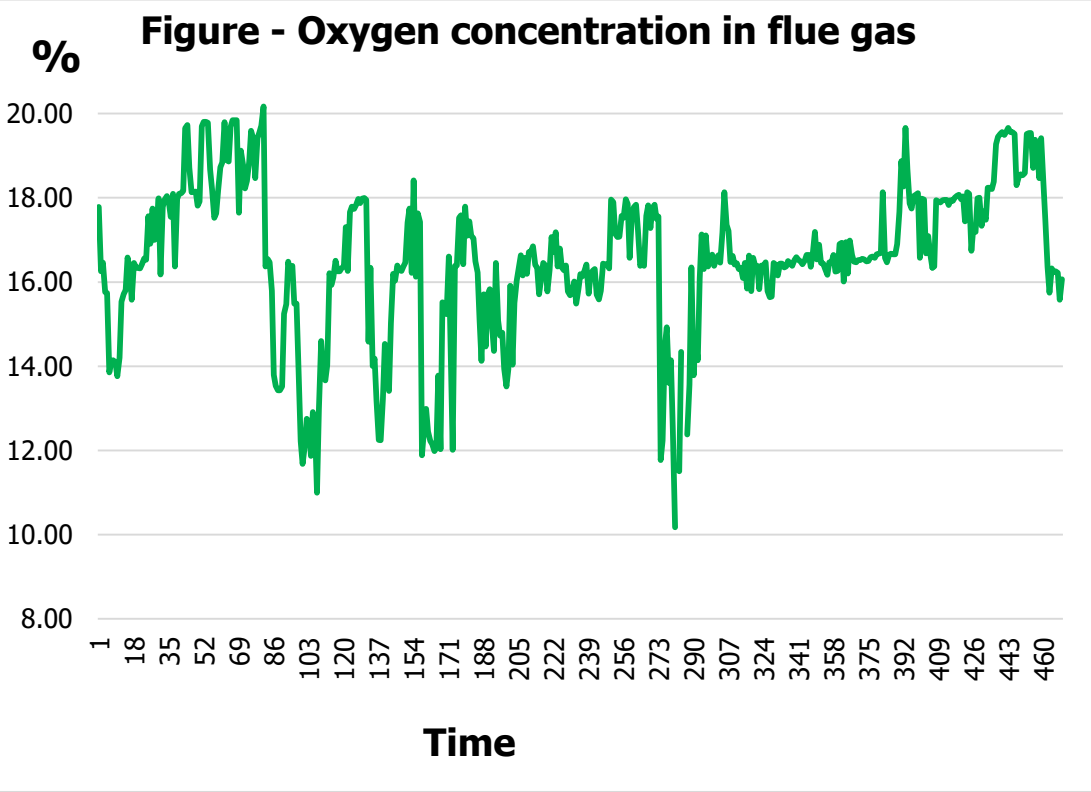
CASE STUDY 1

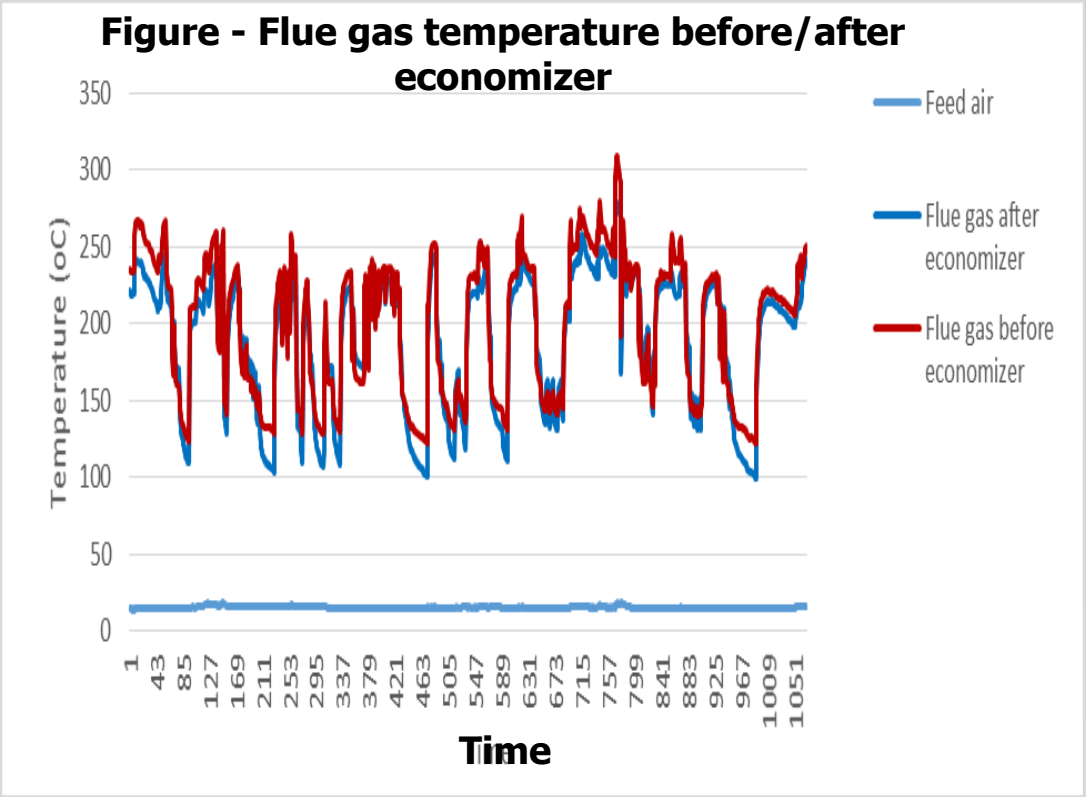
Background

- Boiler capacity: 6 tph
- This boiler system was equipped a system of condensate water recovery and an economizer improving the boiler efficiency;
- The oxygen concentration of the flue gas was 16.46%. This very high value caused heat loss due to flue gas to high;
- The difference of flue gas temperature before and after the economizer is very low. This shows that the economizer was operating inefficiently;
- Boilers operated at 30% - 40% of the designed capacity.

CASE STUDY 1

- The following are some figures of measuring result





CASE STUDY 1

Energy saving solution

- Adjusting oxygen concentration of flue gas

  ⇨ The plant carried out this solution (the oxygen concentration of flue gas deceased from 16,68% down 14,17%) in April 2018.

- Repairing the economizer

  ⇨ The plant inspected and cleaned the economizer in May 2018 and the temperature of the flue gas after the economizer is 92^{o}C.

- Replacing by a new boiler in accordance with load and operation mode

  ⇨ The plant replaced by a new boiler in September 2019. Its efficiency currently is 89% higher than the old one (18.08%).

CASE STUDY 1

Achieved results after implementing boiler efficiency improvement

No (1)	Items (2)	Situation before implementing (3)	Results after implementing (4)	Saving* (4) – (3)
1.	Designed boiler capacity (ton/hr.)	6	6	**-**
2.	Boiler efficiency (%)	70.92	77.46	**6.54**
3.	Average steam output (ton/hr.)	2.23	2.23	**-**
4.	Steam output (ton/yr.)	10,704	10,704	**-**
5.	Specific energy consumption (kg coal/ton of steam)	122	112	**-10**
6.	Total energy consumption (ton coal/yr.)	1,308	1,067	**-241**
7.	**CO_2 emission (ton/yr.)**	**3,336**	**2,721**	**-615**

** Note: This result was excluded the solution of "Replace by a new boiler"*

CASE STUDY 2

Traphaco high technology jsc

General information

- Name of company: : Traphaco High Technology JSC
- Address: Tan Quang commune, Van Lam district, Hung Yen province.
- Main field: Medicine
- Annual operation days: 350 days
- Designed boiler capacity: 6 tph
- Fuel: 4b dust coal
- Boiler efficiency before implementing energy saving solutions: 53.91%

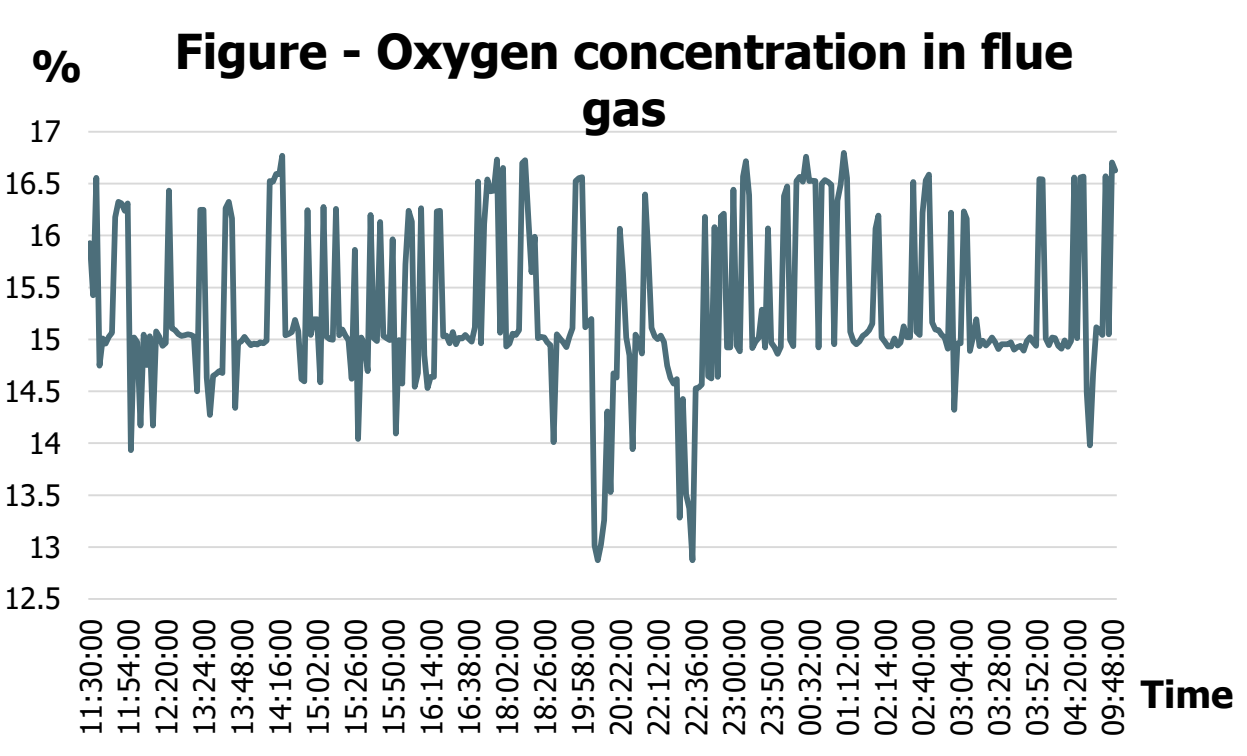
CASE STUDY 2

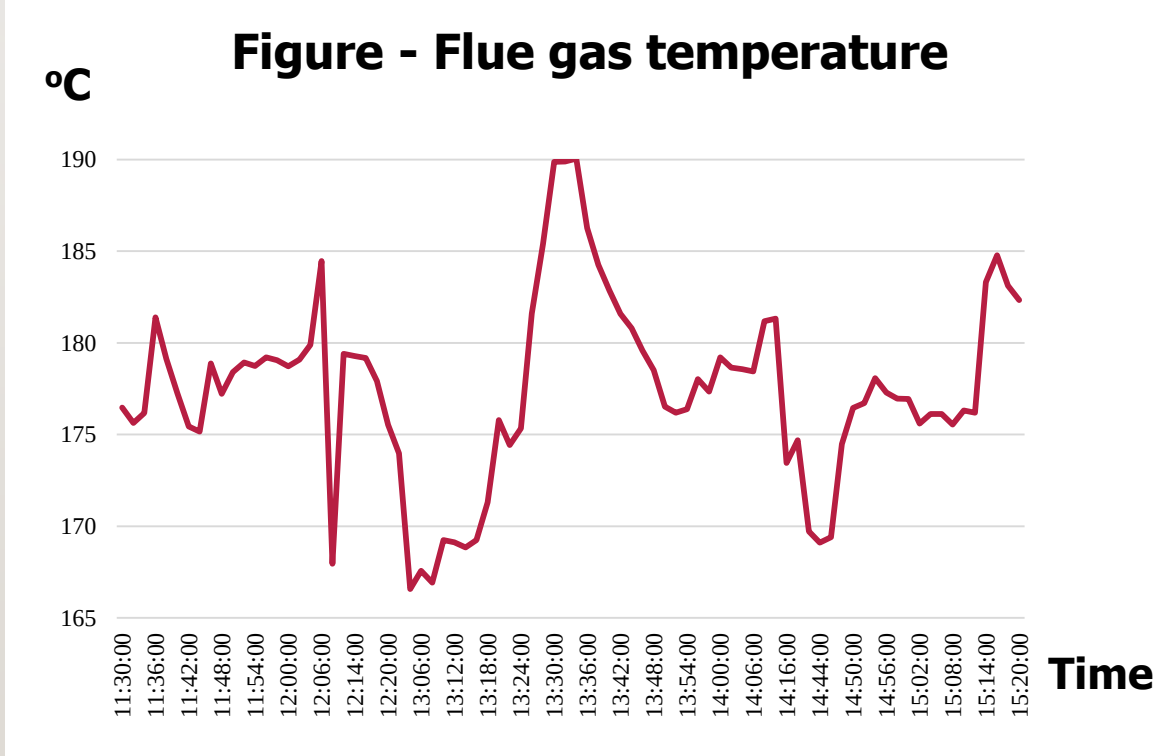
Background

- Boiler capacity: 6 tph
- This boiler system has been equipped an air preheater. However, the air preheater is only used for drying residue from production process to use as a additional fuel and at the measuring time, it was not operating due to no demand;
- The oxygen concentration of the flue gas was 15.1%. This very high coefficient caused heat loss due to flue gas to high;
- Flue gas temperature is 184^{o}C (high), while the air preheater was not operating;
- Unburned carbon in ash is very high (37%);
- Boiler surface temperature is in a range from 50^{o}C - 80^{o}C. In addition, the result was taken at the ambient temperature of 25^{o}C.

CASE STUDY 2

- Measuring results





CASE STUDY 2

Energy saving solution

- Adjusting oxygen concentration of flue gas

  ⇨ The plant carried out this solution (the oxygen concentration of flue gas deceased from 15.1% down 11.8%) in December 2019.

- Adjusting combustion mode

  ⇨ The plant implemented this solution (proportion of unburned carbon in ash decreased from 36.88% down 29.3%) in December 2019.

- Repairing the insulation of furnace shell.
- Utilizing the flue gas heat.

CASE STUDY 2

Achieved results after implementing boiler efficiency improvement

No (1)	Items (2)	Situation before implementing (3)	Results after implementing (4)	Saving* (4) – (3)
1.	Designed boiler capacity (ton/hr.)	4	4	**-**
2.	Boiler efficiency (%)	53.91	60.1	**6.19**
3.	Average steam output (ton/hr.)	1.31	1.31	**-**
4.	Steam output (ton/yr.)	10,121	10,121	**-**
5.	Specific energy consumption (kg coal/ton of steam)	176	151	**-25**
6.	Total energy consumption (ton coal/yr.)	1,785	1,527	**-257**
7.	**CO_2 emission (ton/yr.)**	**4,511**	**3,895**	**-656**

CASE STUDY 3

General information

- Name of Company : Vinachem – DAP 2 JSC
- Address : Tang Loong industrial area, Bao Thang district, Lao Cai province
- Major product: DAP fertilizer
- Annual operation days: 262 days
- Designed capacity: 65 tph
- Fuel: Vang Danh 5b dust coal
- Boiler efficiency before implementing energy saving solutions : 89.28%

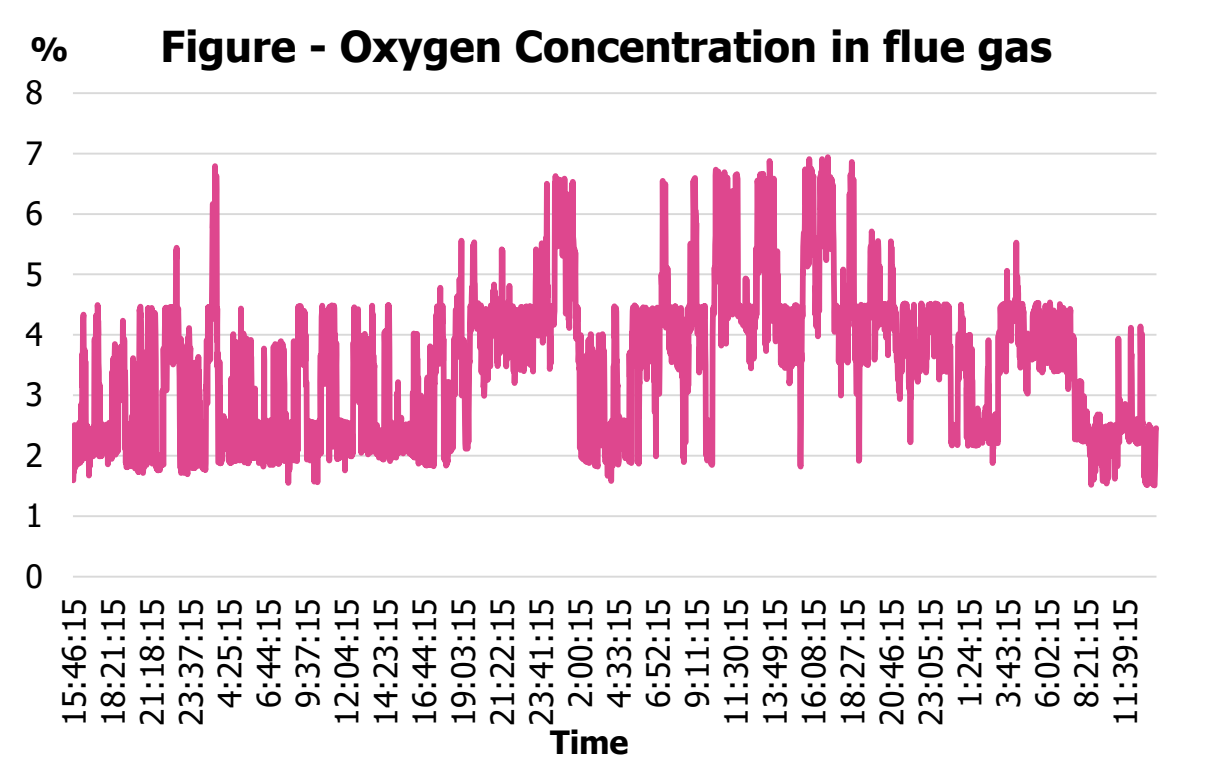
CASE STUDY 3

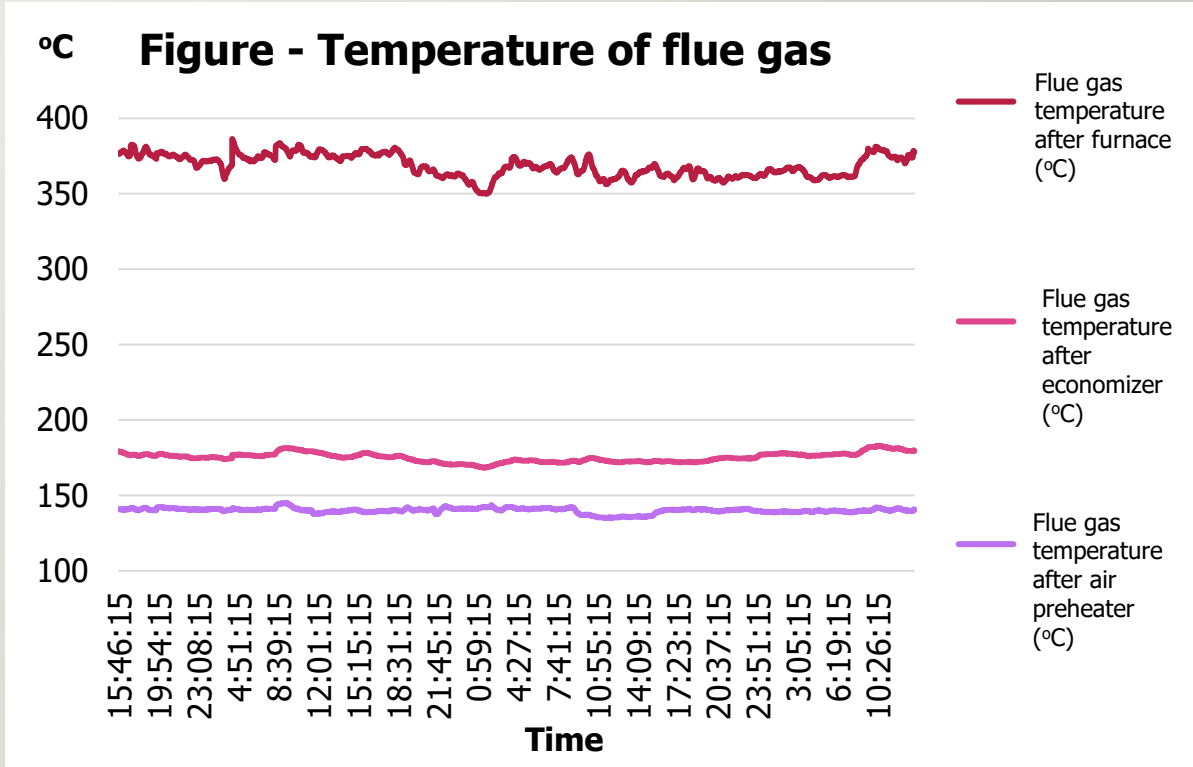
Background

- Boiler capacity: 65 tph
- This boiler system has been fully equipped with devices that absorb extra heat after combustion chambers such as an economizer, an air preheater. Also, deaerator and measurement sensors of temperature and oxygen is equipped to monitor the boiler operation;
- The oxygen concentration of the flue gas is 3.5%;
- The temperature of flue gas is 140^{o}C;
- The blowdown water conductivity is too low to operate the boiler at 38 bar;
- Ratio of unburned carbon in fly ash is 19.2% and it is pretty high;
- The surface temperature of steam pipeline system is 184^{o}C and the measuring time was carried out at the highest ambient temperature of 20^{o}C. So the heat loss was very high;
- The leakage of the steam supply system is very much;
- The plant releases always excess steam into the environment.

CASE STUDY 3

Measuring results





CASE STUDY 3

- Actual situation of steam system

Broken insulation

Steam leakage

Excess steam released from SA workshop

CASE STUDY 3

Energy saving solution

- Improving insulation of steam supply system

  ⇨ The plant has carried out in April 2019.

- Repairing steam leakage

  ⇨ The plant has done in April 2019.

- Combining the combustion additive and coal

  ⇨ The plant has done in May 2019 and combustion additive AX 8040.

- Improving insulation of the furnace shell
- Adjusting blowdown regime
- Recovering the steam emitted from SA workshop.

CASE STUDY 3

Achieved results after implementing boiler efficiency improvement

No (1)	Items (2)	Situation before implementing (3)	Results after implementing (4)	Improvement* (4) – (3)
1.	Designed boiler capacity (ton/hr.)	65	65	**-**
2.	Boiler efficiency (%)	89.28	90.50	**1.22**
3.	Average steam output (ton/hr.)	56.85	56.85	**-**
4.	Steam output (ton/yr.)	357,442	357,442	**-**
5.	Specific energy consumption (kg coal/ton of steam)	186	172	**-14**
6.	Total energy consumption (ton coal/yr.)	66,657	61,590	**-5,067**
7.	**CO_2 emission (ton/yr.)**	**169,975**	**157,055**	**-12,920**

CASE STUDY 4

General information

- Name of Company: Hai Phong Hapaco Paper JSC
- Address: Tien Nong village, Dai Ban commune, An Duong district, Hai Phong province
- Major product: Paper
- Annual operation day: 320 days
- Boiler designed capacity: 15 tph
- Fuel: 4-5b dust coal
- Boiler efficiency before implementing energy saving solutions: 46.72%

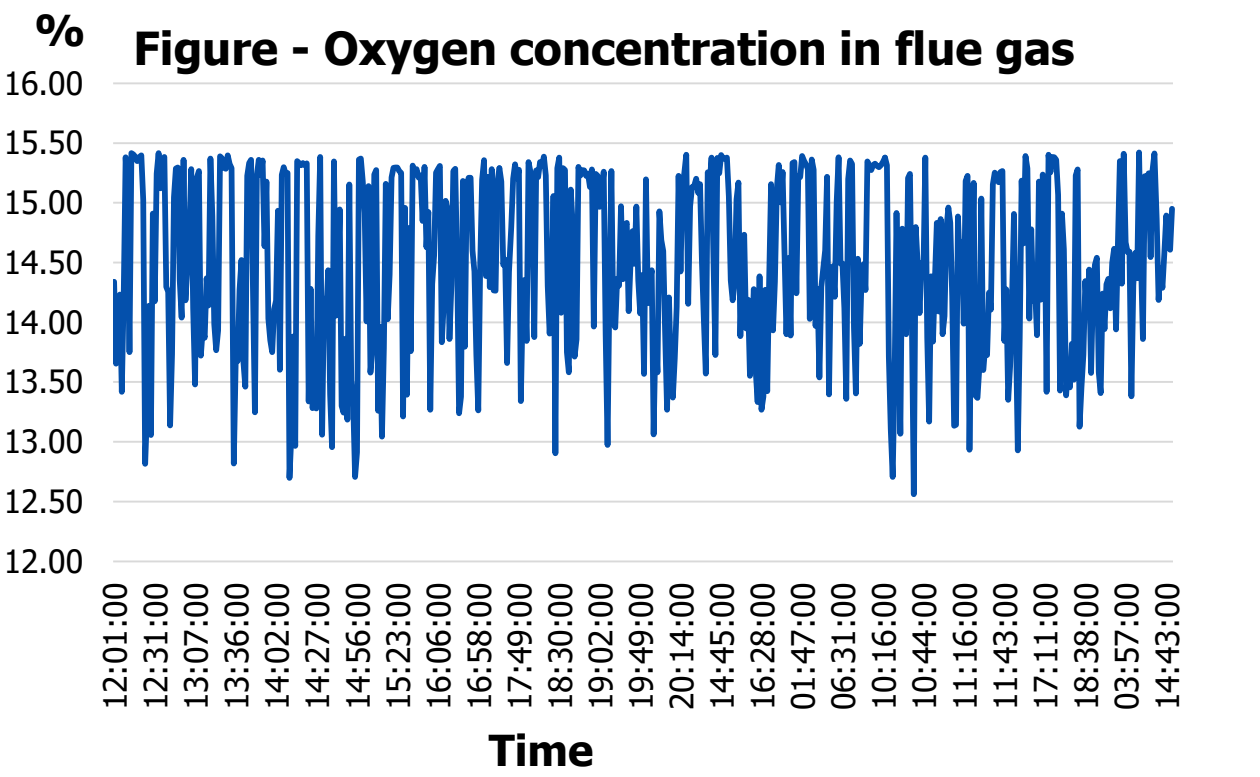
CASE STUDY 4

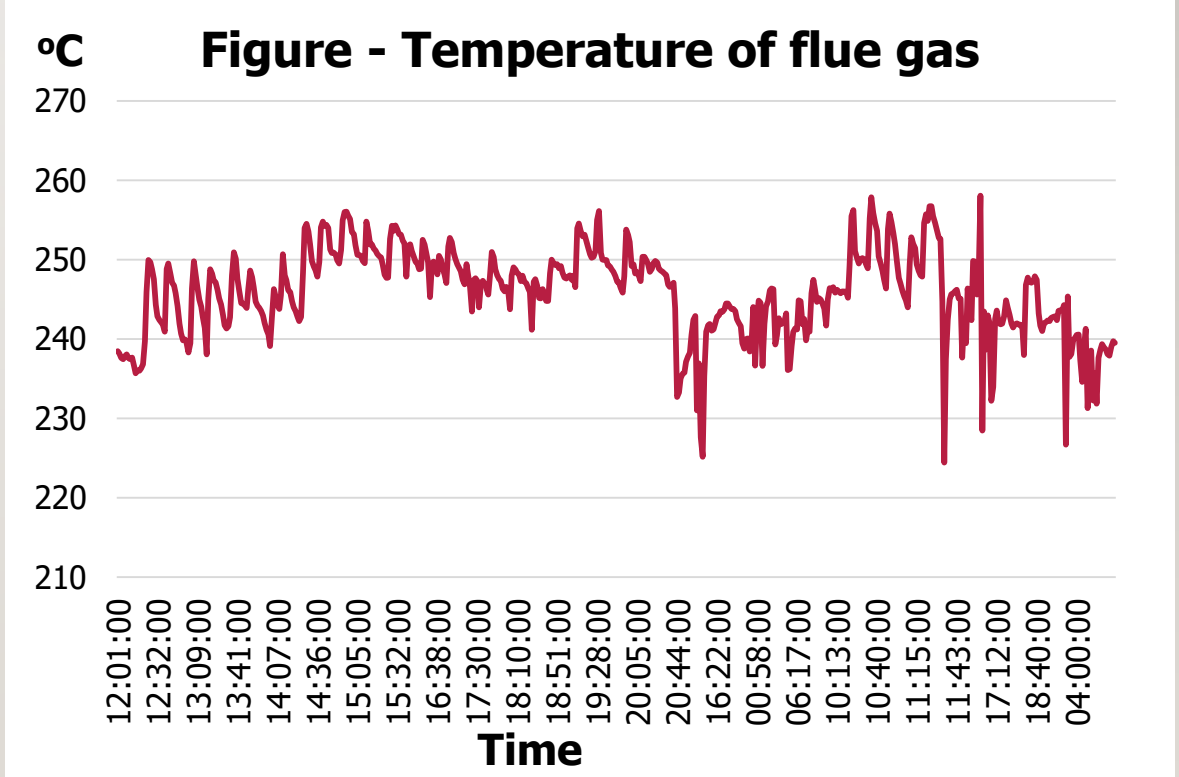
Background

- Boiler capacity: 15 tph
- The boiler system has been equipped an economizer improving boiler efficiency. However, during survey process, the experts found that it was broken without repairing a long time ago;
- The oxygen concentration of the flue gas is 14.5%. This value is too high to make heat loss due to flue gas so much;
- Blowdown ratio of 6.47% is too high to make heat loss more;
- The flue gas temperature of 245^{o}C is very high, while the economizer was broken without repairing a long time ago;
- The steam leakage of the steam supply system is high;

CASE STUDY 4

Measuring results





CASE STUDY 4

Energy saving solution

- Adjusting oxygen concentration of flue gas

  ⇨ The plant has decreased oxygen concentration of flue gas from 14.5% down 12.3% in December 2019.

- Repairing economizer

  ⇨ The plant has repaired economizer and the flue gas temperature decreased from 254^{o}C down 195^{o}C in December 2019.

- Repairing steam leakage.
- Controlling blowdown regime.

CASE STUDY 4

Achieved results after implementing boiler efficiency improvement

No (1)	Items (2)	Situation before implementing (3)	Results after implementing (4)	Improvement* (4) – (3)
1.	Designed boiler capacity (ton/hr.)	15	15	**-**
2.	Boiler efficiency (%)	46.72	56.02	**9.3**
3.	Average steam output (ton/hr.)	5.03	5.03	**-**
4.	Steam output (ton/yr.)	38,593	38,593	**-**
5.	Specific energy consumption (kg coal/ton of steam)	156	125	**-31**
6.	Total energy consumption (ton coal/yr.)	6,010	4,811	**-1,199**
7.	**CO_2 emission (ton/yr.)**	**15,326**	**12,269**	**3,056**

LESSONS AND EXPERIENCES IN BOILER OPERATION PROCESS

- For boilers with the 25tph less capacity, staff often operate based on experience leading large heat loss due to blowdown and flue gas;
- Chain grate boilers don't often control heat loss due to unburned carbon (q_4) properly, so this loss are usually quite large, and especially it is for boilers with operation mode at great fluctuated loads.
- Most boilers haven't been equipped with sensors of temperature or oxygen concentration; thus it is impossible to control the performance of economizer and air preheater causing the high heat losses due to flue gas.
- In the boiler operation, operators don't consider recording and synthesizing major operating parameters such as hourly feed water, coal consumption, pressure, flue gas temperature, oxygen concentration of flue gas and blowdown/feed water conductivity. The record will be very useful for operators to form the process of operating boiler according to the load demand.
- Commonly, plants only consider supplying enough steam for the production process, so they don't focus on how to operate boiler efficiently and economically.
- It is limited knowledge of the boiler in general, as well as the implementation of energy saving solutions in practice in particular, there are so many energy saving opportunities in boiler and the steam system.
- In many cases, boiler equipped have capacity much higher than the actual demand, boilers operating in low load leading to inefficient operation and difficult for adjusting oxigent in flue gas.

THANK YOU VERY MUCH!