China Climate Change Partnership Framework (CCPF): Outcome 2:1 - Mitigation

Promotion of Small-Scale and Medium Temperature Waste Heat Recovery Power Generation – A Case Study in Chin1ese Coal-Gangue Brick-Making Sector

Project Partners:

1. United Nations Industrial Development Organization (UNIDO)
2. Ministry of Agriculture (MoA)
3. Private and State-Owned Sector Coal-Gangue Brick Enterprises

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MDG ACHIEVEMENT FUND IN CHINA

Waste Heat Recovery

- WHR is where heat energy produced by industrial processes, such as cement or iron and steel production is ‘captured’ instead of being vented to the atmosphere and made to do some form useful work such as input material pre-heating or raising steam.

- The essential factor to consider when evaluating WHR is not the amount of waste heat being produced but its quality. Usually, the higher the temperature, the higher the quality of the waste heat and the more economically viable and attractive WHR will be.

Benefits of Waste Heat Recovery

- ***Direct Benefits:***

  Increase in energy efficiency of the process. This is reflected by a reduction in process, energy and utility consumption and hence costs.

- ***Indirect Benefits:***

i. Reduction in pollution and GHG emissions
ii. Reduction in equipment sizes – e.g. heat transfer systems, stacks..
iii. Reduction in auxiliary energy consumption – e.g. fans, pumps…

Level of WHR benefit depends on the quality of the waste heat, the potential uses for the waste heat – and the economics involved.

Waste Heat Recovery Power Generation

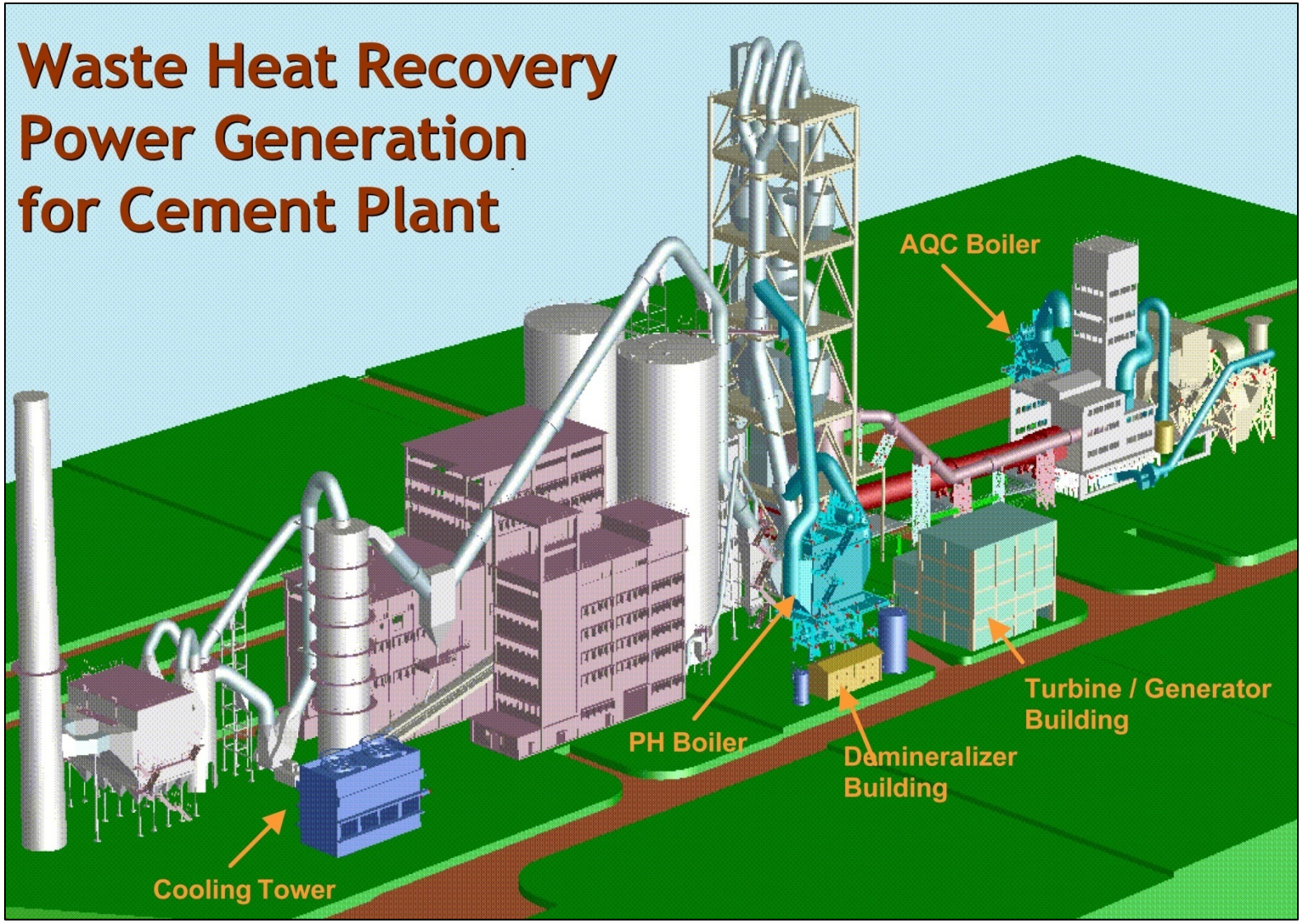
- One of the most beneficial applications of WHR is in the generation of electricity - for use either in the industrial facility and/or export to the grid.
- WHRPG is effectively where the waste heat energy is used to raise high temperature and pressure steam which is then expanded through a steam turbine and generator set to produce electricity.
- This application/technology was initially developed in Japan due to Japan's high energy costs and relatively low levels of capital costs.
- Since its development, WHRPG has now become quite common in Asia, particularly in China where these systems have become a kind of 'standard' in such industries as the cement sector.
- In Europe and other industrialized countries, while there is interest in deploying these systems, high project costs present a significant barrier.

WHRPG in China

- In China focus has been at the large scale utilizing high temperature waste heat (with installed capacities of 10 – 12 MW) in sectors such as cement, iron and steel, coking, glass etc.

- Gov. policy and the Clean Development Mechanism (CDM) have been major driving forces the deployment of many of the WHRPG systems in China. GHG emission reductions are based on avoided utility (or self-generated) electricity consumption and hence the carbon intensity of the displaced electricity.

The Typical Large-Scale Application of WHRPG



Source: Kawasaki

WHRPG at a Smaller Scale

- This project is promoting WHRPG at a smaller scale the Chinese coal-gangue brick sector - in the range of 1.0 to 2.0 MW, utilizing medium temperature waste heat produced in the tunnel kilns where the bricks are fired.

Coal-Gangue

- What is Coal-Gangue? Coal-gangue is the rock-type waste left over from coal mining and contains a variety of rock-type materials – including coal particles.

Coal-Gangue Mounds in Zibo, Shandong Province, China

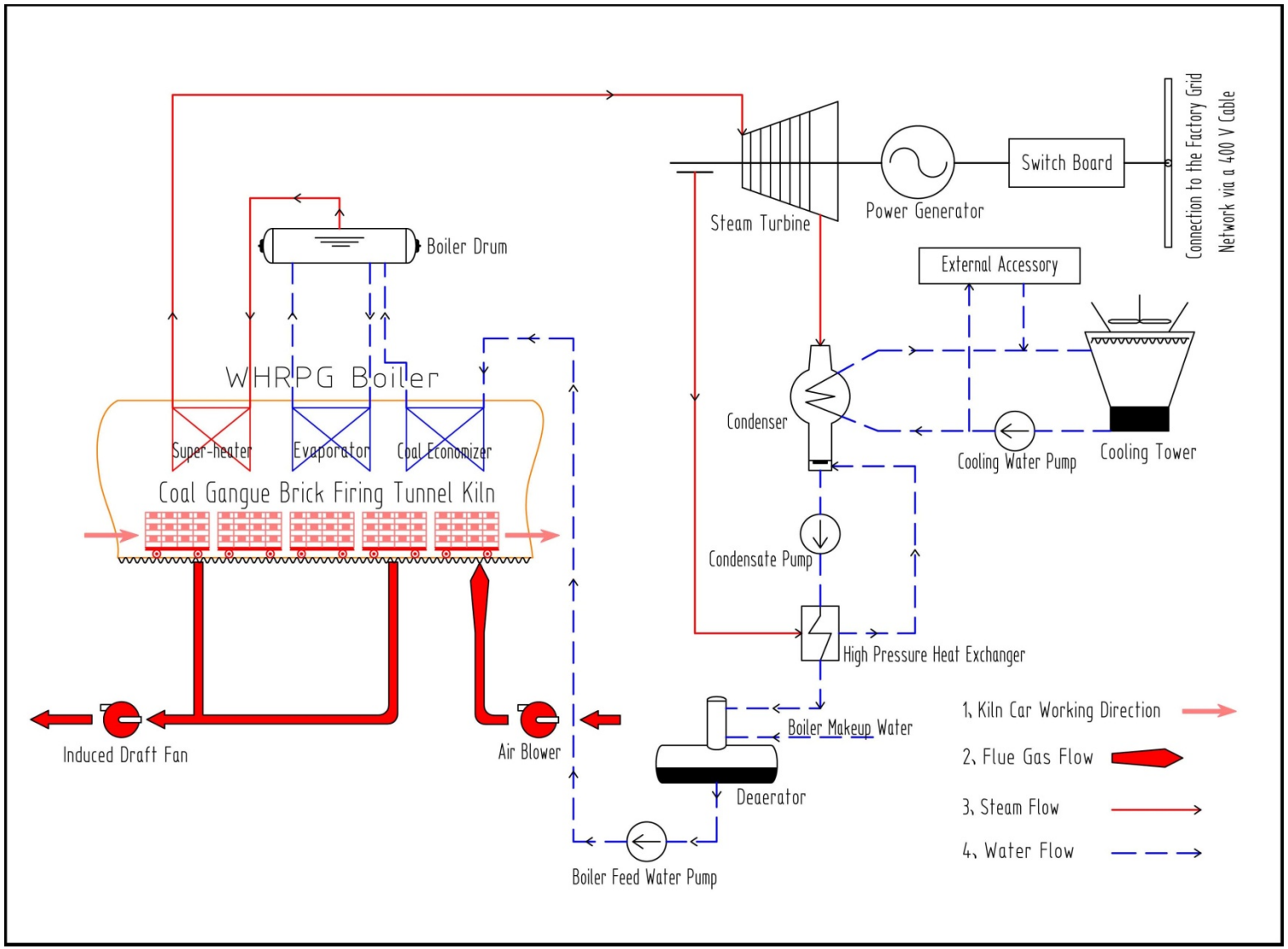
Coal-Gangue

- For each ton of coal, 0.1 – 0.15 tons of coal-gangue is produced – which then piled into large mounds.
- Each year China produces 250 – 330 million tons of coal-gangue China had, by the end of 2007, piled up some 5.0 billion tons of coal-gangue.
- There are a number of quite serious environmental and health issues surround coal-gangue and its stock-piling.
- The Government is pushing for the utilization of coal-gangue as a potential resource. Coal-gangue brick making is one of the main uses for this resource.

The Chinese Coal-Gangue Brick Sector

- The Chinese brick sector is huge – producing some 900 billion bricks in 2008.
- Government focus to reduce clay brick-making due concerns on arable farm land destruction and a desire to utilize industrial waste products like coal-gangue.
- In 2008, there were ~ 5,000 coal-gangue brick factories of different sizes. Most are private enterprises and ~ 400 are within the formal state-owned coal-mining sector. Together they produce some 20 billion coal-gangue bricks or 2.2% of the Chinese brick sector.
- The project has been targeting both private and state-owned enterprises using **tunnel kilns** with outputs in the range of ~ 100-200 million coal-gangue bricks per year.

Schematic Diagram of a Coal-Gangue Brick WHRPG Plant



Project CG Brick Pilot WHRPG Installations

Pilot WHRPG Data	Xinrong New Buildings Materials Co. Ltd., Shanxi Province	Hebei Guo Neng New Materials Co. Ltd., Hebei Province
Size of WHRPG System (Installed Capacity)	1.5 MW	1.0 MW
Expected Hours of Operation	7,200	7,200
Expected Power Production	6.66×10^3 MWh	6.10×10^3 MWh
% of Factory Power Needs	100	43
Cost of WHRPG System	US$ 1.50 M / RMB 10.2 M	US$ 1.47 M / RMB 10.02 M
Annual Cost Savings Based on Avoided Electricity Purchases (Taking into Account WHRPG O&M Costs).	US$ 367,600 / RMB 2.5 M	US$ 295,600 / RMB 2.01 M
Pay Back Period	4.0 Years	5 .0 Years
IRR (Post Tax)	25.4	20.9
GHG Emissions Reduction (as Based on Carbon Intensity of Grid Electricity)	6,328	5,796

Barriers to smaller-Scale WHRPG in the Coal-Gangue Brick Sector 1/2

- Lack of awareness of CGB enterprise owners/operators on the potential benefits of WHPRG and the suitability of their operations to the technology.
- Lack of capacity of existing staff to operate and maintain a WHRPG plant.
- Resistance by national electrical grid operators to connect WHRPG installations to the grid and purchase power from the producer.
- Lack of access to capital for financing WHRPG investment.

Barriers to smaller-Scale WHRPG in the Coal-Gangue Brick Sector 2/2

- CDM eligibility issues – only WHRPG installations under 0.5 MW can be classed as 'financially additional' under the Chinese CDM WHRPG condition (pre-tax IRR cutoff of 11%). Installations below 0.5 MW struggle to justify the capital expenditure required to build the WHRPG plant.

- Therefore in terms of the CDM, these projects are 'stuck between a rock and hard place'

- Programmatic CDM may offer a potential mechanism – but p-CDM does not yet have clear rules of engagement.

Project Activities to Promote Replication

1. **Coal-Gangue Brick WHRPG Sectoral Support and Self-Assessment Package –** To be distributed across the 'China Brick and Tiles Industrial Association (CBTIA) membership base**.**

2. **Policy/Regulatory/Financial Incentive Advice -** for Central Government on the Promotion of WHRPG in the Coal-Gangue Brick Sector

3. **CCTV documentary movie about WHRPG in the Chinese Coal-gangue brick sector**

4. **Coal-Gangue Brick WHRPG Sectoral Awareness Programme –** Sectoral Workshops to held across the main coal-gangue brick producing regions of China in partnership with CBITA.

Conclusion

- WHRPG has significant potential to improve the profitability of tunnel kiln operating coal-gangue (and standard brick enterprises) while at the same time improving their environmental performance.
- China is a potential world leader in this new field of smaller-scale WHRPG.
- The application of WHRPG at the smaller-scales and lower temperatures faces significant barriers and will not easily qualify for the CDM.
- The large-scale WHRPG market also faced a set of barriers at the beginning of it's own development – therefore, with the right policy approach with appropriate access to capital financing, smaller-scale WHRPG should also have a strong future.

- Thank you for your attention.

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