Annexure 'A' to the Directors' Report:

PARTICULARS REQUIRED UNDER THE COMPANIES (DISCLOSURE OF PARTICULARS IN THE REPORT OF THE BOARD OF DIRECTORS) RULES, 1988:

Conservation of Energy

a. Energy Conservation measures taken:

i. Highest ever power generation through Top Recovery Turbines (TRT) in the Blast Furnaces.

ii. Highest ever steam generation through Coke Dry Quenching in Batteries # 5, 6 & 7.

iii. Use of Pellets at Blast Furnaces to reduce their coke rate.

iv. Efficient use of by-product gases for Power Generation – Highest ever in-house power generation through by-product gases.

v. Lowest ever Middling Coal and Light Diesel Oil (LDO) consumption.

vi. Energy Audit.

b. Additional investments and proposal for reduction of consumption of energy:

i. Commissioning and operation of new LD Gas holder and its export system so as to recover LD Gas from all three (3) Steel Melting Shops at a Benchmark level of 80 Nm3/tcs.

ii. Recovery of sensible heat of coke by installation of Coke Dry Quenching systems in Batteries 10 & 11 at the Coke Plant.

iii. Replacement of one boiler at Power House # 4.

c. Impact of the above Measures:

Impact of energy conservation measures in Financial Year 2013-14:

i. Plant specific energy consumption – 6.017 Gcal/tcs

ii. Highest ever power generation through TRT – 23.45 MW

iii. Highest ever steam generation through CDQ – 75.13 tph

iv. Lowest ever middling consumption – 65471 t

v. Plant Specific Overall Power Rate – 408 Kwh/tss

Form - A

Form for disclosure of particulars with respect to Conservation of energy: 2013-14

Particulars	2013-14	2012-13	Difference	Reasons for variation
A. POWER & FUEL CONSUMPTION				
1. Electricity				
(a) Purchased				
Units (M. KWH)	**3,494.30**	*3,348.18*	146.12	An increase in production resulted in requirement of higher power which was fulfilled by purchasing the same at a rate which was 4% more than the previous year.
Total Amount (₹ Lakhs) #	**144,235.01**	*133,144.51*	11,090.50	
Average Rate/Unit (₹/KWH)	**4.13**	*3.98*	0.15	
(b) Own Generation				
(i) Through Diesel Generator				
Units (M. KWH)	**2.64**	*5.08*	(2.44)	Lower requirement of diesel due to better availability of power. Distribution of Fixed Cost on lower no. of units and higher diesel prices resulted in a higher cost per unit.
Units per litre of Diesel Oil (KWH)	**3.96**	*3.59*	0.37	
Average Cost/Unit (₹/KWH)	**47.26**	*39.13*	8.13	
(ii) Through Steam Turbine/Generator*				More utilisation of by product gases, better upkeep of the plant and better efficiency factored in increment of 'units of electricity generated through steam turbine' per tonne of 'coal used for power generation'.
Units (M. KWH)	**1,093.75**	*1,074.60*	19.15	
Units per tonne of Coal (KWH)	**12,681**	*8,509*	4,172.37	
Average Cost/Unit (₹/KWH)	**2.49**	*2.60*	(0.11)	
(iii) Through TRT				
Units (M. KWH)	**205.40**	*129.23*	76.17	Commissioning of TRT at 1 Blast Furnace in Financial Year 13 last quarter helped in generating more power through TRT.
Average Cost/Unit (₹/KWH)	**2.00**	*2.00*	0.00	
2. Coal				
(i) Coking Coal & Cokeries				
Quantity (Million Tonnes)	**6.32**	*5.57*	0.75	The cost effect due to rise in Coal quantity requirement due to higher production was diluted due to fall in imported coal prices.
Total cost (₹ Lakhs)	**472,483.58**	*448,487.37*	23,996.21	
Average Rate (₹/Tonnes)	**7,472.43**	*8,057.72*	(585.29)	
(ii) Blast Furnace Injection Coal				
Quantity (Million Tonnes)	**1.20**	*0.95*	0.25	
Total cost (₹ Lakhs)	**122,313.05**	*107,439.33*	14,873.72	
Average Rate (₹/Tonnes)	**10,153.02**	*11,303.04*	(1,150.02)	
(iii) Middling Coal and ROM				
Quantity (Million Tonnes)	**0.07**	*0.11*	(0.05)	Lower midding requirement due to higher and more regular use of by product gases.
Total cost (₹ Lakhs)	**1,293.51**	*1,990.41*	(696.90)	
Average Rate (₹/Tonne)	**1,882.45**	*1,732.00*	150.45	
3. Furnace Oil				
Quantity (Kilo Litres)	**13,445.52**	*13,063.84*	381.68	
Total Amount (₹ Lakhs)	**5,936.20**	*5,492.49*	443.72	
Average Rate (₹/KL)	**44,150.05**	*42,043.44*	2,106.61	
4. Others				
L.D.O.				
Quantity (Kilo Litres)	**1,339.00**	*2,583.00*	(1,244.00)	Reasonably lower power interruptions than the previous year brought down the requirement of LDO for Diesel Generator significantly.
Total cost (₹ Lakhs)	**845.01**	*1,512.09*	(667.08)	
Average Rate (₹/KL)	**63,107.74**	*58,540.20*	4,567.53	
5. Others				
L.P.G.				
Quantity (Tonnes)	**7,221.53**	*7,644.60*	(423.07)	
Total cost (₹ Lakhs)	**4,825.91**	*4,627.98*	197.93	
Average Rate (₹/Tonnes)	**66,826.70**	*60,539.20*	6,287.49	
6. Others				
HSD. Oil				
Quantity (Kilo Litres)	**113.98**	*80.81*	33.17	Rise in quantity due to a number of CO gas line shutdowns in the last quarter in the Tubes Division. HSD had to be fired to keep the Galvanising baths hot.
Total cost (₹ Lakhs)	**60.52**	*36.81*	23.71	
Average Rate (₹/KL)	**53,094.38**	*45,551.29*	7,543.09	

Excludes electricity duty paid on purchases.

* Power generation is gas based. Coal is used only in case of shortage of gases/shutdown of blast furnaces. Electricity per tonne of coal represents total electricity (including gas based) divided by coal used for electricity generation.

B. CONSUMPTION PER UNIT OF PRODUCTION

Particulars	Steel (per tonne)	Tubes (per tonne)	Bearings (per no.)	F.A.M.D. (per tonne)	Growth Shop (per tonne)	CRC West (per tonne)	Wire Div. (per tonne)
Electricity (KWH)	**408.00** *(416.00)*	**108.00** *(107.00)*	**0.36** *(0.38)*	**3,741.81** *(3,741.29)*	**260.41** *(537.68)*	**73.96** *(84.03)*	**193.65** *(209.22)*
Furnace Oil (Litres)		**0.04** *(0.05)*			**4.54** *(13.59)*	**3.60** *(3.61)*	**22.53** *(21.10)*
Coking Coal (Tonnes)*	**0.60** *(0.55)*						
Others:							
Light Diesel Oil (Litres)	**0.12** *(0.27)*						**1.25** *(1.66)*
High Speed Diesel Oil (Litres)		**0.28** *(0.16)*					
L.P.G. (kg)						**9.11** *(9.61)*	**18.04** *(19.46)*

* Coal Consumed in HMC for producing Coke has not been considered for this calculation.

Form - B

Form for disclosure of particulars with respect of Technology Absorption 2013-14.

Research and Development

1. **Specific Areas in which R&D was carried out by the Company:**
   - Raw Materials
   - Cost and productivity
   - Market and new products
   - Energy and Environment
2. **Benefits derived and Future plan of action:**

- **Photovoltaic coatings for solar rooftop applications**

This project was taken up to develop suitable insulating barrier coating on steel substrate for photovoltaic applications.

As the surface of steel is extremely rough, uneven and non-uniform, nickel electroplating was adopted to smoothen and planarize it. This made the surface compatible for photovoltaic coating. Furthermore a silicon nitride thin film was preferred to develop an insulating barrier layer using the hot wire chemical vapour deposition technique (HWCVD). Amorphous silicon (a-Si:H) thin film solar cells were also fabricated by HWCVD technique on silicon nitride coated steel substrate.

Nickel electroplating on low carbon steel substrate was found to be the most promising technique to reduce the surface roughness of steel substrates. Consequently the surface roughness of bare steel dropped dramatically from 150-200 nm to 10-20 nm. Silicon nitride (SiNx) coatings have shown high breakdown strength of 1.31 MV/cm when deposited over nickel plated steel substrate. The a-Si:H thin film PV coatings were developed on the SiNx coated substrate by the HWCVD method and small area solar cells with moderate efficiencies were obtained in operational condition.

Silicon nitride coating was developed for insulating barrier layer application on Nickel plated steel substrate by hot wire chemical vapour deposition. There was a great success in reducing the surface imperfection of steel by nickel coating. Silicon nitride films developed over Ni plated steel had shown improved dielectric properties. a-Si:H solar cells with 2-3% efficiency had been successfully fabricated at lab scale on these substrates.

In the present work, a very smooth and uniform steel substrate was developed, which is essential for any electronic device to be grown on steel. Thermal mismatch between steel and existing dielectric materials, make it almost impossible to develop insulating barriers for large area applications. Thus an alternative approach will be adopted and photovoltaic coating will be directly developed on the planarized steel substrate without any insulating coating.

- **Development of a methodology to produce coke with CSR >70, CRI >28 and mean size >52 mm.**

The main objective of the project is to develop a methodology to produce coke with Coke Strength after Reaction (CSR) >70, Coke Reactivity Index (CRI) >28 and mean size >52 mm.

Coke is the most important and expensive raw material used in the Blast Furnace and has a strong influence on the process efficiency and hot metal quality. Its increasing cost as well as environmental concerns associated with it have led to a growing trend to replace coke by other fuels such as by injecting pulverised coal through tuyeres in order to decrease reliance on coke. Coke performs several functions in a blast furnace namely thermal, chemical and mechanical: a fuel providing the energy required for endothermic chemical reactions and for melting of iron and slag; a reductant by providing gases for iron oxide reduction; a permeable support providing the passage for liquids and gases in the furnace. At low coke rate BF operation, less amount of coke is available in the burden to maintain sufficient permeability of bed. As the coke moves towards lower zones of a blast furnace, it degrades and generates fines, which affects both bed permeability and process efficiency. Therefore, superior coke quality is critical for stable and efficient blast furnace operations under low coke rate conditions. Given this scenario, a project was initiated to produce superior quality coke under stamp charge condition without deterioration of oven health. Tata Steel currently operates with CSR 65; CRI 27 and Arithmetic mean size (AMS) is around 49 mm. The project deals with several modules to address the issue. Some pre-carbonisation techniques and additives have presently been recommended to improve CSR by 2-3 units. However calculations by the Iron Making Technology Group (IMTG) indicate that 1 unit improvement of CSR helps to reduce coke by 2 units and increases productivity by 2 units. Also some operating methods like zero heating after carbonisation not only generate improvement in CSR but also savings in energy and improvement in CO_2 emission. The above mentioned techniques are proved in lab scale. Presently a team from R&D is working along with the Coke Plant on a plant trial.

- **Life Cycle Assessment (LCA) of Tata Tiscon.**

The main aim of this research was a Life Cycle Assessment study of the rebar to develop an environmental product declaration for Rebars.

Life Cycle Assessment (LCA) is a very effective tool for the development of an eco-label. LCA provides a holistic approach for the study. The ISO 14040 series of standards provides the guideline for such studies. In the present study LCA was used as a tool to develop an Environmental Product Declaration (EPD) for the long product, rebar (rebars + Wire rods), based on the World Steel Association methodology. The goal of the study is to develop Life Cycle Inventories (LCI) for the production and resource extraction phases of the rebar life cycle. These LCIs can, in turn, be used for development of an EPD for the Rebars. The LCIs also help identify hot spots in the rebars production process chain.

A Life Cycle Assessment model for the production phases of the rebar life cycle has been developed in GaBi 4. GaBi (Ganzheitlichen Bilanzierung {German for Holistic Balancing}) is a software tool for creating life cycle balances. The raw material, intermediates, & ancillaries consumption data were taken from the Company's SAP system and are therefore 'measured'. The air emissions data comprises SO_2, NOX and particulates emissions from stack. Emissions to water and soil are not considered. The CO_2 emissions have been calculated based on Carbon balances across the process and are essentially direct emissions. The factors used for the carbon balance are site specific.

The results have been shown in the table below:

Sr. No.	Environmental impact category	Effect	Reference Unit	Amount per tonne of rebar
1.	Global warming potential (GWP)	Increased warming of the troposphere due to anthropogenic greenhouse gases e.g. from the burning of fossil fuels	kg CO_2-Equiv.	1,648
2.	Acidification potential (AP)	Increase in the pH-value of precipitation due to the wash-out of acidifying gases e.g. Sulphur dioxide (SO_2) and nitrogen oxides (NO_2)	kg SO_2-Equiv.	45.72
3.	Eutrophication potential (EP)	Excessive nutrient input into water and land from substances such as phosphorus and nitrogen from agriculture, combustion processes and effluents	kg PO_4-Equiv.	0.48

The next step forward is to refine the current model with more accurate data and develop a similar model for flat products.

- **New generation high strength steels (mainly for the transport applications).**

  This strategic development programme aims to unlock the potential of steel for various demanding applications (automotive, transport, yellow goods). It focusses on step change improvements in material properties. This new generation of products not only allows the automotive industry to produce lighter and safer cars at competitive costs, but also increases the payload for heavy transport vehicles. The low density steel activities were closed after evaluation proved that the products can technically be made. However, cost effective manufacturing could not be achieved with technologies in the market. New subjects in Financial Year 2013-14 focussed on microstructure control at nano scale, where promising results were achieved. It is the intention of R&D to progress these developments as soon as technical viability is demonstrated.

- **Advanced coatings developments.**

  The focus is on development of Physical Vapour Deposition (PVD), a breakthrough coating technology that allows reduced coating thickness through application of advanced protective systems. Products are intended for use in the automotive sector, where coating of advanced high strength steels with legacy technologies is approaching its limit. Good progress has been made in Financial Year 2013-14 towards product quality as well as demonstrating that smooth coatings with excellent automotive outer part standard surface and corrosion properties can be produced. Also the evaporation rate of the source has been developed such that ramp up to semi production scale can be started. This activity is being run in strategic cooperation with Posco.

- **Graphene based coatings for steel.**

  Graphene is a rapidly developing technology field offering huge opportunity to develop carbon based low cost protective (building envelope) and functional (batteries, Photo voltaic etc.) coating systems. In cooperation with a number of leading universities, Tata Steel R&D has built a portfolio of feasibility studies.

- **Steel opportunities in the electric vehicle market.**

  This is a strategic study into new opportunities for steel use that might arise from the ongoing move to hybrid and full electric powered vehicles. Areas of attention include structural, engineering and electrical steels. The "proving factory" initiative is a vital part of the Tata Steel strategy and will enable production of prototype parts at a semi industrial scale. This will greatly facilitate and speed up volume developments in the high value add market segments.

3. Future plan of action:

In Financial Year 2014-15, R&D shall continue to improve the competitive position of Tata Steel by pursuing research related to existing operations as well as its future business needs. R&D shall continue to maximise value creation and create stakeholder delight through world class differentiating research. A corporate function, R&D aligns itself to the objectives and strategies outlined in Tata Steel's corporate vision.

4. Expenditure on R&D:

		(₹ in crores)
(a)	Capital	: 12.06
(b)	Recurring	: 68.45
(c)	Total	: 80.51
(d)	Total R&D expenditure as a % of Total Turnover	: 0.19%

Technology, Absorption, Adaptation and Innovation

Efforts made on the process front:

Iron ore pellets and large Blast Furnaces

- Ramp up and stabilisation of India's largest pellet plant to its rated production of 6 mtpa along with production of 'olivine' and limestone mix-fluxed pellets for the first time in the country to optimise results at large blast furnaces.

- The large blast furnaces with rated capacities of 3 mtpa per furnace were fully operated, marking the highest production rate from individual blast furnaces in the country.
- The blast furnace burden comprised up to 45% pellets – the first such regime in large blast furnaces in the country – and amongst few worldwide.

Stabilisation of 'retro-fitted' Coke Dry Quenching installations:

- Stabilisation of the first CDQ facility – a 25-year-old coke plant, 'retro-fitted' with CDQ technology, was stabilised in Financial Year 2013-14. It then yielded a significant improvement in the quality of coke – apart from the heat recovery from red-hot coke.
- Performance of 'G' blast furnace, after use of dry quenched coke, improved considerably, adding to the gains made from recovery of heat from red-hot coke.

Coal beneficiation improvements:

- Diesel – conventionally used as a 'collector' in washing of fine coal fractions at washeries – was completely replaced by a 'synthetic collector'. Apart from replacement of diesel – an initiative to reduce use of petroleum products – the performance of floatation also improved resulting in gains in clean coal yield.

Use of Waste Materials:

- Development of iron ore slime briquette.
- Development of the tunnel furnace process for the production of DRI from iron ore slime and Jhama Coal.
- Development of smelting process for the production of hot metal from self-reducing briquettes containing iron ore slime and Jhama coal.
- Commercialisation of LD slag brick.

New Product Development:

- Development of Ferrite – Bainite and Ferrite Martensite grades for auto customers through the TSCR route.
- Development of micro alloyed grades for wheel applications through the TSCR route.
- Commercialisation of API-60 grade.
- Development of a new grade of 50-12 (Mn:Si) of silico manganese – produced exclusively from local ores.

Process Development:

- Development of a robust roll testing process to prevent the spall of HSM rolls.
- Development of an Annealing Simulator for the optimisation of BAF and CAL annealing cycles.
- Improvement in the Cold Crushing Strength of pellets with the addition of Limestone.

FAMD:

- Development of a hydrometallurgical process for the extraction of Nickel, Cobalt and Iron from the Chrome Overburden of Sukinda.

Bearings Division:

- Nine new products with varied applications developed for different OE manufacturers, along with channels.
- New auto TRB closing m/c developed in-house and operationalised.
- New cutting coolant introduced to obtain higher productivity and better consumable life.
- Testing & validation:
  - Life testing of Ball Bearing, Taper Roller Bearing.
  - Accelerated Test Rig for Rear Wheel Bearings.
  - Testing of Bearings under Heated Oil Condition (up to 90°C) to simulate Gear Box application of 4 wheelers (indigenous development).
  - Mud Bath Test Rig for Rear Wheel Bearings.
  - Dust chamber test rig for Fan Support Bearings to check sealing ability.
  - Endurance Test Rig for HUB Bearings.
  - Retrofitting of existing test rig to validate the performance of products with actual hub assembly from customer at nearby simulated running condition.
  - Retrofitting of an existing test rig for tapered roller bearing to accommodate the testing of deep groove ball bearings.

FORM B - PARTICULARS OF TECHNOLOGY IMPORTED DURING LAST FIVE YEARS

	Steel Division	Absorption	Status of Implementation
a)	Top Gas Recovery Turbine for 'G' Blast Furnace	2010	Commissioned
b)	4th Stove for 'G' Blast Furnace to facilitate relining of other stoves, without hampering hot metal production	2010	Commissioned
c)	Continuous Emission Monitoring stations at 4 locations inside Tata Steel Works	2010	Commissioned
d)	Installation of Roll Coating & Drying System at Continuous Galvanising Line at Cold Rolling Mill	2011	Commissioned
e)	Use of Blast Furnace Gas at New Reheating Furnace using regenerative burners at Hot Strip Mill	2011	Commissioned
f)	Installation of Chiller system for maintaining temperature of cooling medium for 'H' Bl. Fce Blower Drives at Blower House No. 5	2011	Commissioned
g)	Installation of 6.0 mtpa Pellet Plant for making pellets using iron ore fines, for use in Blast Furnaces	2012	Commissioned
h)	Installation of New Steel Melting Shop (LD3), and one strand of Thin Slab Casting & Rolling (TSCR) facility	2012	Commissioned
i)	Pipe Conveyor in the Lime handling circuit	2012	Commissioned
j)	Rapid Loading Station at Dispatch Yard of Noamundi Iron Ore Mines, including Extromat Silo Extractor in the fines circuit	2012	Commissioned
k)	Barrel Reclaimer at Noamundi Iron Mines	2012	Commissioned
l)	Installation of 0.25 mtpa FHCR (Full Hard Cold Rolling) Mill at Bara in Jamshedpur	2012	Commissioned
m)	Installation of Coke Dry Quenching facilities at Coke Oven Battery Nos. 5, 6 & 7	2012	Commissioned
n)	Installation of Compactor at Wire Rod Mill	2012	Commissioned
o)	Installation of 0.7 mtpa capacity 5 metres tall Stamp Charge Coke Oven Battery No. 10 with pushing, charging and quenching emission control systems	2013	Commissioned
p)	2 Nos. of 600 tpd capacity, suspended cylinder Lime Kilns	2013	Commissioned
q)	Installation of second strand of TSCR	2013	Commissioned
r)	Online continuous emission monitoring system for stack emissions and ambient air quality	2013	Commissioned
s)	Coromax Technology for Power Saving in ESP at Sinter Plant No. 3	2013	Commissioned
t)	Composting Plant for Canteen waste	2013	Commissioned
u)	Installation and commissioning of secondary emission control system at LD # 1	2014	Commissioned
v)	Installation of Nozzlex addition facility in tilters at LD # 1	2014	Commissioned
w)	Installation of Multifunctional gauge for Finishing Mill at Hot Strip Mill	2014	Commissioned
x)	Installation of Variable Frequency Drive with Inverter Duty Motor for FD fans at Power House No. 4	2014	Commissioned