

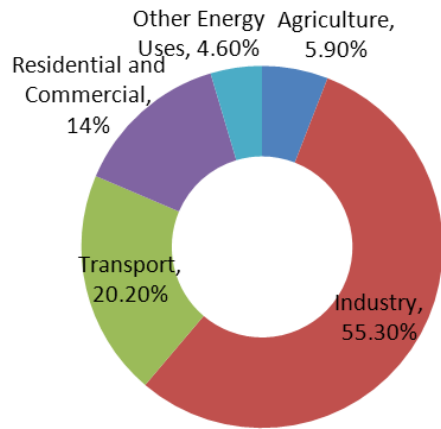
Waste Heat Recovery: Case study of Indian Glass Industry Sector

**6th Annual Energy Management Action Network
(EMAK) workshop**

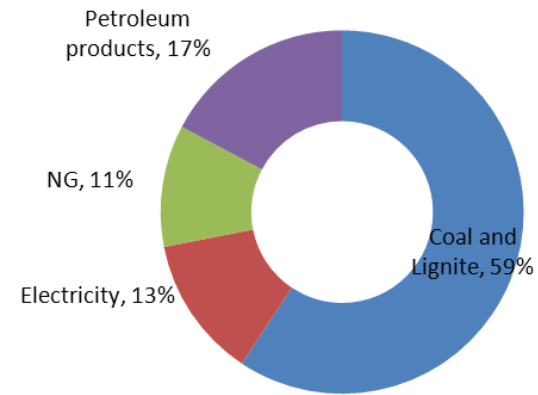
**Sachin Kumar
Fellow**

**The Energy and Resources Institute
(TERI), New Delhi, India**

Energy Consumption Pattern in India



Commercial Energy Consumption in India (2010-11)

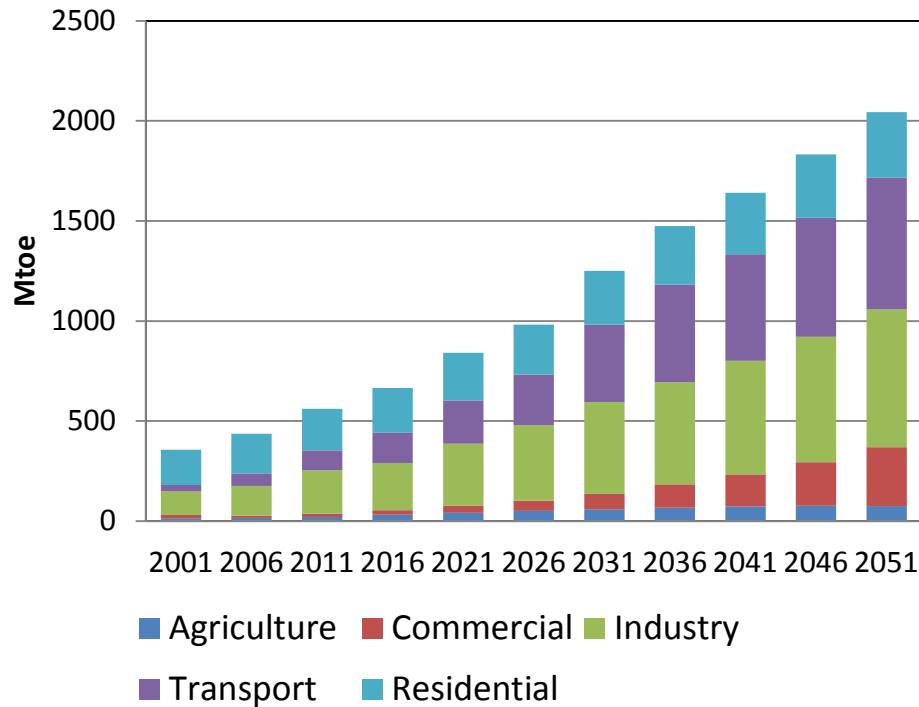


Commercial Energy Consumption in Industry (2010-11)

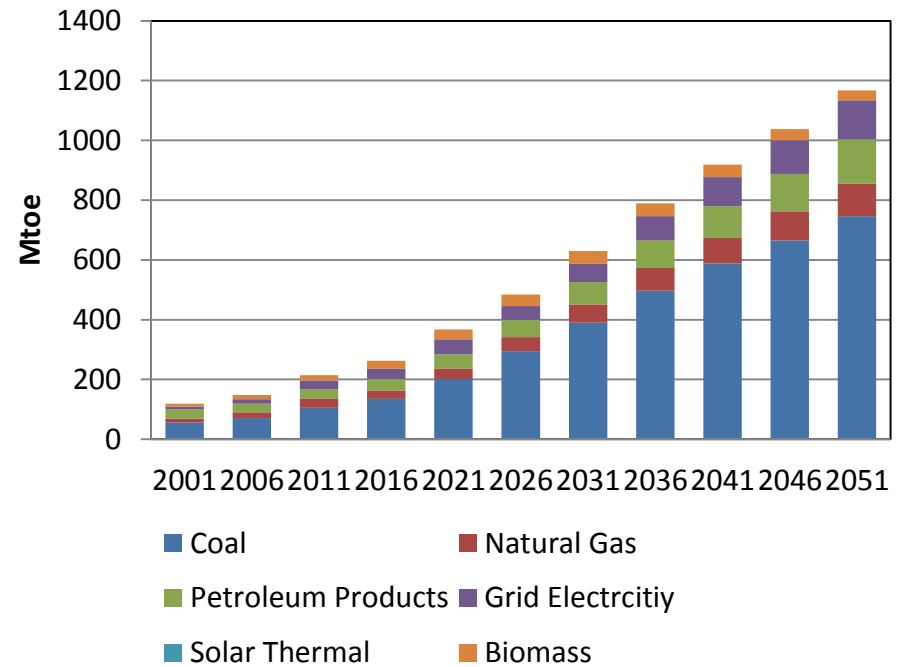
- Industry is the largest consumer of commercial energy
- Coal is the major energy source in the industry sector

Future Energy Projection

Final energy demand



Fuel use in industry sector



- Industry will remain leading energy consumers of the country
- In industry sector coal will remain major energy sources

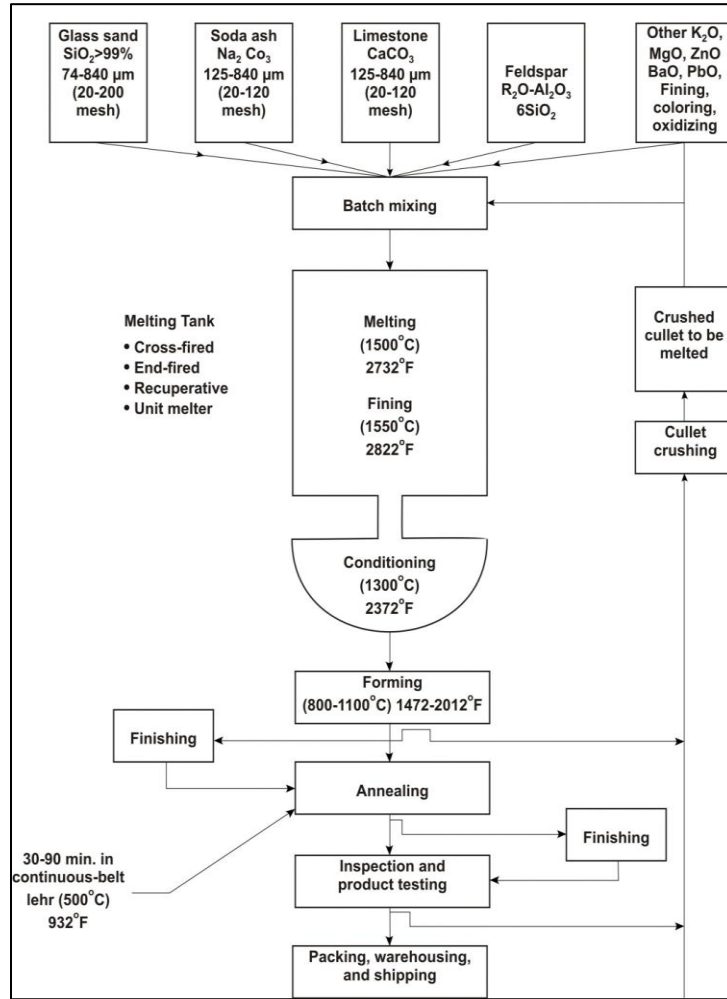
Industry Sector: Present Situation

- Industry sector accounts for more than half of total commercial energy consumption in India (2010/11)
- Large Industry sector
 - New plants: Mostly adopt energy efficient/state of the art technological options as per the global standard on their own. e.g. cement, fertiliser, etc.
 - Existing/old plants: Options exist for energy efficiency improvements
 - PAT scheme focuses on 478 Designated Consumers covering 8 sub-sectors to improve their energy efficiency levels
 - Target SEC reduction - about 5%
- MSME sector
 - 26 million enterprises
 - Existence of many energy intensive industrial clusters
 - Manufacturing 6000 products and employing 60 million people
 - Majority of units use obsolete technologies and unskilled manpower
- Glass manufacturing: highly energy intensive, represented in both large and MSME

Indian Glass Industry

Installed Capacity (tonnes per day)	Container glass – 7000, Flat glass – 4700
Reported Market	> USD 1.5 billion
Major Players	HNG, Saint Gobain, Asahi glass, Piramal, AGI glasspac, Gujarat Guardian
Major Small-scale industry cluster	Firozabad (Uttar Pradesh)
Main Fuel	Natural Gas, Furnace Oil
Thermal energy share	80 % (approximately)
Average SEC (KJ/kg melted glass)	> 5000
Estimated Energy Consumption (million toe/yr.)	1.2
Future scenario	About 12% annual growth expected due to increase in packaging, construction and automobile sector

Glass Manufacturing & Types



Source: U.S. Department of Energy (April 2002)

Chemical Composition

Soda- Lime glass

Lead crystal and crystal glass

Borosilicate glass

Special glass

Market

Container glass

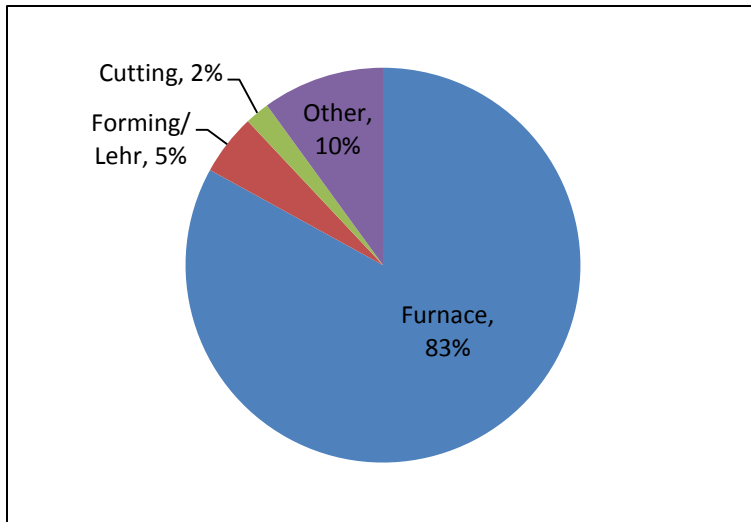
Flat glass

Fibre glass

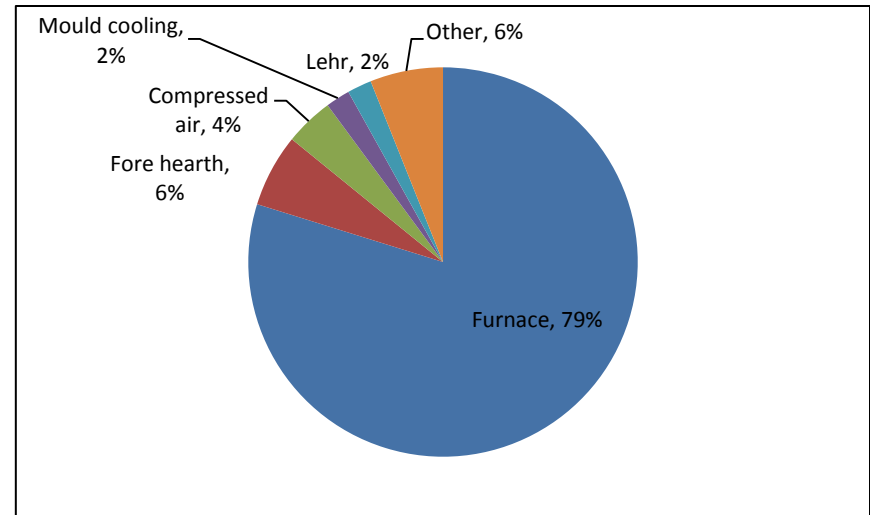
Domestic glass

Speciality glass

Glass Manufacturing: Energy Use



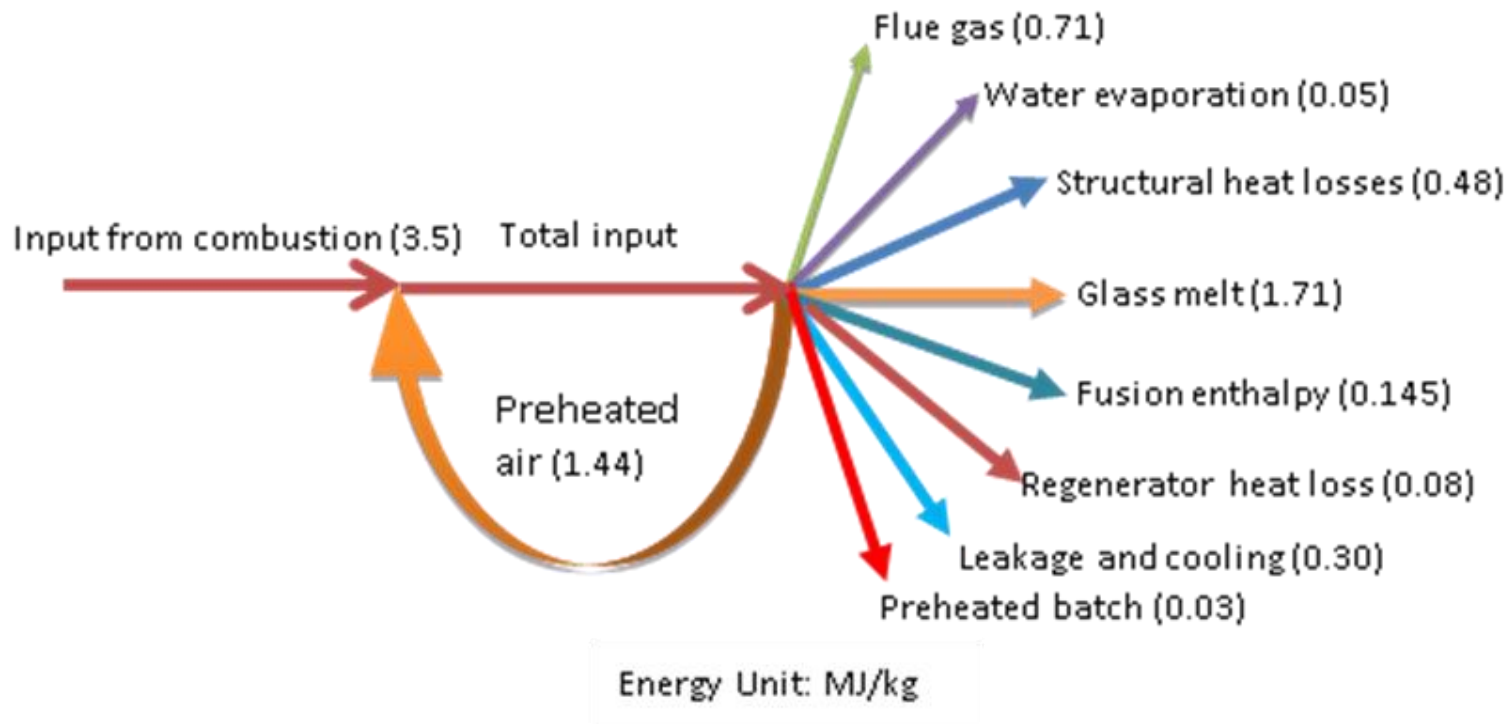
Energy Use in typical flat glass process



Energy Use in typical container glass process

Energy Cost is more than 25% of total production cost

Glass Manufacturing – Energy Flow



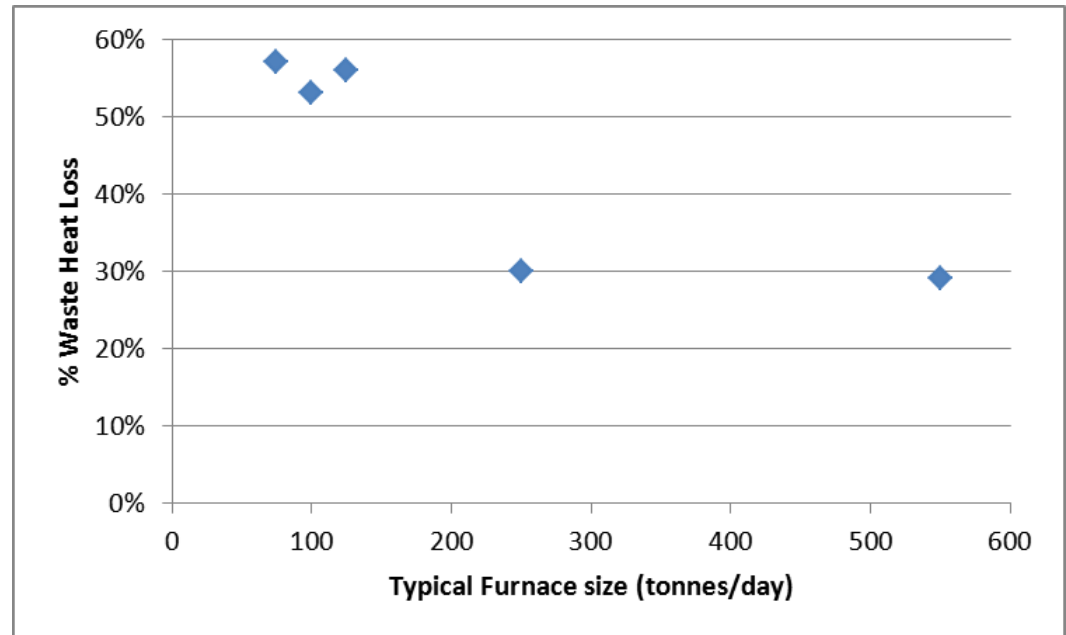
Cross-fired energy efficient regenerative container glass furnace with 70-75% cullet ratio

(Source: Glass Manufacturing industry Council 2004)

Best Practice furnaces have efficiencies about 40%; Majority of primary energy input is wasted

Waste Heat Recovery (WHR)

- High temperature (1300 – 1500 °C) of glass melting furnace; high exhaust gas temperature;
- WHR – potential energy consumption reduction option
 - Preheat combustion air
 - Preheat batch and cullet material
 - Using Waste Heat Boilers for electricity generation



Relationship between typical furnace size and average waste heat losses in different segment of glass industry

Source: Waste Heat Recovery: Technology and Opportunities in U.S. Industry, U.S. Department of Energy (2008)

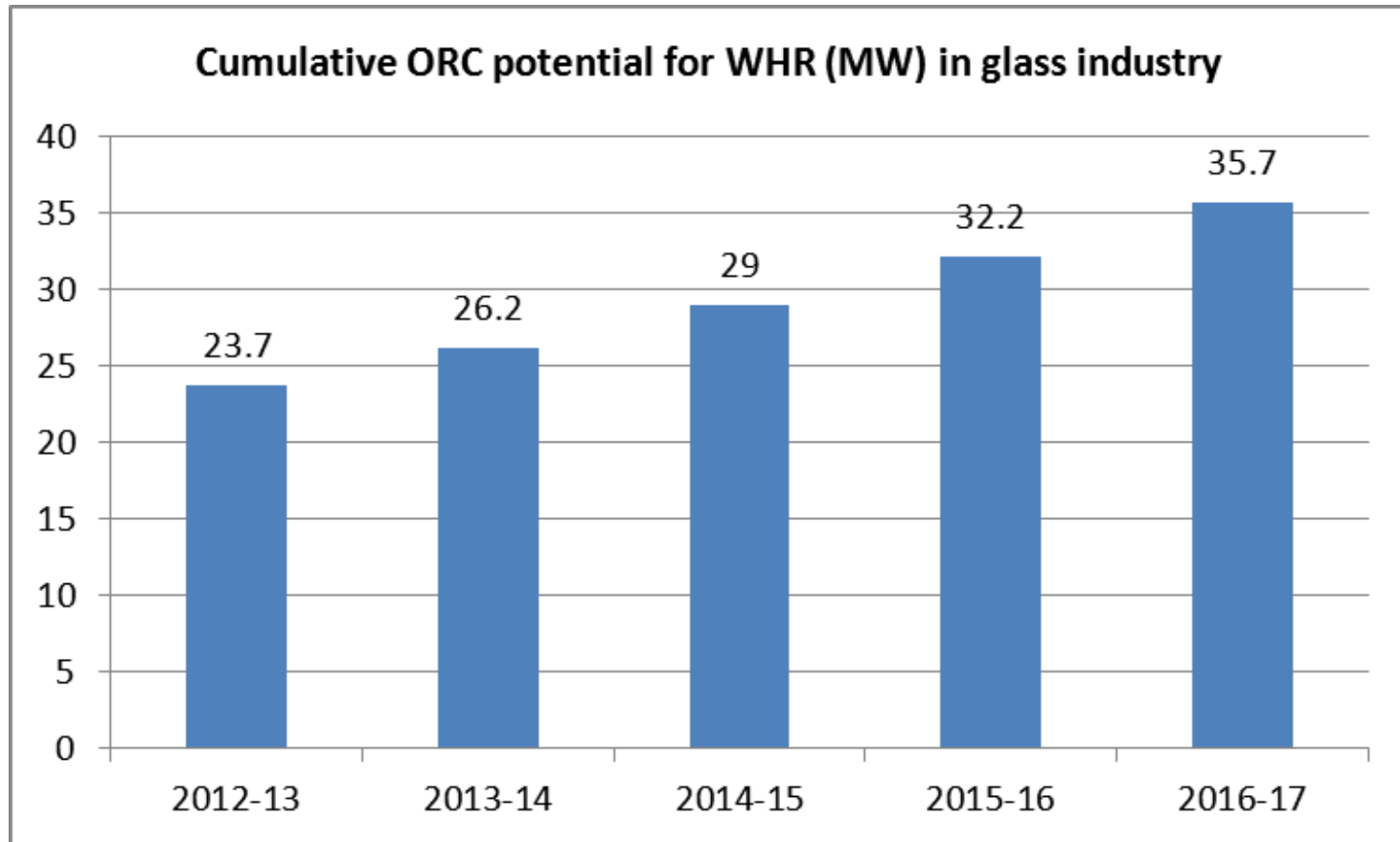
Combustion Air Preheat

Increase in Furnace Efficiency with combustion air preheat

Furnace Outlet Temperature	Combustion Air Preheat Temperature				
	204°C	316°C	427°C	538°C	649°C
1,427°C	22%	30%	37%	43%	48%
1,316°C	18%	26%	33%	38%	43%
1,204°C	16%	23%	29%	34%	39%
1,093°C	14%	20%	26%	31%	36%
982°C	13%	19%	24%	29%	33%
871°C	11%	17%	22%	26%	30%
760°C	10%	16%	20%	25%	28%

Source: Waste Heat Recovery: Technology and Opportunities in U.S. Industry, U.S. Department of Energy (2008)

Indian Glass Industry: Electricity generation potential



Source: Market potential Study for ORC Technology in India, IGEF (2014)

Firozabad Glass Cluster

- Largest cluster in small scale glass sector
 - Annual Glass Production: 1.0 million ton/yr.
 - Estimated annual energy consumption: 0.2 million toe
- Major product - Bangle
 - Other products: colored decorative items, tableware, lab-ware, glass shells etc.
- Falls within the Taj Trapezium Zone (TTZ)
- Industry mandated to switch over to natural gas (1996 Supreme Court Mandate)
- TERI with support of SDC (Swiss Agency for Development and Cooperation) worked in the cluster to design, develop, demonstrate and disseminate energy efficient natural gas-based technologies for glass bangle industries

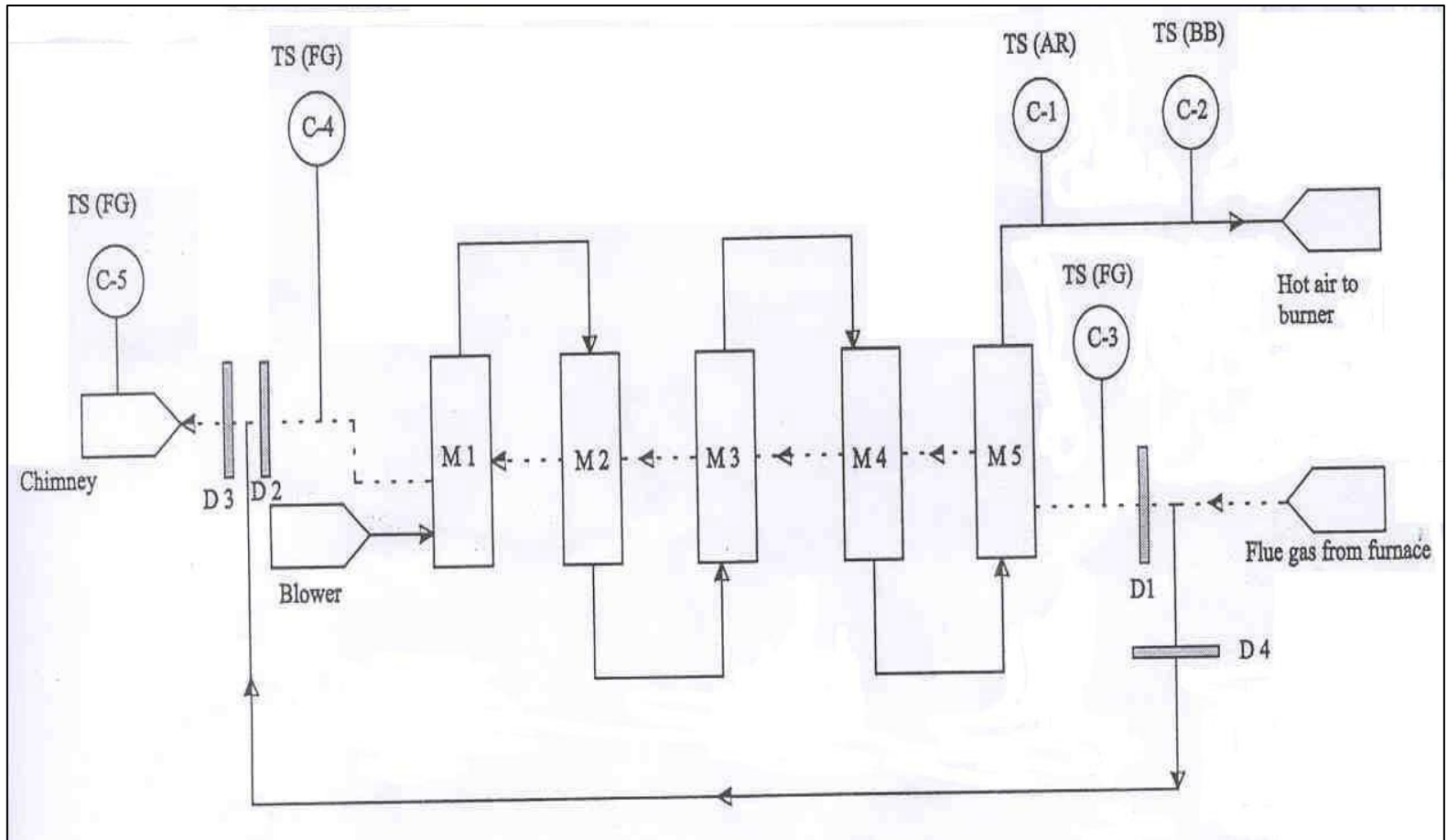


Conventional coal fired pot furnace



Recuperative natural gas fired pot furnace

Demonstrated WHR –Recuperator Layout



Waste Heat Recovery – Recuperator Contd...

- Counter flow metallic recuperator
- 5 Stainless Steel modules
- Air preheat temperature: 550 – 600°C
- Energy Saving: About 25 – 30%
- Payback period: < 0.5 year
- Adopted by almost all cluster units



Thank You for your attention !!