

## ANNEXURE – 4

### R&D Projects undertaken under the R&D scheme with financial assistance from Government Fund:

(Rs. in Lakhs)

Sl. No.	R&D Projects	R&D Agency	Total Project Cost	Sanctioned Government Funding	Start Date/ Completion Date	Project Status
1	Improvement in sinter productivity through deep beneficiation and agglomeration technologies for rational utilization of low grade iron ores and fines	CSIR-NML	1,255.80	1,255.80	Start Date: April 2010  Completion Date: June 2014	<ul style="list-style-type: none"> <li>• <b>Project Completed.</b></li> <li>• Detailed bench scale &amp; pilot scale studies were undertaken for development of process route for beneficiation of the three iron ore samples.</li> <li>• Micro-pelletization studies on fine grained iron ore concentrate and Sintering studies were carried out using micro-pellets as the partial feed under varied conditions.</li> <li>• Use of (50%) the micro-pellets/pre-balled concentrate alongwith 50% sinter fines led to marked improvement in sinter productivity due to improved bed permeability.</li> <li>• Techno-economic feasibility studies of the processes developed have been carried out in association with MECON.</li> </ul>
2	Development of Alternate complementary Route of Iron/Steel making with reference to Indian raw material viz low grade iron ore and non coking coal	CSIR-NML	858.00	858.00	Start Date: April 2010  Completion Date: December 2013	<ul style="list-style-type: none"> <li>• <b>Project completed.</b></li> <li>• Coal samples were procured from various sources and flow sheets developed to obtain clean coal with ~12% ash for each one of them.</li> <li>• Clean coal and iron ore concentrate used to produce composite micro-pellets.</li> <li>• Micro pellets were reduced in coke oven with excess carbon to form ferro-</li> </ul>

						<p>carbon. Excellent metallization was achieved under optimum conditions. and sufficient quantity of ferro-carbon was produced in the pilot oven for further melting studies.</p> <ul style="list-style-type: none"> <li>• Smelting studies carried out with the generated ferro-carbon in the SAF for steel making. Although good metallization has been achieved in the Ferro Carbon (around 90%), the steel produced have around 1.5% C and 0.1% P which are not desirable.</li> <li>• Findings not encouraging for implementation.</li> </ul>
3	Production of low Phosphorus Steel using DRI through Induction furnace route adopting innovative fluxes and/or design (refractory) changes.	CSIR-NML	237.00	237.00	<p><b>Start Date:</b> April 2010</p> <p><b>Completion Date:</b> November 2012</p>	<ul style="list-style-type: none"> <li>• <b>Project completed.</b></li> <li>• Process has been developed in laboratory scale for production of low Phosphorus steel in laboratory scale Induction Furnace using DRI.</li> <li>• Industrial Scale Trials taken up in 2nd Phase (Project SI.No.9).</li> </ul>
4	Smelting reduction of iron ore/fines by hydrogen plasma and elimination of CO2 emission	CSIT-IMMT	990.35	990.35	<p><b>Start Date:</b> April 2010</p> <p><b>Completion Date:</b> July 2015</p>	<ul style="list-style-type: none"> <li>• <b>Project Completed.</b></li> <li>• Very futuristic technology demonstration project.</li> <li>• Feasibility of smelting reduction of iron ore/fines using hydrogen plasma has been explored in laboratory/ pilot scale for which a patent has also been filed in the US</li> </ul>
5	Beneficiation of Iron Ore slimes from Barsua Mine	RDCIS, SAIL	2,769.40	1,408.20	<p><b>Start Date:</b> Jan 2012</p> <p><b>Scheduled completion Date:</b> March 2017</p>	<ul style="list-style-type: none"> <li>• <b>Project kept in abeyance.</b></li> <li>• Pilot plant could not be setup pending statutory clearances at mine site.</li> </ul>
6	Development of pilot scale pelletization technology for Indian Goethitic/hematite ore with varying degree of fineness	RDCIS, SAIL	4,188.77	2,206.27	<p><b>Start Date:</b> Jan 2012</p> <p><b>Scheduled Completion Date:</b> March 2018</p>	<ul style="list-style-type: none"> <li>• <b>Project Completed. Project Completion Report to be submitted.</b></li> <li>• Pilot Scale pelletisation plant setup.</li> <li>• The automated Pellet Heat Hardening System has been commissioned and test work has been carried out using the system.</li> </ul>

						<ul style="list-style-type: none"> <li>• Trials completed.</li> <li>• PCR to be submitted</li> </ul>
7	CO2 abatement in Iron and Steel production by process optimization	IIT Kharagpur	84.36	84.36	<p><b>Start Date:</b> Jan 2011</p> <p><b>Completion Date:</b> September 2014</p>	<ul style="list-style-type: none"> <li>• <b>Project completed.</b></li> <li>• Based on the predictions of the developed mathematical models the following optimization results has been obtained with Input conditions of moisture content 35-64 gms/Nm3, blast temperature 903-1018 C, sinter/ore ratio of 2.07-2.75 and validated during BF#3 Trials at RSP: <ul style="list-style-type: none"> <li>○ Increase of Productivity by about 10 - 12 % based on observed productivity 1.6-1.7 T/day/M3 of W.V</li> <li>○ Decrease of CO2 in the exit gas by about 8 -10%</li> <li>○ Decrease of Carbon rate by about 8 – 10 % based on observed C rate of around 500 kg/THM</li> </ul> </li> </ul>
8	Production of low ash (10% ash) coal (coking non coking) from high ash Indian coals including desulphurisation of high sulphur North East coal	CSIT-IMMT	1,943.53	1,688.53	<p><b>Start Date:</b> Jan 2011</p> <p><b>Completion Date:</b> June 2014</p>	<ul style="list-style-type: none"> <li>• <b>Project completed.</b></li> <li>• It has been established at laboratory scale that it is possible to beneficiate ROM coal with less than 30% ash to achieve 10% ash with appreciable yield.</li> <li>• Multiple flow sheets for beneficiation were developed for different grades of coking &amp; non coking coals which can be used by the user industry.</li> </ul>
9	Development of the technology for production of CRGO Steel Sheets and other value added Steel Products (DPR)	CSIR-NML	137.83	34.46	<p><b>Placement of Order for the DPR of the CRGO Project:</b> May 2015</p> <p><b>Submission &amp; Approval of DPR:</b> Sept 2016</p>	<ul style="list-style-type: none"> <li>• <b>DPR of the project prepared by MECON and approved by Stakeholders.</b></li> <li>• Project to initiate after signing of Memorandum of Agreement by the stakeholders.</li> <li>• <b>CSIR is reluctant to sign the Memorandum of Agreement. Hence project could not be initiated.</b></li> </ul>
10	Production of low Phosphorus steel through Induction Furnace route using	CSIR-NML	193.00	193.00	<p><b>Start Date:</b> August 2014</p>	<ul style="list-style-type: none"> <li>• <b>Project Completed.</b></li> <li>• Industrial Trials completed showing</li> </ul>

	DRI as major ferruginous raw material – An Industrial Assessment				<b>Completion Date:</b> <b>March 2016</b>	<ul style="list-style-type: none"> <li>encouraging results.</li> <li>Follow up industrial trials in neutral lining IF planned to achieve lower phosphorus levels.</li> </ul>
11	Development of Automation System for Optimum Coal Blending at Coal Handling Plant of Coke Oven Batteries	RDCIS, SAIL	<b>1,290.00</b>	<b>645.00</b>	<b>Start Date:</b> <b>June 2015</b>  <b>Scheduled Completion Date:</b> <b>May 2018</b>	<ul style="list-style-type: none"> <li><b>Project in progress.</b></li> <li>Project Delayed</li> <li>Scheduled to be completed in May 2018</li> <li>Expected to be completed in 2018-19 (December 2018)</li> </ul>
12	Economic production of iron through direct reduction of Mill Scale by low grade coal of Rajasthan	MNIT	<b>540.00</b>	<b>166.00</b>	<b>Start Date:</b> <b>October 2015</b>  <b>Scheduled Completion Date:</b> <b>September 2018</b>	<ul style="list-style-type: none"> <li><b>Project in progress.</b></li> <li>Project on Schedule</li> <li>Expected to be completed in September 2018</li> </ul>
13	Develop Procedure for Joining Next Generation High Temperature Material to be used for Supercritical/ Ultra Supercritical Power Plant by Friction Stir Welding	Jadavpur University	<b>567.26</b>	<b>558.26</b>	<b>Start Date:</b> <b>October 2015</b>  <b>Scheduled Completion Date:</b> <b>September 2018</b>	<ul style="list-style-type: none"> <li><b>Project in progress.</b></li> <li>Project Delayed</li> <li>Scheduled to be completed in 2018-19</li> <li>Actual Completion date not certain</li> <li>Committee under Director SRTMI to examine viability of the project.</li> </ul>
14	Development of Cost Effective Refractory Lining Materials for Induction Melting Furnace suitable for production of Quality Steel	CSIR-CGCRI	<b>165.00</b>	<b>165.00</b>	<b>Start Date:</b> <b>April 2016</b>  <b>Completion Date:</b> <b>March 2018</b>	<ul style="list-style-type: none"> <li><b>Project Completed. PCR to be submitted.</b></li> <li>Refractory lining ramming mass developed and trials done in lab scale induction furnace</li> <li>PCR to be submitted</li> </ul>
15	Development of Dry Slag Granulation Technology and Energy Recovery System for Blast Furnace Slag for Producing Clinker Compatible Product	IIT Madras	<b>168.74</b>	<b>84.37</b>	<b>Start Date:</b> <b>April 2016</b>  <b>Scheduled Completion Date:</b> <b>March 2020</b>	<ul style="list-style-type: none"> <li><b>Project in progress.</b></li> <li>Project on Schedule</li> <li>Expected to be completed in 2019-20</li> </ul>
16	Development of Infrared Camera Based Torpedo Ladle Car Condition Monitoring System	MECON	<b>308.00</b>	<b>154.00</b>	<b>Start Date:</b> <b>August 2016</b>  <b>Scheduled Completion Date:</b> <b>July 2018</b>	<ul style="list-style-type: none"> <li><b>Project in progress.</b></li> <li>Project on Schedule</li> <li>Expected to be completed in July 2018</li> </ul>

17	Development of nickel free nitrogen austenitic stainless steel for biomedical applications	IIT BHU	284.45	284.45	Start Date: Jan 2017  Scheduled Completion Date: Dec 2019	<ul style="list-style-type: none"> <li>• <b>Project in progress.</b></li> <li>• Project on Schedule</li> <li>• Expected to be completed in 2019-20</li> </ul>
18	Indigenous Development of Model based Breakout Prediction System (BOPS) for Continuous Casters	RDCIS	582.00	260.00	Start Date: Jan 2017  Scheduled Completion Date: Dec 2019	<ul style="list-style-type: none"> <li>• <b>Project in progress.</b></li> <li>• Project on Schedule</li> <li>• Expected to be completed in 2019-20</li> </ul>
19	Development of Fluidised Bed Reduction Roasting Process for slimes & low grade iron ores by utilizing thermal grade coal for their magnetic susceptibility properties and maximizing the iron recovery	IIT Madras & JSW Steel	245.52	122.76	Start Date: Dec 2016  Scheduled Completion Date: Nov 2020	<ul style="list-style-type: none"> <li>• <b>Project in progress.</b></li> <li>• Project on Schedule</li> <li>• Expected to be completed in 2020-21</li> </ul>
20	Production of low Carbon & low Phosphorus Ferromanganese by metallothermic treatment of high Manganese Slag using Silicomanganese	CSIR-NML Jamshedpur.	150.00	150.00	Start Date: Jan 2017  Scheduled Completion Date: Dec 2018	<ul style="list-style-type: none"> <li>• <b>Project in progress.</b></li> <li>• Project on Schedule</li> <li>• Expected to be completed in December 2018</li> </ul>
21	Production of highly metallised Directly Reduced Iron from mill scale & lean grade coal in Tunnel Kiln	CSIR-NML Jamshedpur.	203.00	151.00	Start Date: Dec 2016  Completion Date: March 2018	<ul style="list-style-type: none"> <li>• <b>Project completed in March 2018.</b> Production of highly metallised iron through Tunnel Kiln achieved successfully</li> <li>• PCR to be submitted</li> </ul>
22	Reduction Roasting and Microwave Heating of some difficult to treat Ores for the production of Pellet Feed Concentrate	CSIR-IMMT Bhubaneswar	124.80	124.80	Start Date: Dec 2016  Scheduled Completion Date: Nov 2019	<ul style="list-style-type: none"> <li>• <b>Project in progress.</b></li> <li>• Project on Schedule</li> <li>• Expected to be completed in 2019-20</li> </ul>
23	Modeling & Optimization of High Concentration Iron Ore fines /concentrate slurry Pipelines for Indian Iron Ore Processing Industries	CSIR-IMMT Bhubaneswar & NMDC Ltd.	425.00	212.50	Start Date: Jan 2017  Scheduled Completion Date: Dec 2019	<ul style="list-style-type: none"> <li>• <b>Project in progress.</b></li> <li>• Project on Schedule</li> <li>• Expected to be completed in 2019-20</li> </ul>
24	Development of a cost effective green technology for Pre Reduction of Chromite Ore in Tunnel Kiln and	NISST, NML & MECPL	614.00	306.50	Start Date: October 2017	<ul style="list-style-type: none"> <li>• <b>Project in progress.</b></li> <li>• Project on Schedule</li> <li>• Scheduled to be completed in 2019-20</li> </ul>

	Production of High Carbon Ferro Chrome in SAF				Scheduled Completion Date: September 2019	
25	A Novel Approach of Making Green Belite Cement from Electric Arc Furnace Steel Making Slag	IIT Kharagpur	139.20	139.20	Start Date: October 2017 Scheduled Completion Date: September 2020	<ul style="list-style-type: none"> <li>• <b>Project in progress.</b></li> <li>• Project on Schedule</li> <li>• Scheduled to be completed in 2020-21</li> </ul>
26	Amorphous Electrical Steel (AES) for Energy Application submitted by NML Jamshedpur	CSIR-NML Jamshedpur.	3634.00	3634.00	Start Date: Nov 2017 Scheduled Completion Date: Oct 2021	<ul style="list-style-type: none"> <li>• <b>Project in progress.</b></li> <li>• Project on Schedule</li> <li>• Scheduled to be completed in 2021-22</li> </ul>
	<b>Total</b>		<b>22,099.01</b>	<b>16,113.81</b>		