Status of R&D Projects undertaken under the R&D scheme with financial assistance from Ministry of Steel (Government Fund):

(in Rs. lakhs)

Sl. No	R&D Projects	R&D Agency	Sanctioned Government Funding	Start Date/ Completion Date	Name of Project Investigator	Status of Project
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**	• Start Date: April 2010 • Completion Date: June 2014	Dr. Ratnakar Singh, Email: rs@nmlindia.org	• **Project Completed.** • Detailed bench scale & pilot scale studies were undertaken for development of process route for beneficiation of the three iron ore samples. • 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. • 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. • Techno-economic feasibility studies of the processes developed have been carried out in association with MECON.
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**	• Start Date: April 2010 • Completion Date: December 2013	Dr. Avimanyu Das, Email: adas@nmlindia.org	• **Project completed.** • Coal samples were procured from various sources and flow sheets developed to obtain clean coal with ~12% ash for each one of them. • Clean coal and iron ore concentrate used to produce composite micro-pellets. • Micro pellets were reduced in coke oven with excess carbon to form ferro-carbon. Excellent metallization was achieved under optimum conditions. and sufficient quantity of ferro-carbon was produced in the pilot oven for further melting studies. • 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. • Findings not encouraging for implementation.

3	Production of low Phosphorus Steel using DRI through Induction furnace route adopting innovative fluxes and/or design (refractory) changes.	CSIR-NML	**237.00**	• Start Date: April 2010 • Completion Date: Nov 2012	Shri R. K. Minj, Email: rkm@nmlindia.org	• **Project completed.** • Process has been developed in laboratory scale for production of low Phosphorus steel in laboratory scale Induction Furnace using DRI. • Industrial Scale Trials taken up in 2nd Phase (Project Sl.No.10).
4	Smelting reduction of iron ore/fines by hydrogen plasma and elimination of CO2 emission	CSIT-IMMT	**990.35**	• Start Date: April 2010 • Completion Date: July 2015	Dr.B.Bhoi, Email: bbhoi@immt.res.in	• **Project Completed.** • Very futuristic technology demonstration project. • 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
5	Beneficiation of Iron Ore slimes from Barsua Mine	RDCIS, SAIL	**1,408.20**	• Start Date: Jan 2012 • Scheduled Completion Date: March 2017	Dr S K Pan, Email: skpan@sail-rdcis.com	• **Project not pursued** beyond the lab scale studies. • Pilot plant could not be setup pending statutory clearances at mine site.
6	Development of pilot scale pelletization technology for Indian Goethitic/hematite ore with varying degree of fineness	RDCIS, SAIL	**2,206.27**	• Start Date: Jan 2012 • Scheduled Completion Date: March 2018	Dr S K Pan, Email: skpan@sail-rdcis.com	• **Project Completed.** • Pilot Scale pelletisation plant setup. • The automated Pellet Heat Hardening System has been commissioned and trials successfully carried out using the system. • It was demonstrated by suitably changing the variable parameters, all types of low grade ores with high LOI content can be agglomerated to pellet form for further use in steel industry. • Pilot scale facilities created at RDCIS and IMMT can be utilized by scientists/technologists all over the country for further development of pelletisation technology.

7	CO2 abatement in Iron and Steel production by process optimization	IIT Kharagpur	**84.36**	• Start Date: Jan 2011 • Completion Date: September 2014	Prof. P. K. Sen, Email: pksen@metal.iitkgp.ernet.in	• **Project completed.** • 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: • Increase of Productivity by about 10 - 12 % based on observed productivity 1.6-1.7 T/day/M3 of W.V • Decrease of CO2 in the exit gas by about 8 -10% • Decrease of Carbon rate by about 8 – 10 % based on observed C rate of around 500 kg/THM
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	**1,688.53**	• Start Date: Jan 2011 • Completion Date: June 2014	Dr. S. K. Biswal skbiswal@immt.res.in	• **Project completed.** • 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. • Multiple flow sheets for beneficiation were developed for different grades of coking & non coking coals which can be used by the user industry.
9	Development of the technology for production of CRGO Steel Sheets and other value added Steel Products (DPR)	CSIR-NML	**34.46**	• Placement of Order for the DPR: May 2015 • Submission & Approval of DPR: Sept 2016	Dr Amitava Mitra amitra@nmlindia.org	• DPR of the project prepared by MECON and approved by Stakeholders. • CSIR did not pursue the project further.
10	Production of low Phosphorus steel through Induction Furnace route using DRI as major ferruginous raw material – An Industrial Assessment	CSIR-NML	**193.00**	• Start Date: August 2014 • Completion Date: March 2016	Shri R. K. Minj, Email: rkm@nmlindia.org	• **Project Completed.** • Lime based flux was indigenously developed. Trial heats in 1-10 ton capacity induction furnaces resulted in reduction of P level from 0.075-0.09 to 0.06% max. • Lime based composite pellets were tried in industrial heats of 1-8 ton capacity. Dephosphorisation to the extent of 15% max could be achieved. • Basic engineering package prepared.

11	Development of Cost Effective Refractory Lining Materials for Induction Melting Furnace suitable for production of Quality Steel	CSIR-CGCRI	**165.00**	• Start Date: April 2016 • Completion Date: March 2018	Dr. H. S. Tripathi hstripathi@cgcri.res.in	• **Project Completed.** • Magnesia based refractory mass was developed and series of laboratory scale induction furnace trials were conducted to evaluate the performance of the ramming mass during refining of steel. • In all the trials 80% DR was used in the charge mix to replicate the industrial practice. A dephosphorisation flux earlier developed in one of the completed R&D project was used. • The results showed a reduction of phosphorus level from 0.06-0.10% in the input charge to below 0.05% in the final steel. • The lining life was found to be higher (13-16 heats) than the target lining life of 8-10 heats in 20Kg induction furnace trials. The maximum lining life achieved was 19 heats.
12	Development of Infrared Camera Based Torpedo Ladle Car Condition Monitoring System	MECON	**154.00**	• Start Date: August 2016 • Completion Date: July 2018	Dr. B.Chakraborty bchakraborty@meconlimited.co.in	• **Project Completed.** • An infrared camera based torpedo car condition monitoring system was successfully commissioned in SMS-II of RSP. • The system is capable to monitor continuously the condition of the torpedo ladle, detect hot spots, sound an alarm and prevent breakouts during a torpedo's campaign life.
13	Production of low Carbon & low Phosphorus Ferromanganese by metallothermic treatment of high Manganese Slag using Silicomanganese	CSIR-NML	**150.00**	• Start Date: Jan 2017 • Completion Date: Dec 2018	Shri R. K. Minj, Email: rkm@nmlindia.org	• **Project Completed.** • Low Carbon & low Phosphorus Ferromanganese successfully produced in lab scale by metallothermic treatment of high Manganese Slag using Silicomanganese.

14	Production of highly metallised Directly Reduced Iron from mill scale & lean grade coal in Tunnel Kiln	CSIR-NML	**151.00**	• Start Date: Dec 2016 • Completion Date: March 2018	Dr. Dayanand Paswan dnpaswan@nmlindia.org	• **Project Completed.** • Technology has been developed for the production of highly metalized DRI from iron ore, mill scale and lean grade coal in tunnel kiln. • Commercial scale trials were successfully conducted to demonstrate the technology at M/s SMRW and 100 tons of DRI was produced in a continuous manner • Technology has been transferred to M/s SMRW, Ranchi for commercial production of DRI through tunnel kiln.
15	Development of Automation System for Optimum Coal Blending at Coal Handling Plant of Coke Oven Batteries	RDCIS, SAIL, Ranchi	**645.00**	• Start Date: June 2015 • Scheduled Completion Date: **September 2019**	S Mitra +91-8986880347 smitra@sail-rdcis.com	• The integrated automation system for coal blending has been successfully implemented in Coal Handling Plant of Bokaro Steel Plant and is in operation. Project Completed.
16	Economic production of iron through direct reduction of Mill Scale by low grade coal of Rajasthan	MNIT, Jaipur	**166.00**	• Start Date: October 2015 • Scheduled Completion Date: Dec 2019	M K Banerjee 9660005498 mkbanerjee@hotmail.com, Amar Patnaik patnaik.amar@gmail.com Mobile: 9549657318	• Solid Gas Reactor has been designed and fabricated by the vendor is completed and installed at MNIT. Trial experiments are successful. Optimization has been done. • The PI has informed that the project has been completed and shall be submitting the Project Completion Report shortly.
17	Develop Procedure for Joining Next Generation High Temperature Material to be used for Supercritical/ Ultra Supercritical Power Plant by Friction Stir Welding	Jadavpur University, Kolkata	**558.26**	• Start Date: October 2015 • Scheduled Completion Date: Sept 2020	Dipankar (Sanyal) Jadavpur University 9831483461, dipans26@gmail.com	• Procurement completed for High temperature furnace for Tensile Testing Machine, P91 seamless pipes to be welded, Ten M44141 PCBN coated FSW tools, Procurement of input card for FSW machine, UPS carried out • Repairing Y-axis travel, E-stop button and MMI PC of the existing FSW machine carried out. • Installing programmable rotary turntable fixture for welding pipes of ID between 255mm and 260mm completed • Issues faced in welding of P91 pipes. • The project is on progress and has been partially successful, so far. • To be completed by September 2020.
18	Development of Dry Slag Granulation Technology and Energy Recovery System for Blast Furnace Slag for Producing Clinker	IIT Madras, Chennai	**84.37**	• Start Date: April 2016 • Scheduled Completion Date: March 2020	S Pushpavanam spush@IITM.AC.IN Mobile: 9445104479	• Lab Scale work on determining optimum parameters for dry slag granulation, heat transfer studies and lime dissolution studies with BF Slag successfully carried

	Compatible Product					out. • However, the experiments envisaged with melting of slag and the experiments with molten slag could not be done at IIT Madras because of various constraints. • The envisaged outcome of the project has not been fully achieved. • Lab scale work to be completed by March 2020.
19	Development of nickel free nitrogen austenitic stainless steel for biomedical applications	IIT BHU, Varanasi	**284.45**	• Start Date: Jan 2017 • Scheduled Completion Date: June 2020	G S Mahobia Mobile : 9889296522 gsm.met@iitbhu.ac.in	• The envisaged material has been developed successfully. • The studies & findings have shown that the material have acceptable biocompatibility, improved corrosion resistance and fatigue strength. • Project in progress and expected to be completed in June 2020.
20	Indigenous Development of Model based Breakout Prediction System (BOPS) for Continuous Casters	RDCIS, Ranchi	**260.00**	• Start Date: Jan 2017 • Scheduled Completion Date: Dec 2020.	I Banerjee Mobile : 8986880021 indranil@sail-rdcis.com	• Model development for BOPS to detect sticker & prevent breakout, in progress • Procurement of mould instrumentation and data acquisition system in progress. Issues faced in procurement. • Project in progress and expected to be completed in December 2020.
21	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, Chennai & JSW Steel	**122.76**	• Start Date: Dec 2016 • Scheduled Completion Date: Nov 2020	Sabita Sarkar Mobile: 9445737724 sabita.sarkar@iitm.ac.in	• Reduction of iron ore sample was done in a fluidized bed reactor using reducing gas in National Metallurgical Laboratory (NML), Jamshedpur. Experimental results show good conversion from hematite to magnetite. • Reduction of iron ore sample was done in the fluidized bed reactor at IIT Madras using coal. However, poor conversion rate was obtained. • Modification in the design of the reactor is being planned. • Project in progress and expected to be completed in November 2020.
22	Reduction Roasting and Microwave Heating of some difficult to treat Ores for the production of Pellet Feed Concentrate	CSIR-IMMT Bhubaneswar	**124.80**	• Start Date: Dec 2016 • Scheduled Completion Date: March 2020	Swagat S. Rath Cell No.+91-7873411250 ssrath@immt.res.in	• MW assisted reduction roasting-magnetic separation studies were carried out for a BHQ & BHJ samples with encouraging results. • Validation work in progress. • Project in progress and expected to be completed in March 2020.

23	Modeling & Optimization of High Concentration Iron Ore fines /concentrate slurry Pipelines for Indian Iron Ore Processing Industries	CSIR-IMMT Bhubaneswar & NMDC Ltd.	**212.50**	• Start Date: Jan 2017 • Scheduled Completion Date: October 2020	P K Senapati Mobile: 9437002838 pksenapati@immt.res.in	• The experimental studies has been successfully carried out using newly installed pipe test loop facility of 50 mm & 100 mm NB pipe sizes • Installation, commissioning & experimental studies with 150mm & 200mm NB pipe test loop in progress. • Project in progress and expected to be completed in October 2020.
24	Development of a cost effective green technology for Pre Reduction of Chromite Ore in Tunnel Kiln and Production of High Carbon Ferro Chrome in SAF	NISST, NML & MECPL	**306.50**	• Start Date: October 2017 • Scheduled Completion Date: September 2020	Shri. Rajib Paul, Director NISST, 9560004102, director@nisst.org	• Renovation of tunnel kiln and 500kVA SAF completed. • Pilot Scale trials for pre-reduction of chromite ore in Tunnel Kiln and pilot Scale smelting studies in SAF, is in progress. • Project in progress and expected to be completed in September 2020.
25	A Novel Approach of Making Green Belite Cement from Electric Arc Furnace Steel Making Slag	IIT Kharagpur	**139.20**	• Start Date: October 2017 • Scheduled Completion Date: September 2020	Dr. Koushik Biswas, IIT Kharagpur k_biswas@metal.iitkgp.ac.in Mobile: 9433473932	• Lab/ Pilot scale studies has been successful in bringing out the cementitious properties of EAF slag. • The compression test data shows that the cement clinker formed by using 5% EAF slag addition showed strength properties greater than that of Masonry cement. • Validation & Testing on progress. • Bottleneck faced in delivery and installation of the equipments • Project in progress and expected to be completed in September 2020.
26	Amorphous Electrical Steel (AES) for Energy Application submitted by NML Jamshedpur	CSIR-NML Jamshedpur	**3634.00**	• Start Date: Nov 2017 • Scheduled Completion Date: Oct 2022	Dr Amitava Mitra, NML, amitra@nmlindia.org, Tel.No.:+91 657 2345205/ 2345220	• Development of newer materials and laboratory scale experimentation on amorphous electrical steel alloy compositions, their ribbon preparation and property evaluation in progress. • Site development and building of shed for Pilot Plant in progress • Issues faced in procurement of the Pilot Plant. • Project in progress and expected to be completed in October 2022.
27	Development of Design Guidelines and Specifications for utilization of steel slag in road construction	CRRI	**286.50**	• Start Date: October 2018 • Scheduled Completion Date:	Shri Satish Pandey, CRRI M: +91 9999 366937 satishpandey.crri@nic.in	• Comparative evaluation of steel slag aging and processing methodology completed.

				September 2021		• Characterization of Steel Slag/ Laboratory evaluation of processed LD slag from JSW, Essar Steel & Tata Steel has been completed. • Developmental work for cement concrete mixes with steel slag as aggregrate completed. • Field evaluation & pavement design at Hazira carried out. • Procurement of various laboratory and field study equipments Identification of test section for field trial with Industrial partner and NHAI officials on progress. • Development of Steel Slag Characterization lab on progress • Project in progress and expected to be completed in September 2021.
28	Development of super alloy grade 625 & 825 for commercial market	MIDHANI	**800.00**	• Start Date: September 2018 • Scheduled Completion Date: September 2021	Dr Lekhi, CMD, MIDHANI nishank.jain@midhani.com, 040-24184494 cmd@midhani-india.in snprasad@midhani-india.in	• Trials melts were taken in Electric Arc Furnace (EAF), Air Induction Melting (AIM) Furnace and Vacuum Induction Refining (VIR) Furnace but desired gas levels were not achieved. • A lower vacuum of less than 10-3 mbar desired. • Modification of existing 2.5T Vacuum Induction (VIM) furnace and procurement of new 8T Vacuum Induction Melting (VIM) Furnace were planned. • Pumps for the modification of 2.5 T VIM procured and modification activity is under progress. PO for new 8T VIM has been placed. • Project in progress and expected to be completed in September 2021.
29	Optimisation of floatation process for Indian Coking Coal using advanced Pneuflot Floatation Cell by IMMT	IMMT	**91.54**	• Start Date: October 2018 • Scheduled Completion Date: March 2021	Dr R K Dwari, IMMT, Mobile: 9437194521, Email: rkdwari@immt.res.in	• Detail physico-chemical characterisation and petrography analysis of on low grade Dugda & Chasnala washery coal fines completed. • Column Flotation studies on the Dugda & Chasnala wahsery feed coal/ washery rejects (fines) using Denver floatation cell is completed. • Surfactant synthesised from vegetable oil refinery waste. Floatation response

						studies were carried out using vegetable oil refinery waste and synthesised surfactant. • Pneuflot flotation cell (Make: MBE Germany) has been indented. Purchase order to be placed with delivery time of 4 months. • Project in progress and expected to be completed in March 2021.
30	Fundamental process engineering to minimize re-oxidation of steel during teeming via a ladle shroud leading to improved castability and cleanliness	IIT, Kanpur	**154.63**	• Start Date: September 2018 • Scheduled Completion Date: September 2021	Prof Dipak Mazumdar, IIT Kanpur, Tel:91-512-2597640;91-512-2597328, dipak@iitk.ac.in	• Existing modes of external gas injection designs in industrial shrouds is largely insufficient to ensure 360° shielding of S-CN joint. • Significant improvement in ladle shroud performance can be ensured by engineering argon flow rate as well as gas delivery arrangements • Data collection from Industry completed. • Fabrication of working, full scale, PERSPEX shroud system with tundish sections have been completed • All major equipment purchased and commissioned • Industrial scale trials in a special steel plant has been planned with a modified shroud design developed at IIT Kanpur. Agreement for collaborative work and trial of new shroud design with Sunflag Steel is in final stage. • Project in progress and expected to be completed in September 2021.
31	Conversion of emitted CO2 to chemical fuels.	IMMT, Bhubaneswar	**77.05**	• Start Date: October 2018 • Scheduled Completion Date: Oct 2021	Prof. Suddhasatwa Basu, Director, IMMT, Tel: +91 (0674) 2567126; 2379400; E-mail: dir@immt.res.in, sbasu@immt.res.in	• Fabricated the single cell as the graphite (G) and Copper (Cu) as the Anode and Cathode electrodes and Nafion 117 as Cation exchange membrane. • Experiments conducted on single cell by varying the electrolytes, electrodes, coating materials on electrodes. • Balance Work: Analysis of product on single cell, planning and fabrication of stack cell, experimental and product analysis of stack cell, cost analysis. • Project in progress and expected to be completed in September 2021.
32	Development of newer	CBRI,	**195.00**	• Start Date: October	Dr S. K. Singh, CBRI,	• Experiments carried out on development

	Cementitious Materials using Chemically Activated LD Slag.	Roorkee		2018 • Scheduled Completion Date: Oct 2021	9412074787(Mob) sksingh_cbri@yahoo.co.in	of slag cement with alkali activated slag and OPC using different percentages of NaOH, NaSiO3, NaCO3. • The proposed slag activity index of LD slag is 75% while the tested activity index of raw LD slag is 58.16% which indicates the need for further activation of slag. • Based on physical, chemical and compressive strength testing, EAF slag has the potential as a suitable raw material to use as coarse aggregates in concrete, while LF slag is suitable for application as cementitious binder. • Further experiments on progress. • Project in progress and expected to be completed in October 2021.
33	Integrated cost effective technology for attaining Zero liquid discharge in steel plants with emphasis on slag utilization	CIMFR	**23.24**	• Start Date: October 2018 • Scheduled Completion Date: Oct 2020	Prof Pallabi Das, pallabidas@cimfr.nic.in, Tel: 9654979245	• Experiments are on progress on identification of different wastewater matrix that can be removed by slag. Wastewater characterization is in progress. Stage-wise remediation studies are being undertaken. • Experimentations are ongoing, to explore possibility of value added product recovery viz. ammonia recovery, extraction of silicate from steel slag. • Procurement of lab equipment in progress. • Project in progress and expected to be completed in October 2020.
34	Synthesis of Kudremukh Iron Ore Mine Tailings based Geopolymer Aggregate using Fly Ash as Precursor in Construction Industry	KIOCL & DCE, Bangalore	**11.20260**	• Start Date: December 2018 • Scheduled Completion Date: Dec 2020	K V Bhaskara Reddy, GM (Mining & Exploration) Mob: 9611127688 bnbd@kioclltd.com Dr.H.K.Ramaraju Professor & Head DCE, Mob: 8026662226, hkramaraju@gmail.com ashasavi@gmail.com	• Collection of fly ash, bottom ash from Raichur thermal power plant and Kudremukh iron ore mine tailings from lakya dam, Karnataka. • Detailed Characterization of iron ore tailing and fly ash for physical, chemical and mineral properties. • Experiments on progress to identify the optimum mix to synthesize an appropriate geopolymer precursor. • Experiments are in progress to examine addition of geopolymer aggregates in concrete mix and study short-term (28 days) and long-term (6-8 months)

						Engineering integrity. • Project in progress and expected to be completed in December 2020.
35	Waste Management of Generated Sludge from Indian Steel and Steel Related Plants: A Sustainable Business Model	BITS-Pilani, Hyderabad Campus	**38.05**	• Start Date: November 2018 • Scheduled Completion Date: Oct 2021	Prof. Srikanta Routroy, BITs Pilani, srikanta@pilani.bits-pilani.ac.in, Mobile: 09694096456	• Pickling sludge samples had been collected from common effluent treatment plants situated at Bhiwadi. • Electroplating sludge sample had been collected from Jaquar & Company Private Limited., Bhiwadi. • Physico-chemical analysis of the collected sludge carried out. • Concrete cubes were casted from pickling sludge and electroplating sludge. Testing in progress • Balance work: Development of Value added products shall be explored using different types of sludge and slag and mixing with copper slag. • Balance Work: Estimation of the total supply chain cost and environmental impact analysis from sludge to value added product(s). • Project in progress and expected to be completed in October 2021.
36	Development of a cost effective refractory lining materials for induction melting furnace suitable for production of quality steel: phase-II (Industrial Trials)"	NISST, CGCRI & NML	269.00	• Start Year: 2019-20 • Completion Schedule: 2022-23	Director NISST, director@nisst.org	• Project initiated and in progress.
37	Indigenous development of Austempered Ductile Iron technology for use in automobile & agricultural industries in India	PEC Chandigarh	149.00	• Start Year: 2019-20 • Completion Schedule: 2022-23	Dr. Uma Batra (PhD Metallurgy) Prof. & Head Materials & Metallurgical Engg. Punjab Engineering College umabatra2@gmail.com	• Project initiated and in progress.