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Canadian Iron and Steel Energy Research Association

CISERA

2024-2025 Annual Report
(April 1, 2024-March 31, 2025)

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The Canadian Iron and Steel Energy Research Association (CISERA) was formed on September 2, 1965 – providing over 60 years of Research supporting the Canadian Coal and Carbonization Industries

CISERA

CHAIR'S REMARKS

In order to encompass, emphasize and promote the additional areas of research the association has been focusing on, the name of the CCRA (Canadian Iron and Steel Energy Research Association) has been updated. In an effort to better reflect the work we are now conducting in order to meet the Canadian 2050 GHG targets we agreed that a more suitable name would be the Canadian Iron and Steel Energy Research Association (CISERA). This does not change the history of this rich and valuable association but better reflects the new goals that are needed to meet our members needs of the future.

Since its inception in 1965, the Canadian Iron and Steel Energy Research Association (CISERA) has provided a valuable framework for technical cooperation between government and industry, which has been very successful for all parties. CISERA is a unique organization in the fact that it is Canada's only technical support for the Canadian metallurgical coal and coking industries. This organization continues to be of extreme value to its member companies and to the financial health of the associated industries as we transition to a net-zero world. The value of its research continues to be recognized and appreciated on an international basis.

The key role of CISERA is to strive to meet its members' technological needs in an ever-changing world. Its research program continues to evolve as the demands of the coal, cokemaking and ironmaking industries change with the environmental pressures facing Canada and the world. GHG reduction in heavy industries including steel, cement and limestone are major area of focus. It was announced in 2021 that two of the three integrated steel companies in Canada are targeting >60% GHG reductions with the transformation from the traditional cokemaking, ironmaking and BOF steelmaking process to EAF technology by 2030. These EAF's will be fed by either direct reduced iron or scrap. Meeting GHG reduction targets for the remaining steel production in Canada via the traditional blast furnace route which will be in operation for years to come will have its own unique challenges. In all cases, biocarbon use, carbon capture and either sequestration or utilization will require further R&D initiatives.

Overall, CISERA will continue to be visionaries during this transformational change period and will help industry prepare for the future. The Canadian Steel Producers Association (CSPA) has recognized the CISERA as a technical leader in research and implementation of solutions and is now their technical branch for their members going forward. CISERA has a long history and successful collaboration with CanmetENERGY-Ottawa in technology development. This collaboration will continue and has been extended to include other Canmet Laboratories including NRCan (CanmetENERGY-Ottawa, CanmetENERGY-Varennes and CanmetMATERIALS-Hamilton) to work with their experts on the broader scope of technology transformation and implementation for coal producers, steel producers, and other heavy industries. There are numerous scientific experts working at CanmetENERGY on decarbonization and these resources will be relied upon to further advance the CISERA R&D program.

The CISERA program continues to be updated to meet the current needs of its members as well as future challenges. It must be noted that the CISERA will continue to support the very important coal and cokemaking sector in Canada. However, CISERA has also recognized that the R&D program must also include GHG reduction initiatives for its members and other heavy industries. This aligns with Federal Government policy and direction.

The Net Zero Emission Process Development program continues to be a key area of focus for our research, as well as Blast Furnace process enhancement. Areas of focus for CISERA research includes:

Blast furnace process enhancement

- Fundamentals of coal science
- Blast furnace carbon efficient enhancement

Net Zero Emission Process Development

- Supply of Alternate Reductants and Alternative Fuels
- Utilization of Alternative Reductants (Biocarbon, H2, Electrons)
- Utilization of Alternate Heating (Renewable Fuels and Non-Emitting Electricity)
- CO2 Capture, Utilization, Transportation and Storage
- System Integration and Optimization

CISERA will continue to advance technologies that will support our members GHG reduction initiatives today and into the future. We look forward further exploring these new technical challenges and developing new partnerships as we transform our program. It is important to include other industries facing similar technical challenges and GHG reduction goals. Co-operation is key and CISERA will be active in including these partners.

Finally, it is important that we continue sharing our research findings with colleagues and industry across the globe. CISERA has again published its work in several international journals and will continue to present papers at both domestic and international conferences.

Globally, CISERA is autonomous in its ability to continue to expand and meet its members' requirements. The remarkable co-operative relationships between the coal industry, steel industry and government are truly unique, and the CISERA R&D technical program will strive to address and reflect its members needs for years to come.

Jason Halko

Jason Halko,
Chair, Board of Directors

TECHNICAL COMMITTEE REPORT

TECHNICAL COMMITTEE MEETINGS

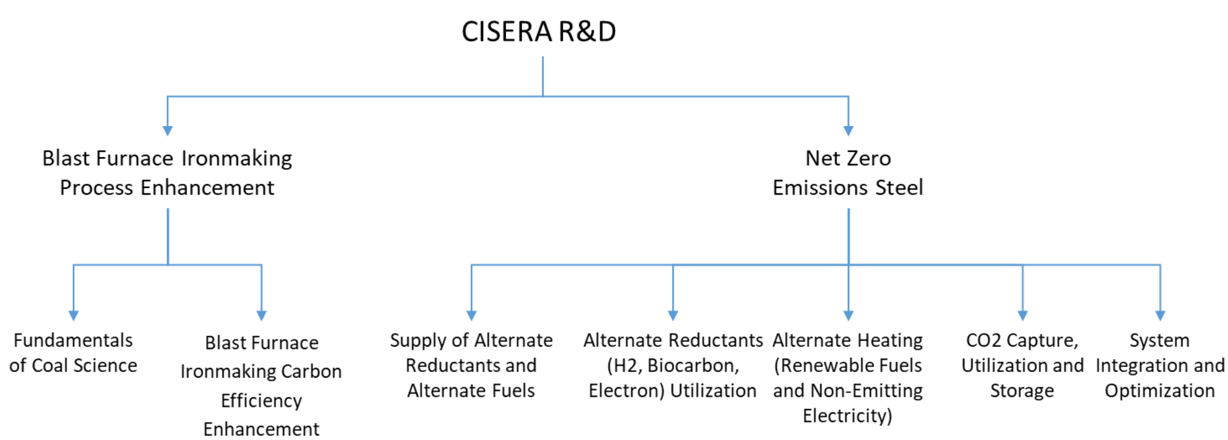
The CISERA Technical Committee held four meetings during Fiscal Year 2024-2025:

Meeting No.	Location	Date
267	CanmetENERGY Ottawa	June 4-5, 2024
268	CanmetENERGY Ottawa	October 2-4, 2024
269	CanmetMATERIALS Hamilton	December 10-11, 2024
270	CanmetENERGY Ottawa	March 11-12, 2025

CISERA Research Program Update

One of the keys for CISERA success is its ability to manage the change in industry priorities. With the announcement of CSPA in achieving net-zero CO2 emissions by 2050, the priority of the steelmaking members is decarbonization of their production processes. It was also recognized that support for the coal industry and BF/BOF steel producing members will continue as coke will be essential for decades to come. Hence, the CISERA program is updated to meet the current challenges. The Net Zero Emission Process Development program was added to the existing Blast Furnace Process Enhancement program. The new CISERA program consists of the following:

- **Blast furnace process enhancement**
  - Fundamentals of coal science
  - Blast furnace ironmaking process carbon efficient enhancement
- **Net Zero Emission Process Development**
  - Supply of Alternate Reductants and Alternative Fuels
  - Utilization of Alternative Reductants (Biocarbon, H2, Electrons)
  - Utilization of Alternate Heating (Renewable Fuels and Non-Emitting Electricity)
  - CO2 Capture, Utilization, Transportation and Storage
  - System Integration and Optimization



The table below shows the status of projects in the **Blast Furnace Process Enhancement** Program

Sub Program	Project	Status
Fundamental of Coal Science	CISERA 54: ISO and ASTM Coal and Coke Standards	Active
	CISERA 80: Characterization of Coal Washing Plant Streams and Product Quality Upgrade	Not Active
	CISERA 81: Mineral Matters in Western Canadian Coal	On Hold
	CISERA 86: Performance of Canadian Coals in High Inert Blends	Completed
	CISERA 87: Technical Merits of Western Canadian Coals	Completed
	CISERA 90: Exploration Sample Assessment for Current and New Coal Mines in Canada	Active
	CISERA 93: Performance of Western Canadian Coal in Stamp Charge	Active
	CISERA 94: New Project Development: Semifusinite	Active
Blast Furnace Ironmaking Process Carbon Efficiency Enhancement	CISERA 82: Factors Affecting Coke Bed Permeability	Completed
	CISERA 84: Coke Degradation Mechanisms	Active
	CISERA 88: Application of Small-Scale Coking	On Hold
	CISERA 91: Blast Furnace Energy Reduction Initiatives using Auxiliary Fuel Injection	Completed

Publications:

During FY 2024-25, CISERA published 6 papers.

- Relationship between coking properties measured by automatic Sapozhnikov plastometer with other measurements, International Journal of Coal Preparation and Utilization, https://doi.org/10.1080/19392699.2024.2402438
- Evaluation of Biochar and Coke Blends for Slag foaming applications in EAF Steelmaking, Steel Research International; https://doi.org/10.1002/srin.20240051
- Solid carbonaceous materials transformation during pulverized coal and natural gas co-injection, Ironmaking & Steelmaking, https://doi.org/10.1177/03019233241259298
- Effect of Biocarbon Incorporation in Cokemaking and Resultant Coke Properties, International Conference on Sustainable Cokemaking and Ironmaking (ICSCI 2025), 16-19 March 2025 - Newcastle, Australia
- Interaction between Biogenic Carbon and Electric Arc Furnace Slag, International Conference on Sustainable Cokemaking and Ironmaking (ICSCI 2025), 16-19 March 2025 - Newcastle, Australia
- An Experimental Setup and Investigation on Biochar Blends for Slag Foaming Applications, 13th European Electric Steelmaking Conference, 3-7 June 2024, Philharmonie Essen, Germany

1. Fundamentals of Coal Science

CISERA 54: ISO and ASTM Coal and Coke Standards

The effect of sample particle size on rheological properties (Gieseler plasticity and Ruhr dilatation) measurement results was studied in detail. Samples examined included Western Canadian coal, Appalachian coal and coal blends containing both Canadian and US coals. The results showed that the sample particle size significantly affects the measured values of maximum fluidity and dilatation. However, the melting range and T3-T1 were found relatively insensitive to variation in sample particle size. Experimental efforts highlighted the importance of sample preparation on rheological properties measurement consistency. To further elaborate, rheological properties on purposely over-crushed samples were conducted to illustrate the importance of sample preparation. Furthermore, sample particle size distribution in ISO standards related to plasticity and dilatation measurements were reviewed. It was proposed to specify test sample particle size distribution to eliminate effect of sample preparation on ASTM rheological properties measurement. Experimental measurement results will be published and will be shared with ASTM D05 for refinement of ASTM rheological properties measurement procedures.

CISERA 81: Mineral Matters in Western Canadian Coal

The project was put on hold due to lack of expertise and equipment for mineral matters characterization in coal and coke.

CISERA 87: Technical Merits of Western Canadian Coals

The works on western Canadian and US Appalachian coal were completed. The intent was to obtain Australian coal samples to complete the study. Multiple attempts were made for exploring the possibility in obtaining Australian coal without success. The project was put on-hold as inactive project until the challenges in Australian coal sample acquisition was resolved.

CISERA 90: Exploration Sample Assessment for Current and New Coal Mines in Canada

This project consists of two parts:

A. Development of water base Roben Jig washing technology for preparation of clean coal composite sample for properties assessment.

B. Identification of alternate liquid for coal washability study to replace hazardous organic liquid.

Part A was completed and the usefulness of Roben Jig for preparation of clean coal composite for properties assessment and carbonization test were successfully demonstrated. However, it was observed that the data generated from Roben Jig washing is insufficient for washing plant design. Therefore, float/sink washability study using organic liquid is still necessary. Due to the hazardous nature of organic liquid commonly used in float/sink washability study, it is desired to identify an alternate liquid to improve health and safety of the task.

Product of Halocarbon was identified as potential candidate for replacement of organic liquid for coal washability study. Halocarbon sample was received from the manufacturer and experimental works were conducted to evaluate its performance in float/sink washability study. Clean coal composite samples were prepared by washing with the conventional organic liquid and the alternate liquid. Sole-heat oven carbonization tests were conducted for evaluation of the effect of washing liquid on resultant coke quality.

Besides coke quality, the texture analysis of the resultant cokes was conducted to compare the effect of washing liquid on detail coke characteristics.

CISERA 94: Semifusinite

Based on the preliminary exploration works conducted, the goal of this project was developed:

- To determine the mechanism of transformation of both partially and completely fusible semifusinite in WCC coals in comparison to Appalachian coals.
- To understand the role of measured rheological and petrographic properties of semifusinite transformation during coking.
- To determine the binder and filler phases that semifusinite transforms into from partial and complete fusible macerals.

A comprehensive literature review was conducted, and 2 immediate tasks were identified to initiate the research activities.

- Task 1: Analysis Techniques Development.
- Task 2: Macerals Chemical Composition/Structure Characteristics and Behavior Observation.

The goal of the above tasks is to identify equipment suitable for observing and characterizing macerals behaviors during coal to coke transformation. The usefulness of numerous analytical equipment in different universities and research institutions was explored. It was concluded that capability in direct microscopic observation of maceral transformation is essential. Hence, CISERA was committed to purchase a hot stage to be installed in Metallurgical Fuels Lab microscopic laboratory for enabling direct observation of maceral transformation. The equipment procurement is undergoing.

In parallel with the above efforts, TGA analysis of the devolatilization behavior of coal during coking was conducted. It was observed that majority of volatile matters released occurred at above Gieseler re-solidification temperature. Since the release of volatile matters is an outcome of macerals transformation, the observation suggested that majority of macerals transformation occurred during semi-coke to coke transformation. Further experimental works will be conducted by carbonizing coal to different stages of coking for detail examination of macerals transformation.

2. Research Program: Blast Furnace Ironmaking Process Carbon Efficiency Enhancement

CISERA 84: Coke Degradation Mechanisms

The tensiometer was successfully set up and commissioned in Metallurgical Fuel Lab. The equipment enables direct observation of the sample upon heating. Using the tensiometer, the expansion and contraction behavior of coal samples during heating was examined. The behaviors of US-HV, US-LV, WCC and 2 coal blends were studied and compared. The coal samples were compacted into a cylindrical pellet (D: 6 mm; H: 3mm) and heated in inert gas atmosphere. The changes in volume during experiments were measured by image analysis. The experiments revealed the difference in expansion followed by contraction behaviors between samples. Coupling with the TGA analysis results, the evolution of sample density during coking can be calculated. Further experimental work will be conducted to study contraction behavior and its relationship with fissuration and resultant coke quality.

CISERA 88: Application of Small-Scale Coking

No activity was conducted in FY 2024-25.

CISERA 93: Performance of Western Canadian Coal in Stamp Charge

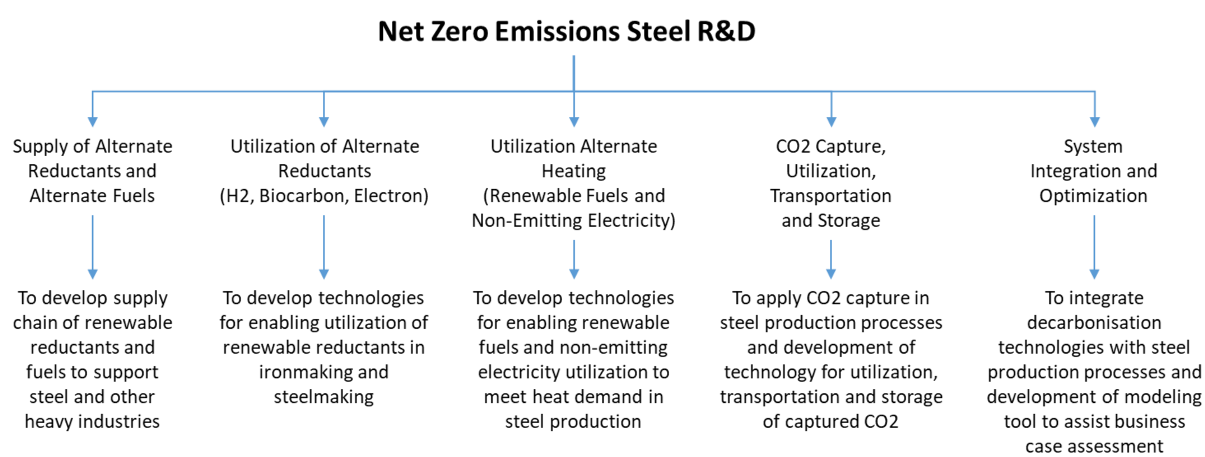
One of the barriers preventing progress of this project is the capability in densifying coal to the desired >1000kg/m3 dry bulk density for conducting carbonization test using the 350 kg capacity pilot scale oven in Canmet. With the available of TSR 90 kg coke oven, this barrier can be relatively easier to overcome. In preparation of further test work, the previous stamp charge work conducted at TSR and Canmet were revealed. It was clearly shown that the increase in bulk density increases ASG of resultant coke, hence coke quality increases. Despite the challenges in materials handling is relatively smaller using the TSR oven, there are still operating issues to be overcome in conducting experimental work at high bulk density.

The effect of WCC incorporation on coal blend stampability was studied. The methodology for studying soil compaction was adopted for quantifying coal blend stampability. Coal blend samples with and without WCC is compacted with same energy input. The compacted coal bed density and compressive strength were measured and compacted. It was observed that incorporating WCC enhanced the stampability of the coal blend. In other words, high bulk density and coal bed with high strength were obtained with the same compacting energy input.

3. Research Program: Net Zero Process Development

Steel Decarbonization R&D Pillars

Decarbonization of steel production requires a combination of different technologies and requires expertise from different fields. To coordinate various efforts, the 5 pillars of R&D activities have been established. The purpose of this effort is for grouping of expertise for coordination of effort to accelerate decarbonization technologies development.



Leads of each pillar were appointed as follows:

- Alternate reductants/fuels supply: Peter Gogolek
- Alternate reductants utilization: Ka Wing Ng
- CCUS: Nicole Bond
- System integration and optimization: Milad Aghabararnejad

The leads have developed a 1-pager summary of scope of research activities in each pillar. The research activity scopes were presented in TC 267 and shared with CSPA for dissemination via CSPA and CISERA websites.

The progress in research activities was disseminated to industrial partners via TC meetings. A total of 26 presentations were discussed in TC meetings. The discussions covered a wide spectrum of research activities including biocarbon standards development, activities to address technical challenges of utilization of biocarbon, application of CCUS etc. The efforts informed industrial partners on the latest technologies development to achieve the goal of decarbonization.

An important outcome of the efforts was promoting collaboration between research groups in Canmet. As an example, 4 research groups were engaged to address the technical challenges in biocarbon utilization for slag foaming in EAF steelmaking. It successfully demonstrated collaboration was essential in advancement of technology and significant progress was achieved.

The collaborative efforts were further extended to engage academic researchers. Researchers from 3 universities, U of T, McMaster U, UQAC were invited to discuss their efforts on industrial decarbonization. The goal is to enhance awareness of research activities between researchers. Through these efforts, CISERA Technical Committee meetings are established as a platform for sharing information and avoid duplication to acceleration decarbonization technologies development.

4. CanmetENERGY Met Fuels Lab Facilities

Annual MWO Benchmarking

Annual benchmarking of the Canmet MWOs is conducted to ensure the reliability of the equipment. No issues were seen in the results.

CanmetENERGY-Ottawa Met Fuels Facilities Utilization:

Table 1 - Utilization of CanmetENERGY Facilities
2023-2024 vs 2024-2025

Utilization of CanmetENERGY Facilities								
Oven	**Coal Companies**		**Steel Companies**		**CISERA Research**		**Totals**	
	Sole – Heated Oven							
	2023-2024	**2024-2025**	**2023-2024**	**2024-2025**	**2023-2024**	**2024-2025**	**2023-2024**	**2024-2025**
SHO1	71	69	46	28	6	7	123	104
SHO2	91	64	23	17	3	2	117	83
Total SHO	**162**	**133**	**69**	**45**	**9**	**9**	**240**	**187**
	Movable Wall Oen							
18 Inch	0	1	22	14	4	2	26	17
Carbolite	136	120	0	0	2	0	138	120
Total MWO	**136**	**121**	**22**	**14**	**6**	**2**	**164**	**137**
	CSR							
CSR	147	119	6	4	20	8	173	131
SHO CSR	25	20	25	14	7	7	57	41
Total CSR	**172**	**139**	**31**	**18**	**27**	**15**	**230**	**172**
	Other							
PCI Rig	**0**	**0**	**0**	**3**	**0**	**0**	**0**	**3**
HT Furnace	**0**	**0**	**3**	**3**	**1**	**0**	**4**	**3**

OTHER BUSINESS

1. **CISERA Technical Roadmap**
    a. The roadmap was reviewed and aligned with the Technical Committee planning table. The research activities/streams have been reorganized and updated to better reflect current project work.
    b. The CISERA BOD is responsible for updating and planning the roadmap for the Technical Committee.
    c. The roadmap was continually updated to address the R&D needs for achieving the steel industry goal of net zero emission in 2050 while continue to provide support on coal and coke research.

2. **CISERA Research Program**
    a. Progress in all CISERA projects now being tracked with A3 plans and planning table.

3. **CanmetENERGY Met Fuels Activities**
    a. Revenues for 2024-25, $2.8M

4. **CanmetENERGY Met Fuels Facilities Upgrade**:
    a. The set up of a new facility for iron ore pellet reduction in DRI process conditions is undergoing for research in steel decarbonization.

5. **CISERA Documents Management**
    All CISERA documents are stored in Google drive to allow easy access by all members. A link was provided in the CISERA website members only area to access all documents.
    https://www.cisera.ca/members/

    Documents include:

    i. Technical committee meeting minutes
    ii. Board of Director meeting minutes
    iii. Annual reports
    iv. A3 plans
    v. Publications
    vi. Technical projects progress reports

6. **CISERA website**
    The CISERA website https://www.cisera.ca was completely redesigned and fully implemented. The website is managed and maintained by Fullview Design, a website development company in Ottawa.

Roben Jig tube filled with coal and water and ready to be jigged.

Technicians getting ready to invert the jig tube holding jigged coal.

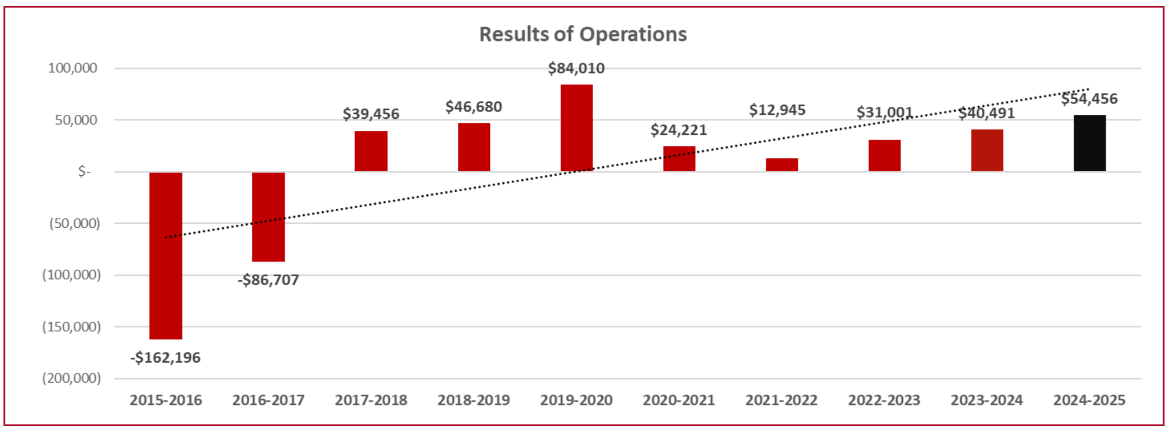
The first slice of coal is ready to be removed from the cylinder. It has been pushed up from the bottom and will be scraped off into a weighing container for Apparent Relative Density test.

FINANCIAL YEAR IN REVIEW

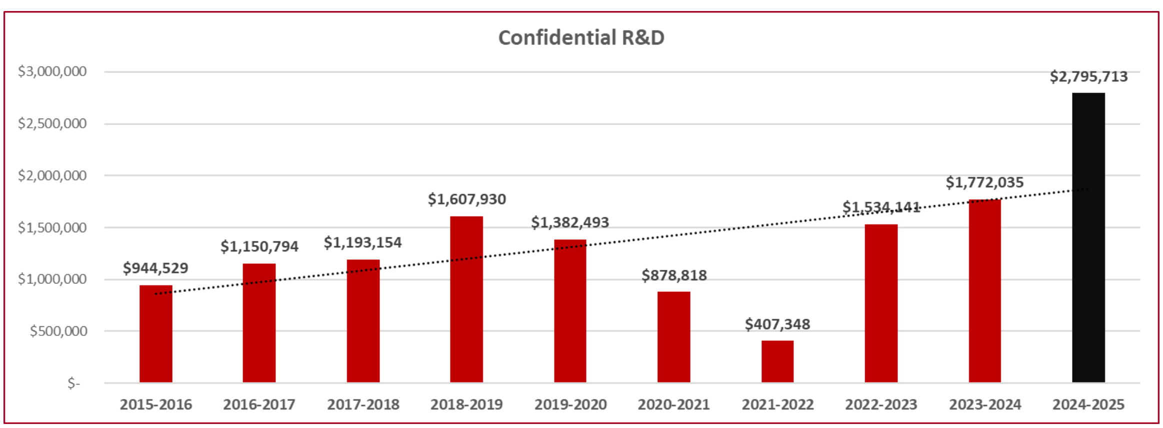
The following provides an overview of the financial performance of the Canadian Iron & Steel Energy Research Association (CISERA) during the 2024–2025 fiscal year, as well as key trends over the past decade. The summary highlights revenue, expenses, and the overall financial health of the organization.

CISERA concluded the 2024–2025 fiscal year with an operating surplus of **$54,456**, an increase from the **$40,491** surplus reported in the prior year. This growth was primarily driven by higher interest income, resulting from larger temporary cash balances associated with an exceptional level of confidential research and development testing and a reduction in administrative costs. Membership levels remained steady at five members, with no changes in research levies or membership fees. However, membership is projected to decline by two members in 2025–2026, largely due to economic challenges arising from the introduction of U.S. tariffs.

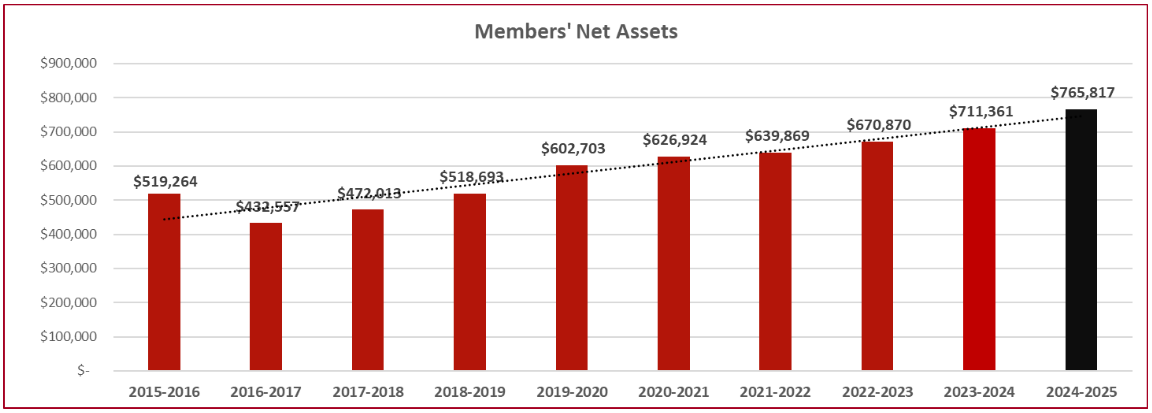
CISERA's financial strategy is designed to generate modest annual operating surpluses while channeling the maximum possible resources toward research initiatives, including ongoing support for CANMET.



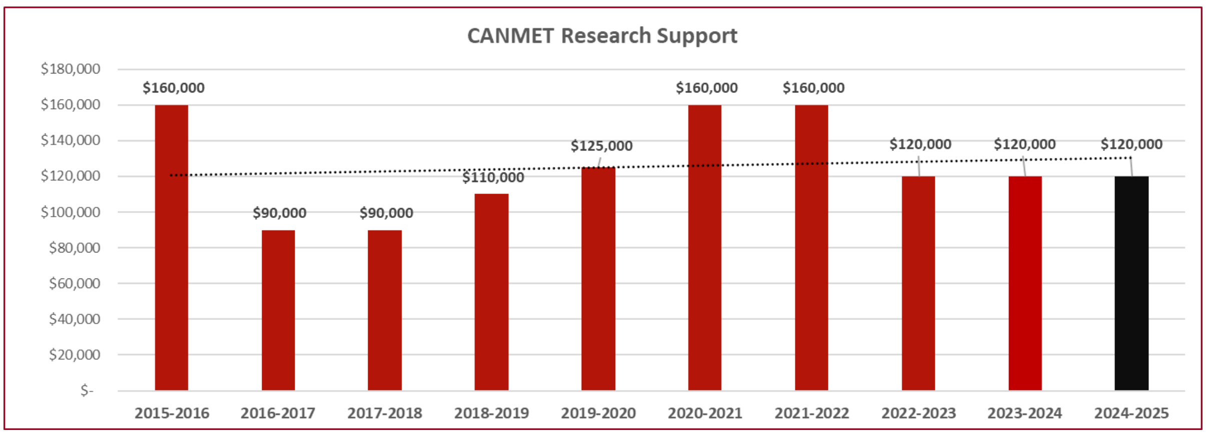
This year, CISERA achieved a record volume of confidential research and development testing, totaling **$2,795,713**—the highest level recorded since 2015–2016. This extraordinary activity was largely attributable to a one-time surge of testing from a single member in response to corporate reorganization.



At year-end, Members' Net Assets totaled **$765,817**, representing a 7.7% increase over the previous year. Over the past decade, CISERA has intentionally managed its Members' Net Assets to maintain financial stability during periods of reduced membership or economic downturns. This prudent approach has enabled CISERA to sustain its operations and research mandate uninterrupted, even during challenging economic cycles. Entering the upcoming period of reduced membership, CISERA remains financially strong and well-positioned to continue its work.



Despite the decline in membership contributions attributable to membership levels, CISERA has maintained its commitment to research support, contributing **$120,000** annually to the CANMET program for each of the last three fiscal years.



Administrative costs continue to be tightly managed. In 2024–2025, overhead expenses totaled **$42,988**, reflecting a reduction of **$2,362** (5.2%) from the prior year. This disciplined approach underscores CISERA's commitment to minimizing overhead in order to maximize funding available for research and development.

In summary, CISERA's strong financial performance in 2024–2025 has reinforced its stable financial position while ensuring the long-term sustainability of its research mandate in collaboration with CanmetENERGY.

Brian D'Amboise, CPA, CA
Treasurer

AUDITED FINANCIAL STATEMENTS

CRAWFORD
SMITH &
SWALLOW

CANADIAN IRON & STEEL ENERGY RESEARCH ASSOCIATION

Financial Statements

March 31, 2025

CRAWFORD
SMITH &
SWALLOW

CANADIAN IRON & STEEL ENERGY RESEARCH ASSOCIATION

Financial Statements

March 31, 2025

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CRAWFORD
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INDEPENDENT AUDITOR'S REPORT

To the Members of the
Canadian Iron & Steel Energy Research Association

Opinion
We have audited the financial statements of the Canadian Iron & Steel Energy Research Association (the "Association"), which comprise the statement of financial position as at March 31, 2025, and the statements of operations and changes in members' net assets and cash flows for the year then ended, and notes to the financial statements, including a summary of significant accounting policies.

In our opinion, the financial statements present fairly, in all material respects, the financial position of Canadian Iron & Steel Energy Research Association as at March 31, 2025, and the results of its operations and its cash flows for the year then ended in accordance with Canadian accounting standards for not-for-profit organizations.

Basis for Opinion
We conducted our audit in accordance with Canadian generally accepted auditing standards. Our responsibilities under those standards are further described in the *Auditor's Responsibilities for the Audit of the Financial Statements* section of our report. We are independent of the Association in accordance with the ethical requirements that are relevant to our audit of the financial statements in Canada, and we have fulfilled our other ethical responsibilities in accordance with these requirements. We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our opinion.

Responsibilities of Management and Those Charged with Governance for the Financial Statements
Management is responsible for the preparation and fair presentation of these financial statements in accordance with Canadian accounting standards for not-for-profit organizations, and for such internal control as management determines is necessary to enable the preparation of financial statements that are free from material misstatement, whether due to fraud or error.

In preparing the financial statements, management is responsible for assessing the Association's ability to continue as a going concern, disclosing, as applicable, matters related to going concern and using the going concern basis of accounting unless management either intends to liquidate the Association or to cease operations, or has no realistic alternative but to do so.

Those charged with governance are responsible for overseeing the Association's financial reporting process.

Auditor's Responsibilities for the Audit of the Financial Statements

Our objectives are to obtain reasonable assurance about whether the financial statements as a whole are free from material misstatement, whether due to fraud or error, and to issue an auditor's report that includes our opinion. Reasonable assurance is a high level of assurance, but is not a guarantee that an audit conducted in accordance with Canadian generally accepted auditing standards will always detect a material misstatement when it exists. Misstatements can arise from fraud or error and are considered material if, individually or in the aggregate, they could reasonably be expected to influence the economic decisions of users taken on the basis of these financial statements.

As part of an audit in accordance with Canadian generally accepted auditing standards, we exercise professional judgment and maintain professional skepticism throughout the audit. We also:

a) Identify and assess the risks of material misstatement of the financial statements, whether due to fraud or error, design and perform audit procedures responsive to those risks, and obtain audit evidence that is sufficient and appropriate to provide a basis for our opinion. The risk of not detecting a material misstatement resulting from fraud is higher than for one resulting from error, as fraud may involve collusion, forgery, intentional omissions, misrepresentations, or the override of internal control.

b) Obtain an understanding of internal control relevant to the audit in order to design audit procedures that are appropriate in the circumstances, but not for the purpose of expressing an opinion on the effectiveness of the Association's internal control.

c) Evaluate the appropriateness of accounting policies used and the reasonableness of accounting estimates and related disclosures made by management.

d) Conclude on the appropriateness of management's use of the going concern basis of accounting and, based on the audit evidence obtained, whether a material uncertainty exists related to events or conditions that may cast significant doubt on the Association's ability to continue as a going concern. If we conclude that a material uncertainty exists, we are required to draw attention in our auditor's report to the related disclosures in the financial statements or, if such disclosures are inadequate, to modify our opinion. Our conclusions are based on the audit evidence obtained up to the date of our auditor's report. However, future events or conditions may cause the Association to cease to continue as a going concern.

e) Evaluate the overall presentation, structure and content of the financial statements, including the disclosures, and whether the financial statements represent the underlying transactions and events in a manner that achieves fair presentation.

We communicate with those charged with governance regarding, among other matters, the planned scope and timing of the audit and significant audit findings, including any significant deficiencies in internal control that we identify during our audit.

St. Catharines, Ontario
August 13, 2025

CRAWFORD SMITH & SWALLOW
CHARTERED PROFESSIONAL ACCOUNTANTS LLP

LICENSED PUBLIC ACCOUNTANTS

CANADIAN IRON & STEEL ENERGY RESEARCH ASSOCIATION

STATEMENT OF FINANCIAL POSITION

March 31, 2025

Assets	2025 $	2024 $
Current Assets		
Cash	16,575	31,024
Short-term investments - note 2	877,732	881,749
Accounts receivable	645,482	
Prepaid expenses	1,151	15
	1,540,940	**912,788**
Liabilities and Members' Net Assets		
Current Liabilities		
Accounts payable and accrued liabilities	11,025	21,037
Government remittances payable	8,416	14,990
Due to CANMET	675,482	30,000
Deferred revenue	80,200	135,400
	775,123	201,427
Members' Net Assets	765,817	711,361
	1,540,940	**912,788**

Signed on behalf of the Board:

________________ Director

________________ Director

See accompanying notes

CANADIAN IRON & STEEL ENERGY RESEARCH ASSOCIATION

STATEMENT OF OPERATIONS AND CHANGES IN MEMBERS' NET ASSETS

for the year ended March 31, 2025

	2025 $	2024 $
Revenue		
Confidential research and development	2,795,713	1,772,035
Research levies	175,000	175,000
Membership fees	500	500
Interest income	49,722	38,341
	3,020,935	1,985,876
Operating Expenses		
Confidential research and development	2,795,713	1,772,035
CANMET research support	120,000	120,000
Outside research	7,778	8,000
Office	19,868	19,038
Professional fees	21,060	24,352
Insurance	2,060	1,960
	2,966,479	1,945,385
Excess of Revenue over Expenses for the Year	54,456	40,491
Members' Net Assets, Beginning of Year	711,361	670,870
Members' Net Assets, End of Year	**765,817**	**711,361**

See accompanying notes

CANADIAN IRON & STEEL ENERGY RESEARCH ASSOCIATION

STATEMENT OF CASH FLOWS
for the year ended March 31, 2025

	2025 $	2024 $
Operating Activities		
Excess of revenue over expenses for the year	54,456	40,491
Changes in working capital components - note 3	(72,922)	(2,779)
Funds provided (used) by operating activities	(18,466)	37,712
Investing Activity		
Purchase of short-term investments	4,017	(24,147)
Increase (Decrease) in Cash Position	(14,449)	13,565
Cash, Beginning of Year	31,024	17,459
Cash, End of Year	**16,575**	**31,024**

See accompanying notes

CANADIAN IRON & STEEL ENERGY RESEARCH ASSOCIATION

NOTES TO FINANCIAL STATEMENTS

for the year ended March 31, 2025

Organization

Canadian Iron & Steel Energy Research Association (formerly known as Canadian Carbonization Research Association) (the "Association") is a national organization with the purposes to conduct research and development having particular importance to the coal and carbonization industries of Canada; to coordinate and support Canadian carbonization research in and as it relates to steel, foundry, smelting and coal industries; to affliliate with national and international organizations or associations having similar objectives; and to affiliate with industries, academia and engineering of decarbonization and/or greenhouse gas emissions reduction strategies and solutions. The organization was incorporated under the Canada Corporations Act as a not-for-profit association in July 1981. In January 2014, the Association was issued a Certificate of Continuance under the Canada Not-for-Profit Corporations Act.

1. Significant Accounting Policies

The financial statements of the Association are the representations of management prepared in accordance with Canadian accounting standards for not-for-profit organizations, consistently applied. Because a precise determination of many assets and liabilities is dependent upon future events, the preparation of periodic financial statements necessarily involves the use of estimates and approximations. These have been made using careful judgement in the light of available information. The financial statements have, in management's opinion, been properly prepared within reasonable limits of materiality and within the framework of the accounting policies summarized below:

Financial reporting framework

The Association, being a not-for-profit organization, chose to establish their financial statements in accordance with Canadian accounting standards for not-for-profit organizations, issued by the Chartered Professional Accountants of Canada.

Revenue recognition

Revenue from memberships is recognized over the membership term. Revenue related to memberships received in advance of the fee being earned or the service is performed is deferred and recognized when the fee is earned or service performed. Research levies are recognized in the fiscal year for which they have been assessed. Confidential research and development revenues are recognized when the related services are provided. Interest income is recognized in the period it is earned.

Financial instruments

The Association's financial instruments consisting of cash, short-term investments, accounts payable and accrued liabilities and due to CANMET are initially measured at fair value on acquisition and are subsequently measured at amortized cost. Transaction costs and financial fees associated with financial instruments carried at amortized cost are recorded as adjustments to the initial fair value recognized, and amortized over the life of the financial instrument.

CANADIAN IRON & STEEL ENERGY RESEARCH ASSOCIATION

NOTES TO FINANCIAL STATEMENTS

for the year ended March 31, 2025

1. Significant Accounting Policies - continued

Foreign currency translation

These financial statements are presented in Canadian dollars. Assets and liabilities denominated in foreign currencies are translated at the exchange rates in effect at the statement of financial position date. Revenue and expenses are translated at rates of exchange prevailing on the transaction date. Gains and losses on translation are reflected in excess of revenue over expenses of the period.

2. Short-term Investments

Short-term investments consist of three (2024 - three) guaranteed investment certificates bearing interest ranging between 2.20% and 3.70% (2024 - 4.75% and 4.95%) and mature between January, 2025 and March, 2025 (2024 - December, 2024 and March, 2025). Certain of these certificates bear variable interest rates while some are fixed interest rates. They are subject to insignificant risk of change in value. The cost approximates the carrying value of short-term investments on the statement of financial position.

3. Statement of Cash Flows

Changes in working capital components include:

	2025 $	2024 $
Accounts receivable	(645,482)	
Prepaid expenses	(1,136)	1,080
Accounts payable and accrued liabilities	(10,012)	12,139
Government remittances payable	(6,574)	3,902
Due to CANMET	645,482	(60,000)
Deferred revenue	(55,200)	40,100
	(72,922)	**(2,779)**

4. Financial Risks

Transactions in financial instruments expose the Association to certain financial risks and uncertainties. These risks include:

Interest rate risk

Interest rate risk is the risk that future cash flows of a financial instrument will fluctuate due to changes in market interest rates. The Association holds investments that earn income at varying rates of return which are dependent upon market conditions. Accordingly, the Association is exposed to the effects of fluctuations in market rates. Interest received in the year amounted to $49,722 (2024 - $38,341). As a result of an increase in short-term investments during the year, the Association's exposure to interest rate risk has increased over the prior year.

CANADIAN IRON & STEEL ENERGY RESEARCH ASSOCIATION

UNAUDITED FIVE YEAR FINANCIAL REVIEW

UNAUDITED STATEMENT OF OPERATIONS AND MEMBERS' NET ASSETS

for the year ended March 31, 2025

	2025 $	2024 $	2023 $	2022 $	2021 $
Revenue					
Confidential research and development	2,795,713	1,772,035	1,534,141	407,348	878,818
Research levies	175,000	175,000	180,000	215,000	225,000
Outside research grants					4,958
Membership fees	500	500	600	600	800
Interest income	49,722	38,341	19,469	3,103	6,456
	3,020,935	1,985,876	1,734,210	626,051	1,116,032
Operating Expenses					
Confidential research and development	2,795,713	1,772,035	1,534,141	407,348	878,818
CANMET research support	120,000	120,000	120,000	160,000	160,000
Outside research	7,778	8,000	12,500	16,166	17,074
Office	19,868	19,038	17,884	15,392	23,339
Professional fees	21,060	24,352	15,871	11,140	9,797
Insurance	2,060	1,960	2,813	3,060	2,783
	2,966,479	1,945,385	1,703,209	613,106	1,091,811
Excess of Revenue over Expenses for the Year	54,456	40,491	31,001	12,945	24,221
Members' Net Assets, Beginning of Year	711,361	670,870	639,869	626,924	602,703
Members' Net Assets, End of Year	**765,817**	**711,361**	**670,870**	**639,869**	**626,924**

See accompanying notes

CANADIAN IRON & STEEL ENERGY RESEARCH ASSOCIATION

UNAUDITED FIVE YEAR FINANCIAL REVIEW

UNAUDITED STATEMENT OF FINANCIAL POSITION

as at March 31, 2025

	2025 $	2024 $	2023 $	2022 $	2021 $
Assets					
Current Assets					
Cash	16,575	31,024	17,459	36,898	19,285
Short-term investments	877,732	881,749	857,602	800,850	1,652,111
Accounts receivable	645,482				
Prepaid expenses	1,151	15	1,095	3,087	2,689
	1,540,940	**912,788**	**876,156**	**840,835**	**1,674,085**
Liabilities and Members' Net Assets					
Current Liabilities					
Accounts payable and accrued liabilities	11,025	21,037	8,898	8,510	21,908
Government remittances payable	8,416	14,990	11,088	12,057	14,957
Due to CANMET	675,482	30,000	90,000	80,000	834,796
Deferred revenue	80,200	135,400	95,300	100,400	175,500
	775,123	201,427	205,286	200,966	1,047,161
Members' Net Assets	765,817	711,361	670,870	639,869	626,924
	1,540,940	**912,788**	**876,156**	**840,835**	**1,674,085**

See accompanying notes

CISERA HISTORY

The Canadian Iron and Steel Energy Research Association (CISERA) was formed on September 2, 1965, with the adoption of a Constitution by the Canadian Steel and Coal industries, as a mechanism to promote and establish carbonization research in Canada. Representatives of the major cokemaking steel producers, an independent coke producer, major metallurgical coal miners, coal tar users and the Federal Government Department involved with these Industries were at the table.

The Association's original members were Algoma Steel Corporation, Canmore Mines Ltd, Crows Nest Industries, Dominion Foundries and Steel Limited, Dominion Tar & Chemicals Ltd, Dosco Steel Ltd, The Steel Company of Canada Ltd and The Mines Branch of Energy, Mines and Resources (EMR).

CISERA is a unique co-operative Research and Development effort between Industry and Government, which has become a model for many other industry/government R&D joint efforts. CISERA members and CANMET have a consensus-based program that has and continues to meet its members needs over many fruitful years.

The Canadian Iron and Steel Energy Research Association (CISERA) was formed on September 2, 1965 – 60 years of Research supporting the Canadian Coal and Carbonization Industries

Numerous members have also done and continue to perform many confidential test programs at CANMET to meet their needs directly.

Over the years, CISERA and CANMET have carried out many R&D programs to improve the metallurgical coal and cokemaking operations of its members. Many of these have had far reaching effects which have been well documented in studies carried out by consultants for the government showing the economic effects of the Joint R&D Program (NRCan Audit and Evaluation Branch report, 2001 and PricewaterhouseCoopers report, 2015). The benefits to Canadian industry have been substantial, however, it could not have taken place without the joint efforts of CANMET and CISERA. Having a laboratory to conduct carbonization research is beyond the feasibility of any one company so the single shared Canadian laboratory at Bells Corners in Ottawa, Ontario has allowed the continuation of R&D in this field in Canada.

The fields of R&D covered by the joint CISERA/CANMET program include energy and fuel conservation and efficiency, stabilization of supply, GHG reduction, mining, processing, transportation, production of iron, environment, and safety. At any specific time the R&D program places priority on the most pressing problems while not ignoring the longer term work necessary to progress in the future.

The Early Years

The original members of CISERA and the senior officials of EMR were successful in convincing the Minister of EMR to establish a coal carbonization laboratory in Canada. The first Laboratory was located at The Mines Branch on Booth Street in Ottawa and centered around a 12-inch pilot coke oven and a newly designed sole heated oven. At first, the operation of the equipment was often performed by personnel from CISERA member companies and later CISERA employed personnel for this purpose. In 1968, with the help from CISERA members, a new laboratory facility location was chosen at Bells Corners, 20 km west of downtown Ottawa. EMR provided the building facilities and CISERA members supplied much of the carbonization equipment. A showpiece for the new facility was a new 18-inch movable wall pilot oven. A

30-pound coke oven was also part of the new facilities. In December 1968, the group at the Mines Branch responsible for coal and ironmaking were also relocated to Bells Corners.

Expanding Activities in the 1970s

The coal preparation plant from Booth Street was moved to Clover Bar, just outside Edmonton, AB. Research work was managed by Mr. Jack C. Botham under the direction of the Technical Committee and centered on coal pipelining, additives to coking charges, hot briquetting, formed coke, and petrographic methods for all coals. Arrangements were made to establish a coking facility at Clover Bar to accommodate the Western Canadian Coal producers. Algoma arranged to donate their Koppers pilot coke oven. A mini fluidized bed was constructed for heating coal for hot briquetting as part of the formed coke project and by 1974, this facility was operational. EMR hired Drs. John Gransden and John Price who became the backbone of the Technical program and have gained international recognition as coal carbonization scientists.

In the early 1970s, a major focus for research was the fact that Western Canadian coal contains a significant amount of reactive semi-fusinite compared to traditional Appalachian coals from the USA. During this period, R&D programs focused on petrographic analysis and coking tests helped place Western Canadian coal at the forefront of having excellent coking behaviour and producing excellent coke quality. CISERA has spent much effort explaining the benefits of these coals by using its research program to develop technical projects and has presented numerous papers supporting the technical merits of Western Canadian coals. This work is ongoing today as membership changes.

When the energy crisis developed in 1973-74 concern about energy self-sufficiency and sustainability became very important. This crisis resulted in several oil companies getting involved in the coal mining business. CISERA membership then included Shell Canada, Esso Resources, BP Canada and Gulf Canada.

The organization underwent a substantial change in 1975 when the movable wall coke oven crew switched from being CISERA employees to EMR term employees, to conform with Government policy. CISERA established a new Treasurer system to handle the organization's financial affairs and research funding. This change resulted in the Treasurer's position becoming an appointed officer with full financial authority for the Association. At the time, Mr. George A. Chapman was appointed as Treasurer.

Incorporation of CISERA & Facility Changes – the 1980s

CISERA was incorporated under The Canadian Corporations Act on July 16, 1981, as a non-for-profit Research Association. Letters patent set out the organizational structure with each member company putting forward a representative to the Board of Directors and a Technical Committee member.

The administration of CISERA is the responsibility of the Board of Directors to whom the Officers and other appointed positions report. The objectives of CISERA are set out in the Letters patent:

1. *To conduct Research and Development of importance to the coal and carbonization industries in Canada,*
2. *To co-ordinate and support Canadian carbonization Research in and related to steel, foundry, smelting and coal industries,*
3. *To affiliate with national and international organizations or associations having similar objectives, for the benefit of Canada.*

In the early 1980's, new research studies centered around the correlation of coke and processing conditions from the movable wall oven with that from industrial ovens. Gas and wall pressure measurements in pilot and industrial coke ovens were emphasized. This area of study included a unique study which took place at Algoma Steel's No. 6 coke battery, which was scheduled to be demolished. The study used the battery to carbonize very high-pressure coking blends to determine what the high coking wall pressures would do to an oven and if it could even cause wall failure.

One of the Technical highlights of CISERA at that time was the CISERA/NKK Technical Exchanges between Canada and Japan. Four Technical Exchanges took place, where both sides presented papers on their research work. The delegations generally involved 12 to 15 representatives from each country and was highly successful.

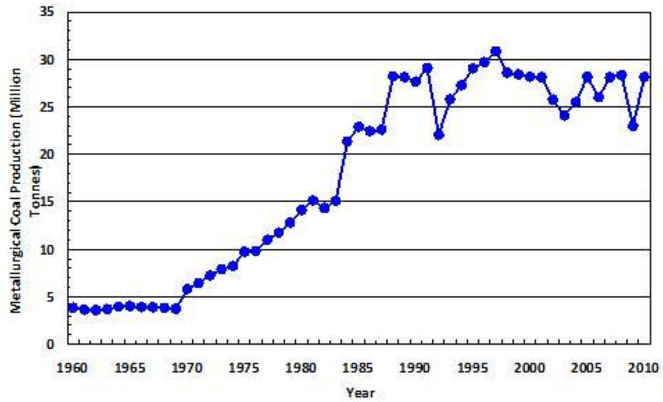
By the latter part of the 1980s, the international energy crisis had subsided, coal and steel prices were dropping, and both industries were entering a period of highly competitive markets. Coal injection into the blast furnace was introduced in Europe and Japan. In that period, many new projects were initiated by the CISERA Technical Committee. Among these were the upgrading of coking quality of Canadian coals through wash plant control, CSR and carbon texture, vertical temperature distribution in a coke oven, and the effect of partial aging/weathering of a component coal on coke quality.

A project to study blast furnace coal injection (PCI) was approved and a special facility was built at Bells Corners. CISERA and Canadian Steel Industries Research Association co-sponsored a study on Strategic Ironmaking with CANMET to review how technologies on ironmaking could evolve in the next 20 years. That study was completed in 1990 and became the road map for the steel industry for many years.

Difficult Times in the Coal and Steel Industries – the 1990s

Canadian coal exports doubled over the 1980s. Research was aimed at reducing the cost of coke and energy for Canadian steelmakers and finding a global niche for Western Canadian coal. With Canadian coke batteries aging, PCI work became very important to coal and steel members. The PCI facilities at Bells Corners was proving its value in the injection program. A CISERA sponsored project at the University of British Columbia on coke oven modeling was completed and the model now resides at CANMET for all to use.

In 1995, CISERA celebrated its 30th anniversary. Because of difficult economic conditions in the Canadian coal and steel industries, membership had declined to eight members and EMR was undergoing a programme review. As a result, CISERA was asked to prepare an impact statement for their review.



History of Metallurgical Coal Production in Canada

By 1997, the CISERA/CANMET fee structure underwent a significant change with confidential oven test work increasing substantially. The Board of Directors approved By-law Number 2 to create a new category of Membership, the Connected Member. This was a category for members who were not financially eligible to join as full members but wished to be part of CISERA.

Consolidation of the Coal Industry and the Challenges of the 2000s

The year 2000 saw another downturn in the steel and coal industries with two of the three Canadian steel members and one coal producer having to discontinue their CISERA memberships because of financial considerations. The reduction in members complicated CISERA's financial situation as the Association had to dip into its limited reserves to maintain its commitments to CANMET. The consolidation of the metallurgical coal producers at the end of 2002 further complicated the financial situation for CISERA as there was now only one coal and one steel member. The Association and CANMET co-operated to keep CISERA as a viable entity and hoped that new members could be attracted when the economy in these industries improved. Dr. Ross Leeder remained as Chair of the Board of Directors and Mr. Ted Todoschuk as Chair of the Technical Committee.

The number of metallurgical coal producers was substantially reduced in 2002 with the formation of Elk Valley Coal, which incorporated most of the producers under one organization. That left but only two members to carry the organization with CANMET. The history of important results on coal blend carbonization and the CANMET database that meet members needs made it an easy decision for the remaining ones to carry on.

The CISERA/CANMET R&D program has provided valuable technical information to the Canadian metallurgical coal industry that is accepted by their international customers as reliable, accurate and unbiased. This has allowed Canadian metallurgical coal to compete on the international market against foreign coals and retain jobs in Canada. The export of Canadian coal generates a significant amount of foreign exchange and assists with Canada's balance of payments. Today, Canada is one of the major exporting countries of metallurgical coal globally.

As CISERA celebrated its 40th Anniversary in 2005, the future looked more promising than it had in the last few years, despite the economic ups and downs of the industries represented by the CISERA. The continued CISERA/CANMET partnership benefited Canada as the participating industries gained new information because of the R&D program. International recognition was achieved for the R&D work performed through the CISERA/CANMET partnership.

International recognition has been achieved for the R&D work performed though the CISERA/CANMET partnership

At the end of 2006, Dr. Ross Leeder, the longest serving member of the Board retired from Elk Valley Coal Ltd. Ross had joined the Technical Committee in 1971 when he was a member of the CANMET staff at Bells Corners. He chaired the Technical Committee before moving to the Board of Directors. Ross became Chair of the BOD in 1989-90 and again in 1999-2006. During the 35 years of his association with CISERA, Ross presented numerous papers on the industry and on the technical merits of Western Canadian coals at Canadian and international conferences.

In 2007, two new coal companies joined as Connected Members, Anglo American Peace River Coal and Western Canadian Coal Corp. and Dr. Barry Ryan, B.C. government geologist, joined as an Individual Connected Member.

In 2008, George Chapman celebrated his 30th anniversary as Treasurer of the Association. Peace River Coal became a full member of the Association and Essar Steel Algoma Inc. joined as a Connected Member. That same year, after a career spanning 35 years, Dr. John Price took retirement from his position as Senior Research Scientist and Manager of Energy for High Temperature Processes at CANMET.

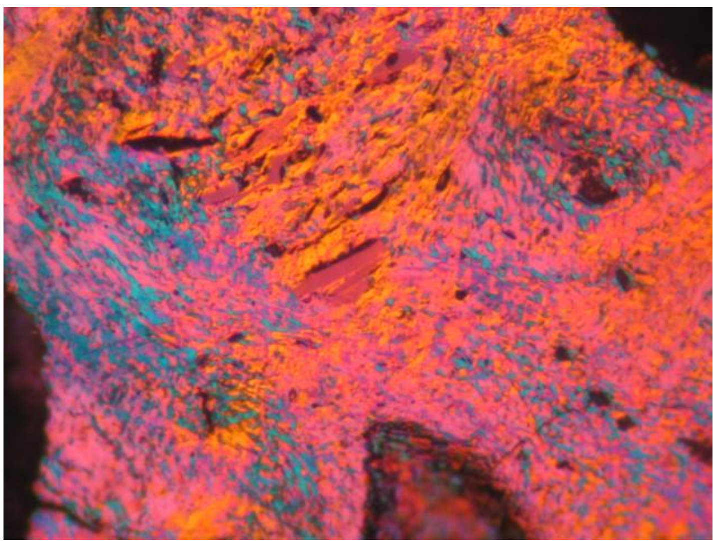
In early 2009, Dr. John Gransden, also Senior Research Scientist in coal carbonization, retired from CANMET. Dr. Gransden received the AIST Joseph Becker Award for career accomplishments in cokemaking research for CISERA and CANMET. The departure of Drs. Price and Gransden, both dedicated research scientists, represented a significant loss to the CISERA within a very short time period. Furthermore, Dr. Barry Ryan retired from the B.C. Government Ministry of Energy, Mines and Petroleum Resources and, as there was no replacement named, the B.C. Government abandoned its membership.

For several years prior to 2008-09, the Greenhouse gas (GHG) file, as driven by the federal government, became a major thrust of the joint R&D program and the research program reflected that reality.

In 2009, the Technical Committee and the Board of Directors spent a significant amount of time and effort gathering information on the development and financing of a pilot Energy Recovery Pilot coke oven for the joint CISERA/CANMET program to examine this alternative/new cokemaking technology. This endeavour is an excellent example of how CISERA adapts to the changes facing industry.

CISERA's 45th Anniversary - 2010

The 45th anniversary of CISERA's foundation was celebrated in 2010. In 2010-2011, the Association started on a very ambitious project to carry out engineering, design, construction and commissioning of an Energy Recovery Pilot Coke Oven (ERCO) at Bells Corners coal and coke facilities. The ERCO technology is an alternate approach to traditional slot coke oven technology and the fact that pilot facilities using ERCO technology are essentially non-existent, R&D cannot be carried out. CISERA's goal for this project was to put Canada at the leading edge of this technology by having a facility where its members could be able to investigate how coal behaves in this type of oven and generate valuable data to allow the Canadian steel industry to evaluate this alternative technology. This facility would also be used to showcase the cokemaking merits of Western Canadian coals using this technology globally as well as making use of it to conduct research on the incorporating of in coal blends for assessing coke quality.



Due to the capital costs to finance such a large project, CISERA members contributed to a special fund. CISERA also signed a Non-Repayable Contribution Agreement with Natural Resources Canada to assist with the costs. The Canadian Steel Producers Association (CSPA) also contributed to the project. The goal was to secure the funding to enable the construction of the facility. In 2011-12, SunCoke Energy, USA was invited to join CISERA as a strategic partner in developing the energy recovery cokemaking programme as they have owned and operated commercial ovens using this technology for many years.

The 2011–2012 fiscal year saw a growth in CISERA members as US Steel Canada, SunCoke Energy, Inc. joined. Grande Cache Coal Corp., Alberta also rejoined the Association after being absent for some years.

During the 2013/2014 fiscal year, CISERA was obligated to transition from its original letters patent legal structure to comply with the requirements of the new Not-for-Profit Corporations Act. As of January 1, 2013, CISERA received its Certificate of Continuance as Corporation Number 117455-0 Industry Canada.

In 2014-2015, the CISERA with CanmetENERGY's cooperation, provided a website for the Canadian Iron and Steel Energy Research Association. The website is accessible at https://www.cisera.ca and contains timely information on the CISERA/CanmetENERGY R&D programs and other information related to the Canadian Coal and Coke industry as a whole.

The CISERA celebrated its 50th year milestone of providing research support to the Canadian Coal and Carbonization industries on September 2, 2015.
On September 30, 2016, Mr. George Chapman retired as Treasurer of CISERA. During his 40-year tenure in that function, Mr. Chapman provided important financial and administration stewardship of CISERA

and support to the Board of Directors and Members. The Board of Directors appointed Mr. Brian D'Amboise CPA, CA to succeed Mr. Chapman as Treasurer effective October 1, 2017. Mr. D'Amboise has over 25 years of involvement with CISERA as the former external auditor to the Association and provided Mr. Chapman valuable assistance in completing the 2016-17 fiscal year end and related tax returns.

CISERA pursued several outside research initiatives during the 2016-17 fiscal year. The Association continued work on the ISO Inter Laboratory Study on Coal Dilatation initiated in 2015-2016 and entered into a new research funding arrangement with Geoscience B.C. to support a study aimed at producing clean coal from Western Canadian Coal Fields using the water-based Roben Jig process. In addition, further studies on coal stamp charging and small-scale coking were developed to meet members future needs.

During 2017-18 fiscal year, the CISERA wrote four papers for presentation at AISTech 2017 in Nashville, USA and a report on Producing Clean Coal from Western Canadian Coalfields using the Water-Based Roben Jig Process in Geoscience BC Summary of Activities 2017. It made a presentation on this work at CoalSMART 2018 and organized two Working Group meetings on use of Biocarbon in Canadian Steel Industry (November 2017 and January 2018).

As well, the new PCI experimental rig at CanmetENERGY-Ottawa was upgraded to allow for better control of coal feeding rate and hot blast composition. A new approach was developed in processing the experimental data including the introduction of two new parameters to quantify the extent of gasification of coal Volatile Matter and Fixed Carbon and a new approach using TGA was developed to quantify the reactivity of combustion residues. Going forward, work will focus on enhancing the rig's capability in terms of NG/COG co-injection, blast gas moisture control and off-gas analysis.

On the use of renewable energy for the steel industry, research was pursued on several fronts including (1) Pyrolysis Technology Evaluation (2) Bio-Carbon for EAF Steelmaking (3) Bio-Briquette Formation (4) Bio-Carbon for Direct Injection in Blast Furnace Ironmaking (5) Biochar Production and Handling.

In 2018-19, the CISERA published three papers in peer-reviewed journals on (i) *"Value-In-Use of Renewable Biocarbon for Direct Injection in Blast Furnace Ironmaking"* in Ironmaking and Steelmaking journal (ii) *"Development of novel method for quantitative determination of carbon chemical reactivity"* in Canadian Journal of Chemical Engineering and (iii) *"Carbonaceous material properties and their interactions with slag during electric arc furnace steelmaking"* in Metallurgical and Materials Transactions B**;** it wrote papers for presentation at AISTech 2018 in Philadelphia, USA, for 8th International Conference on Science and Technology of Ironmaking in Vienna, Austria and a report on Producing Clean Coal from Western Canadian Coalfields using the Water-Based Roben Jig Process: Refining the Process in Geoscience BC Summary of Activities 2018. It made a presentation on this work at Western Canadian Coal Society in February 2019 and organized four Working Group meetings on use of Biocarbon in Canadian Steel Industry (April, June and November 2018 and March 2019).

Again in 2018-19, the CanmetENERGY Bioenergy group was a strong partner and made valuable contributions in assessing existing biomass conversion technologies, in the handling and cleaning and processing and carbonization. The Biocarbon for Iron and Steel production and other large emitters' project successfully secured S&T funding until March 2022.

In 2018-19, four meetings of the CISERA-Biocarbon for Steel Working Group were held at CanmetENERGY-Ottawa. These meetings were successful in advancing the discussion and interest level among the numerous project partners.

In 2021 the CISERA Biocarbon for Steel Working Group has seen the need for further guidance and involvement by other industries. This initiative will be led by CRIBE (Center for Research and Innovation in the Bioeconomy). The concepts remain, but the group will be called Biocarbon for Heavy Industry to include other industries similar to steel in the demand for bio energy. CISERA and its members will continue to be involved and are well engaged.

In 2023 the CSPA formally recognized CISERA as the technical branch for all their members. The goal of CISERA will be to establish communication channels and promote collaboration across the industry to work together to achieve the net-zero emission target by 2050.

Additionally, in honour of one of our esteemed colleagues, CISERA established the 'Louis Giroux Co-op Scholarship in Greenhouse Gas Reduction Science' with the University of Waterloo. This gift will provide students, faculty and researchers some of the resources that are required need to learn, explore and innovate while recognizing the contributions that Louis made to all of us both professionally and personally.

Finally, our very own CISERA Board Chair from 2007-2022 Ted Todoschuk received the distinguished AIST Joseph Becker Award for his contributions and achievements in coal and cokemaking research. The entire industry has benefited from Ted's logical and practical guidance throughout his illustrious career.

CISERA's key accomplishments through the years

The CISERA and its members can be very proud of its accomplishments over the five decades since its inception. It is difficult to list all the accomplishments, but numerous papers and presentations have been made available to interested research organizations. Significant highlights include:

- The 2015 PricewaterhouseCoopers report showed the value of the research program and the significant positive financial impact of CISERA research on the Canadian GDP.
- Enhancing the understanding of the technical merits of Western Canadian coals in international markets leading to significant sales globally.
- Metallurgical coal resource development in Canada using CanmetENERGY-Ottawa pilot scale coal and coke facilities, equipment, and expertise.
- Development of unique coal and coke testing techniques to support CISERA member needs.
- Lower fuel rates and GHG reductions in the Canadian steel industry with coke quality improvements.
- Improved energy efficiency for Canadian Ironmakers with the use of pulverized coal injection.

- Development of a biocarbon strategy to significantly reduce GHG emissions in the steel sector through multiple pathways.
- Engagement with strategic biocarbon supply chain producers to initiate a bio economy with the steel sector.
- Ensuring the development of suitable coal and coke quality standards to support the competiveness of the Canadian coal and steel industries.
- Engagement of CanmetENERGY's various researcher groups including CanmetENERGY-Ottawa Carbon Management Technology (CMT) Group, CanmetENERGY-Ottawa Industrial Innovation Group (IIG), CanmetMATERIALS and CanmetENERGY-Varennes Industrial System Optimization (ISO) which are associate with GHG reduction initiatives with the ultimate goal of supporting industrial receptors Recognized as the technical branch of the CSPA in 2023

Going Forward

The uniqueness of the CISERA program is that it is able to adapt well to current and future needs of its members. The CISERA has recently embarked on R&D projects with international researchers in Australia, France, Japan, Sweden, USA and this has allowed the development of global partners and programs. In addition, CISERA is pursuing significant GHG reduction initiatives with both the coal and steel sectors as this is fast becoming a very significant global directive for these industries. In brief, CISERA is examining ways to achieve carbon-neutral ironmaking in the middle to long-term (2030-2040) by partnering with Canadian and International partners. These changes will ensure that the CISERA continues to meet the needs of industry and align with Government Policies. Much work is already underway and will continue to evolve.

1965-2025 CHAIR OF BOARD OF DIRECTORS

Year	Name	Company
1965 – 1966	C.W. Draker	Algoma Steel Limited
1967 – 1968	F.J. Pearce	The Steel Company of Canada Limited
1969 – 1970	J.E. Ludberg	Dominion Foundries and Steel Limited
1971 –1972	J.S. Anslow	The Steel Company of Canada Limited
1973 – 1974	J.O. Thomas	DEVCO
1975 –1976	A.M. Cameron	Algoma Steel Limited
1977 – 1978	J.T. Collier	DEVCO-SYSCO
1978 – 1979	W.A. Riva	Kaiser Resources Limited
1980 – 1981	J.E. Ludberg	Dofasco Limited
1981 – 1982	A. Johnson	Gulf Resources Limited
1983 –1984	A.W. Kay	Stelco Inc.
1985 – 1986	R. Sagi	Denison Mines Limited
1987 – 1988	W. Becken	Dofasco Inc.
1989 – 1990	W.R. Leeder	Denison Mines Limited
1991 – 1992	K. Carnes	Fording Coal Limited
1993 – 1994	H. Stelmach	Line Creek Resources Limited
1995 –1996	T. Benner	Dofasco Inc.
1997 –1998	W. Jonasson	Algoma Inc.
1999 – 2000	W.R. Leeder	Teck Corporation
2001 – 2002	W.R. Leeder	TeckCominco Corp.
2003 – 2006	W.R. Leeder	Elk Valley Coal Limited
2007 – 2022	T. Todoschuk	ArcelorMittal Dofasco Inc.
2022 - 2025	J. Halko	**Elk Valley Resources Operations Limited**

2024-2025 BOARD OF DIRECTORS

COMPANY	NAME	PHONE (FAX)
Algoma	Kashif Rehman Director, Technology/Technical Service, Strategy 105 West Street Sault Ste. Marie, ON P6A 7B4 *kashif.rehman@algoma.com*	(705) 297-0555 (705-945-4189)
ArcelorMittal Dofasco Inc.	Graeme Scott Programme Leader ArcelorMittal Dofasco Global R&D - Hamilton 1390 Burlington St. E Hamilton, ON, L8N 3J5 *graeme.scott1@arcelormittal.com*	(905) 548-7200 x6619 Cell:(289) 439-0337
CanmetENERGY	Boniface Koudjonou S&T Director, Industrial Innovation Group CanmetENERGY Natural Resources Canada 1 Haanel Drive Ottawa, ON K1A 1M1 *boniface.koudjonou@nrcan-rncan.gc.ca*	(613) 698-5253
Elkem Métal Canada Inc.	Geneviève Giasson Diectrice usine Pilote Elkem Chicoutimi 1261, Rue des Sociertaires Chicoutimi, QC G7J 0K6 *Genevieve.giasson@elkem.com*	(418) 557-3845
Stelco	John D'Alessio Director - Process Technology Stelco - Lake Erie Works BF Control Building, 2nd Floor 2330 Regional Road #3 Nanticoke, ON N0A 1L0 *john.dalessio@stelco.com*	(519) 587-4541 Ext. 5270 Cell: (905) 308-1253
Elk Valley Resources Operations Limited	Jason Halko Director Technical Marketing Elk Valley Resources Operations Limited Suite 1400, 500 Centre Street SE Calgary, Alberta T2G 1A6 *jason.halko@evr.com*	(403) 767-8600 Cell: (403) 671-3798

2024-2025 CORPORATE OFFICERS

CISERA Position	COMPANY	NAME	PHONE (FAX)
Chair	**Elk Valley Resources Operations Limited**	Jason Halko Director Technical Marketing Elk Valley Resources Operations Limited Suite 1400, 500 Centre Street SE Calgary, Alberta, T2G 1A6 *jason.halko@evr.com*	(403) 767-8600 Cell (403) 671-3798
Vice Chair	**ArcelorMittal Dofasco G.P.**	Graeme Scott Programme Leader ArcelorMittal Dofasco Global R&D - Hamilton 1390 Burlington St. E Hamilton, ON, L8N 3J5 *graeme.scott1@arcelormittal.com*	(905) 548-7200 x6619 Cell:(289) 439-0337
Secretary	**CanmetENERGY**	Xianai Huang Research Scientist Metallurgical Fuels Lab Industrial Innovation Group CanmetENERGY-Ottawa Natural Resources Canada 1 Haanel Drive, Ottawa, ON K1A 1M1 *xianai.huang@nrcan-rncan.gc.ca*	(343) 574-5931
Treasurer	**Brian G. D'Amboise Chartered Professional Accountant**	Brian D'Amboise, CPA, CA Chartered Professional Accountant *CISERA-Treasurer@bell.net*	(905) 938-2984 (289) 214-3636

2024-2025 TECHNICAL COMMITTEE MEMBERS

COMPANY	NAME	PHONE (FAX)	ALTERNATE OR CO-MEMBER
CanmetENERGY	Ka Wing Ng (CHAIR) Research Scientist Metallurgical Fuels Lab CanmetENERGY-Ottawa Natural Resources Canada 1 Haanel Drive Ottawa, ON K1A 1M1 *kawing.ng@nrcan-rncan.gc.ca*	(613) 996-8712	Xianai Huang Research Scientist Metallurgical Fuels Lab CanmetENERGY-Ottawa Natural Resources Canada 1 Haanel Drive Ottawa, ON K1A 1M1 (613) 947-6584 *xianai.huang@nrcan-rncan.gc.ca*
ArcelorMittal Dofasco Inc.	Graeme Scott (Vice Chair) Programme Leader ArcelorMittal Dofasco Global R&D - Hamilton 1390 Burlington St. E Hamilton, ON, L8N 3J5 *graeme.scott1@arcelormittal.com*	(905) 548-7200 x6619 Cell:(289) 439-0337	
CanmetENERGY	Xianai Huang (Secretary) Research Scientist Metallurgical Fuels Lab CanmetENERGY-Ottawa Natural Resources Canada 1 Haanel Drive Ottawa, ON K1A 1M1 *xianai.huang@nrcan-rncan.gc.ca*	(343) 574-5931	Keith Ludlow Research Engineer CanmetENERGY Natural Resources Canada 1 Haanel Drive Ottawa, ON K1A 1M1 (343) 551-9384*keith.ludlow@nrcan-rncan.gc.ca*
Elk Valley Resources Operations Limited	Maria Dooley Senior Geologist Supervisor, Coal and Coke Quality Suite 1400, 500 Centre Street SE Calgary, Alberta T2G 1A6 *Maria.Dooley@evr.com*	(250) 425-4066 Cell: (250) 425-4066	Royce Mazo Senior Engineer Coal & Coke Quality Suite 1400, 500 Centre Street SE Calgary, Alberta T2G 1A6 (403) 767-8692 (587) 572-5874 *Royce.Mazo@evr.com*
Stelco	Aram Hermiz Operating Technology & Innovation Coke & Buy-Products Stelco - Lake Erie Works BF Control Building, 2nd Floor 2330 Regional Road #3 Nanticoke, ON N0A 1L0 *aram.hermiz@stelco.com*	(905) 528-2511 ex. 5588 Cell: (226) 931-6338	John D'Alessio Director - Process Technology Stelco - Lake Erie Works BF Control Building, 2nd Floor 2330 Regional Road #3 Nanticoke, ON N0A 1L0 (519) 587-4541 ex. 5270 *john.dalessio@stelco.com*
Algoma	Jarred Kapush Material Handling-Cokemaking 105 West Street Sault Ste. Marie, ON P6A 7B4 *jarred.kapush@algoma.com*	(705) 255-6493	Kashif Rehman Director, Technology/Technical Service, Strategy 105 West Street Sault Ste. Marie, ON P6A 7B4 (705) 206 0943 *kashif.rehman@algoma.com*
Elkem Métal Canada Inc.	Geneviève Giasson Directrice usine Pilote 1261, Rue des Societaires	(418) 557-3845	

COMPANY	NAME	PHONE (FAX)	ALTERNATE OR CO-MEMBER
	Chicoutimi, QC, G7J 0K6 geneviere.giasson@elkem.com		
CISERA Guest Member	Ms. Melanie Mackay Professional Geoscientist 3360 Georgia Street Richmond, BC, V7E 2R6 mmackay@trilliumgeoscience.com	(604) 323-6692	Not Applicable
CISERA Consultant	Dr. John Price 28 Nanook Crescent Ottawa, ON K2L 2A7 jtprice6@gmail.com	(613) 592-4397	Not Applicable
CISERA Consultant	Dr. Ross Leeder 12686 Ocean Cliff Drive Surrey, BC V4A 6N1 ross_leeder@hotmail.com	(604) 531-1944 Cell: (604) 317-7412	Not Applicable
CISERA Consultant	Ted Todoschuk TwithT Consulting 37 Beachgrove Cres. Stoney Creek, Ont. L8J 2N9 twithtconsulting@gmail.com	(905)-520-4451	Not Applicable

Active Projects Summary		
Program	**Program Objectives**	**Projects**
Fundamental of coal science	• To understand the fundamental science of metallurgical coal for supporting efficient exploration and product quality improvement to improve global competitiveness of Western Canadian Coal	CISERA 54: ISO and ASTM Coal and Coke Standards
		CISERA 90: Exploration Sample Assessment for Current and New Coal Mines in Canada
		CISERA 81: Mineral Matters in Western Canadian Coal
		CISERA 94: Semifusnite
Cokemaking and Coke Quality	• To improve quality of metallurgical coke by understanding the fundamental science of cokemaking and coke utilization for supporting high carbon efficiency blast furnace ironmaking.	CISERA 88: Application of Small Scale Coking
		CISERA 84: Coke Degradation Mechanisms
		CISERA 93: Performance of Western Canadian Coal in Stamp Charge
CanmetENERGY MFL Facilities	• To ensure the reliability and repeatability of CanmetENERGY facilities • To develop new research facilities in CanmetENERGY	Benchmarking of Movable Wall Ovens
		Quarterly LQSI Round Robin

<table>
<tr><th colspan="6">Active Projects Planning Table</th></tr>
<tr><th>Program</th><th>Projects</th><th>Team</th><th>Project Objectives</th><th colspan="2">Project Tasks</th></tr>
<tr>
<td rowspan="3">Fundamentals of Coal Science</td>
<td rowspan="3">CISERA 54: ISO and ASTM Coal and Coke Standards</td>
<td rowspan="3">EVR
Jason Halko

Dofasco
Graeme Scott

CanmetENERGY
Xianai Huang

CISERA Consultant
Ted Todoschuk</td>
<td rowspan="3">• Development of standards and procedures pertaining to Canadian Coal and Steel industries</td>
<td>Identify both ASTM and ISO up for review</td>
<td>• On-going</td>
</tr>
<tr>
<td>Effect of coal particle size on rheology measurement</td>
<td>• Gieseler Melting Range for Predictive Coal Blending
o CCRA 54: 001/2023 Estimation of Coal Blend Thermal Rheology Properties from Component Coals
o CCRA 54: 002/2023 Gieseler Melting Range for Predictive Coal Blending
o 263 Technical Committee Presentation

• Effect of particle size on rheology measurement: Coal Blend (A3)
o US and WCC Blends for Oven Benchmarking 2024
o 267 Technical Committee Presentation
o TWT Memo: Evaluation of Particle Size of Rheology Results for Coal Blends

• Effect of Particle Size Distribution on Rheology Measurement
o 269 Technical Committee Presentation
<table>
<tr><th>Sample Preparation</th><th>%Fines (-140M)</th><th>Max. Fluidity</th><th>Melting Range</th><th>SD 2.5</th></tr>
<tr><td>Normal Gieseler</td><td>29.6</td><td>3354</td><td>95</td><td>--</td></tr>
<tr><td>Normal Dilatation</td><td>64.8</td><td>2574</td><td>92</td><td>133</td></tr>
<tr><td>Purposely Over Crush</td><td>76.7</td><td>2226</td><td>89</td><td>118</td></tr>
</table>
• Test Sample Particle Size Specification
o 270 TC Meeting Presentation: Comparison Between ISO and ASTM standards</td>
</tr>
<tr>
<td>Examination of coal oxidation information</td>
<td>• CCRA Publications
o 2001: Determination of organic oxygen in coals with application to the study of coal weathering
o 2003: Application of TG-FTIR to the determination of oxygen content of coals
o 2004: Detection of natural oxidation of coking coal by TG-FTIR-Mechanistic implications</td>
</tr>
</table>

					○ 2006: Application of Thermogravimetric Fourier Transform Infrared Spectroscopy (TG-FTIR) to the Analysis of Oxygen Functional Groups in Coal ○ 2006: Application of TG-FTIR to the determination of organic oxygen and its speciation in the Argonne Premium Coal samples ○ 2006: Storage of small samples of coking coal for thermal rheological tests ○ 2011: Deterioration of coking coal quality in samples and stockpiles
					• Current research status ○ Coal Oxidation Review March 2022: Ross Leeder • Determination of Oxidation Boundary ○ Detail project plan to be developed by Melanie.
	CISERA 90: Exploration Sample Assessment for Current and New Coal Mines in Canada	CISERA Consultant Melanie Mackay Ross Leeder CanmetENERGY Ka Wing Ng EVR Jason Halko	• To investigate alternative environmentally friendly methods to produce clean coal composite from exploration samples for further properties assessment.	**Development of Clean Coal Composite Preparation by water base Roben Jig Technology**	• Preliminary evaluation of Australian Boner Jig facility performance on WCC ○ Completed: The jig worked (2016)
					• Phase 1: Roben Jig Facility Setup in Canada ○ Completed: Commissioning with 4 coal samples (3SEBC and 1 NEBC) (2017)
					• Phase 2a: Performance of Roben Jig on clean coal sample preparation ○ Completed ○ Able to make a clean coal composite that matched the plant sample ○ Misplace material in the Jig was found and measured ○ Jigging with narrow size fraction was impractical ○ Re-jigging helped to remove some misplaced material. +1.54SG material decreased from 6% to 2%

					• Phase 2b: MWO evaluation of coking performance of sample prepared by Roben Jig
					○ Single seam plant coal samples collection
					  ○ Raw coal feed and clean coal
					○ Raw coal feed process
					  ○ Create organic liquid and Roben jig CCC (Dec 9-13, 2019)
					  ○ Coal properties comparison: Plant clean coal vs Organic liquid vs Roben jig (Dec 16-20, 2019)
					○ MWO carbonization
					  ○ MWO carbonization of plant clean coal, sample prepared by organic liquid float/sink and Roben jig CCC completed Jan 2020.
					○ Final Report and Publication
					  ○ Producing Clean Coal from Western Canadian Coal Fields using the Water-based Boner Jig Process – Coal SMART presentation February 2017
					  ○ Producing clean coal from western Canadian coalfields using the water-based Roben Jig process – Geoscience BC Summary of Activities 2017
					  ○ Producing Clean Coal from Western Canadian Coal Fields using the Water-based Boner Jig Process 2018 update – Coal SMART presentation February 2018
					  ○ Producing clean coal from western Canadian coalfields using the water-based Roben Jig process: refining the process – Summary of Activities 2018: Minerals and Mining, Report 2019-01
					  ○ Geoscience BC Report 2019-05: Producing Clean Coal from Western Canadian Coal Fields using the Water-based Roben Jig: Refining the Process
					  ○ Fuel 306 (2021) 121729: Preparation of Clean Coal Samples Using Roben Jig

					• Phase 3: Using Roben Jig to Wash 'Difficult to Wash' Coals ○ Detail project plan to be developed by Melanie
				Alternate liquid for Float/Sink coal washability study	• Effects of Organic Liquids on Western Canadian Coking Coals ○ Fuel Processing Technology 2017: Effects of organic liquids on coking properties of a higher-inert Western Canadian Coal
					• Effect of Float/Sink with Perchloroethylene on HGI ○ Detail project plan to be developed by Melanie

					• Phase 1: Evaluation of Alternate Float-Sink Liquid (3M FC-770 and Novec 7700) for Clean Coal Composite Preparation (A3)
					○ Clean coal composite preparation (GWIL)
					  ○ Float-Sink with perchloroethylene (PCE)
					  ○ Float-Sink with 3M FC-770 and Novec 7700 (NOVEC)
					  ○ Roben Jig (JIG)

<table>
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<td></td>
<td>
Phase 2: Evaluation of Alternate Float-Sink Liquid (Halocarbon) for Clean Coal Composite Preparation

Dec 2023
265 TC Meeting Presentation
SHO Carbonization

<table>
<tr><th></th><th>CLEAN #233290</th><th>100% P-CCC</th><th>100% H-CCC</th></tr>
<tr><td>Coke Ash</td><td>12.24</td><td>10.41</td><td>10.78</td></tr>
<tr><td>Coke VM</td><td>0.78</td><td>0.83</td><td>0.62</td></tr>
<tr><td>Coke FC</td><td>86.98</td><td>88.76</td><td>88.60</td></tr>
<tr><td>Coke S</td><td>0.36</td><td>0.32</td><td>0.32</td></tr>
<tr><td>CSR</td><td>74.14</td><td>72.48</td><td>74.53</td></tr>
<tr><td>CRI</td><td>19.80</td><td>21.46</td><td>19.92</td></tr>
<tr><td>ASG</td><td>1.089</td><td>1.041</td><td>1.074</td></tr>
</table>

Dec 2024
270 TC Meeting Presentation
SHO Carbonization

<table>
<tr><th></th><th>CLEAN #233290</th><th>100% P-CCC</th><th>100% H-CCC</th></tr>
<tr><td>Coke Ash</td><td>12.94</td><td>12.65</td><td>12.56</td></tr>
<tr><td>Coke VM</td><td>2.15</td><td>0.98</td><td>1.01</td></tr>
<tr><td>Coke FC</td><td>84.90</td><td>86.37</td><td>86.43</td></tr>
<tr><td>Coke S</td><td>3.19</td><td>2.96</td><td>2.98</td></tr>
<tr><td>CSR</td><td>26.04</td><td>30.15</td><td>28.05</td></tr>
<tr><td>CRI</td><td>41.78</td><td>41.12</td><td>42.78</td></tr>
<tr><td>ASG</td><td>1.127</td><td>1.115</td><td>1.134</td></tr>
</table>
</td>
</tr>
<tr>
<td rowspan="3">CISERA 81: Mineral Matters in Western Canadian coal</td>
<td rowspan="3">CanmetENERGY
Kun Liu

CCRA Consultant John Price</td>
<td rowspan="3">

To understand the in-situ mineralogy characteristics of western Canadian coal
To understand transformation of minerals during carbonization
To understand the effect of minerals on resultant coke quality

</td>
<td>Preliminary Study</td>
<td>
Publications

ISS-AIME Ironmaking 1994: Minerals in Coal and High Temperature Properties of Coke
AIST 2014: Mineral Matter Transformation in Small-Scale Coke Oven for Evaluation of CSR/CRI
CCRA Report: A Literature Review on Coal and Coke Mineralogy Influences on Coke Properties and Behavior in Blast Furnace

</td>
</tr>
<tr>
<td rowspan="2">Effect of mineral type and size on coke quality</td>
<td>
Mineral Addition Tests

Completed: SHO carbonization of WC MV and US HV with 1% mineral addition at different size

AIST 2017 Effect of Coal Mineral Type and Size on Coke Strength After Reaction
AIST 2019: Effect of Coal Mineral Type and Size on Coke Strength After Reaction

</td>
</tr>
<tr>
<td>
Role of in-situ mineral type and size on CSR prediction

Phase 1: Coals with resultant coke CSR do not align with prediction (A3)

Carbonization of selected coal samples and measurement of CSR
Comparison of measured CSR with predictions

</td>
</tr>
</table>

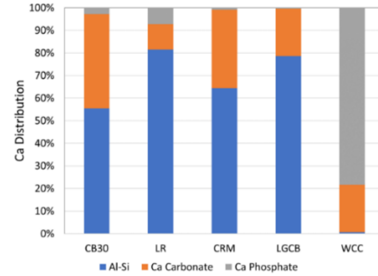
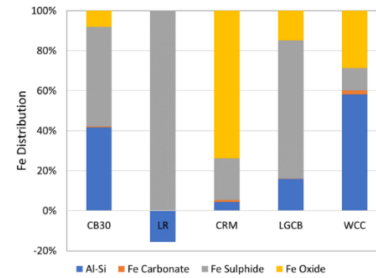
	US LV	WCC	US HV
Canmet Index	**27410**	**27211**	**27992**
Measured CSR	49.9	70.6	76.3
Predicted CSR	64.5	58.4	64.9

- Mineral analysis of both coal and resultant coke
  - Coal Mineralogy Characterization: Completed
  - Coke Mineralogy Characterization: Completed

- Phase 2: Coals and resultant cokes in 2022 Annual Oven Benchmarking Project
  - Coal and corresponding resultant coke samples collection

Index	28324	28325	28326	28327	28337	28346	28354
US 1	100%					25%	15%
US 2		100%				30%	10%
US 3			100%			25%	25%
US 4				100%		20%	20%
WCC					100%	--	30%
Coke Oven	SHO	SHO	SHO	SHO	SHO	SHO and 18in	SHO and Carbolite

  - Mineralogy characterisation of component coals and blends and corresponding resultant cokes
    - CCRA 260 TC Meeting Presentation
  - Mineralogy characterisation of component coals and blends and corresponding resultant cokes
    - CCRA 262 TC Meeting Presentation

					• Component coal and corresponding coke mineralogical data analysis
					○ CCRA 264 TC Presentation
					○ Coal mineralogy characteristics
					
					○ Mineral transformation during coking
					  ○ Ca Phosphate (Apatite) appears stable and does not transform during coking
					  ○ Pyrite (FeS2) convert into Pyrrhotite (Fe_xS) or Troilite (FeS)
					  ○ Ca carbonate (calcite, dolomite and ankerite) decompose into Ca oxide
					  ○ Ca oxide promotes fusion of Al-Si minerals by lowering temperature required to initiate fusion
					  ○ Fusion of Al-Si leads to oversaturation of Fe oxides and results in release of Fe originally bonded with Al-Si minerals
					  ○ Mineralogy of coke from coal blend well aligns with mineralogy of coke from carbonization of component
					  ○ coke mineralogy is additive
					  ○ Understanding component coal mineralogy characteristics and its transformation characteristics is essential

	CISERA 94: Semifusinite	CE-O
		Kun Liu
		Ka Wing Ng
		
		EVR
		Jason Halko
		
		CCRA Consultant
		Ted Todoschuk, John Price
		Ross Leeder
		
		UBC
		Melaine Mackay, Maria Holuszko
			• To determine the mechanism of transformation of both partially and completely fusible SF in WCC coals.
			• To determine the binder and filler phases that SF transforms into with partial and complete fusibilities.
			• To understand the role that rheological and
				Background Study and Project Scope Development	• Background Information Collection
					○ Plastofrost Project Review
					  ○ Report: McMaster University 1988
					  ○ Report: John St James 1997
					  ○ Report: John Price 2022
					  ○ Report: John Price 2023
					○ Re-examination of Samples from Plastofrost Project (A3)
					  ○ Plastofrost sample selection
					    ○ Sample #27 (Fording-MV-6M-1c/min)
					    ○ Sample #29 (Fording-MV-6M-4c/min)
					    ○ Sample #11 (Fording-HV-16M-4 c/min)
					  ○ Re-polish the selected sample
					    ○ Microscopic image of polished sample
					○ Reflectance of Semifusinite and transformation in plastic region
					  ○ CCRA 263 TC Presentation
					  ○ CCRA 264 TC Presentation
					  ○ CCRA 265 TC Presentation
					  ○ CCRA 266 TC Presentation
					  ○ CCRA 267 TC Presentation

			petrographic measured properties play in this transformation.		
					• Project Scope Development ○ Literature Database ○ Ted Todoschuk Report: Investigation on Transformation of Semifusinite During Carbonization ○ A3: CCRA 94 Transformation of Semifusinite during Carbonization ○ Memo CCRA 94 001/2024: Literature Review and Work Plan
				Analysis Technique Development	• Maceral concentration technique development ○ Float/Sink ○ Centrifuge
					• Analytical technique exploration ○ 269 TC Meeting Presentation ○ 270 TC Meeting Presentation: TGA Analysis
				Macerals Chemical Composition/Structure Characterization	• TBD
				In-situ observations of fusible macerals melting behavior and carbon forms analysis	• Technique Exploration ○ 270 TC Meeting Presentation: In House Hot Stage

CISERA

Cokemaking and Coke Quality	CISERA 84: Coke Degradation Mechanisms	EVR Jason Halko CanmetENERGY Ka Wing Ng	• To understand the effect of western Canadian coal on resultant coke size and shape • To understand the effect of coal properties and handling on coke degradation mechanism	**Previous work**	○ AIST 2005 Stabilization of Blast Furnace, Sampling Station, Wharf and Pilot Oven Cokes from Canadian Steel Mills ○ AIST 2011 Implementation of Coke Stabilization at ArcelorMittal Dofasco ○ AIST 2017 CanmetENERGY's Experience on Performing High-Temperature Dilatation Measurements ○ CCRA Report: CCRA84:001/2019 Review of CCRA Research on Coke Degradation

				Effect of WCC on coke size and shape evolution in stabilization	• Effect of WCC in coal blend on resultant coke size and shape 2020 (A3)
					○ Carbonization for coke sample preparation
					  ○ **US Blend**: 25% US LV(CB30)- 35% US HVA (LR)- 15% US HVB (CW)- 25%US HVC (MY)
					  ○ **WCC Blend**: 16% US LV (CB30)- 23% US HVA (LR) -10% US HVB (CW)- 16% US HVC (MY)- 35% WCC
					○ Effect of Oven and WCC on Degradation
					  ○ Extended IRSID completed
					  ○ Test data to be discussed in Dec 2020 meeting
					○ Effect of WCC on size and shape evolution in stabilization
					  ○ Procedures
					    ○ Collect 50kg IRSID sample for image analysis
					    ○ Drop sample from 10 ft
					    ○ Re-screen stabilized sample
					    ○ Redo image analysis on stabilized sample
					○ Report: CCRA 82:001/2021 Effect of Coal Blend Composition on Resultant Coke Size and Shape Characteristics and Degradation Behavior

					• Effect of WCC in coal blend on resultant coke size and shape 2022 (A3)
					○ Coke Sample Preparation
					  ○ US Blend: 25%CB30-35%LR-20%CRM-20%LGCB
					  ○ WCC Blend: 25%CB30-35%WCC-20%CRM-20%LGCB
					○ Effect of WCC on size and shape evolution in stabilization
					  ○ Procedures
					    ○ Collect 50kg IRSID sample for image analysis
					    ○ Drop sample from 10 ft
					    ○ Re-screen stabilized sample
					    ○ Redo image analysis on stabilized sample
					    ○ CCRA TC 260 presentation

	C- 3156(US Blend)			C- 3157(WCC Blend)		
Drops	Sieve	Dia	Shape	Sieve	Dia	Shape
1	67.04	63.2	1.885	66.33	57.1	1.900
2	63.53	56.1	1.881	61.11	52.5	1.861
3	60.36	54.7	1.764	59.43	50.7	1.799
4	57.72	51.7	1.745	56.40	46.0	1.806
5	56.07	43.6	1.802	54.91	43.2	1.870

Fundamental of coke fissures formation

Characterisation Technique Development

- Proposal
    - CCRA 84: 001/2023 Proposal on Characterisation Technique Development for Enabling Coke Degradation Research
- 2nd Contraction Measurement
    - Two Steps Characterisation technique development and validation
        - CCRA 264 TC Presentation
    - Review of Contraction Studies
        - CCRA 265 TC Presentation
- Tensiometer Observation of Expansion and Contraction Behavior
    - 270 TC Meeting Presentation

Factor affecting Fissure formation

- Effect of Heating Rate on Coke Fissuration (A3)
    - 267 TC Meeting Presentation

	Center Coke		Wall Coke	
	Blend A	Blend B	Blend A	Blend B
Initial MCS	58.3	58.0	58.6	59.1
M 10	6.7	6.9	6.7	6.5
M 40	70.3	66.5	68.8	67.2
I 10	19.7	23.9	19.7	22.4
I 20	78.4	74.1	78.4	75.7
I 40	49.1	37.9	47.7	39.8
FFS (mm)	52.2	42.2	50.0	41.0
Stabilization	89.4%	72.8%	85.3%	69.5%
Micum Slope	0.00758	0.00760	0.00748	0.00577

- Tensiometer Observation
    - 270 TC Meeting Presentation

	CISERA 88: Application of Small-Scale Coking	EVR Jason Halko CanmetENERGY Ka Wing Ng	• To develop and demonstrate carbonization methods for small (<350kg) coal samples	**SHO CSR**	• Publication: Fuel 2013: Small scale determination of metallurgical coke CSR

				Canmet multi-compartment box charge capability development	o Equipment Fabrication for Box Charge
					  o Completed
					o Multi-compartment box charge capability demonstration (A3)
					  o Completed: First set of MWO tests
					  o Gravity, 1 compartment, 2 compartment and 3 compartment charge with same coal blend
					  o Demonstrate capability to conduct multi-compartment box charge
					o Observations
					  o No significant variation in coke quality between compartments in 2 compartments box charge and similar to gravity charge
					  o Coke quality in 3 compartment box charge varies between compartments
					  o Current setup does not allow gas pressure and center temperature measurement in each compartment
					  o Needs to design new equipment for gas pressure and center temperature measurement

				Benchmarking of multi-compartment box charge with gravity charge	• Combined gas pressure and center temperature measurement
					o Two Compartment Box Charge
					  o Design and fabrication: Completed
					  o Functionality test: CCRA TC 246 March 2018
					o Three Compartment Box Charge
					  o TBD
					• Benchmarking of two compartment box charge with gravity charge (A3)
					o TBD
					• Benchmarking of three compartment box charge with gravity charge
					o TBD

	CISERA 93: Performance of Western Canadian Coal in Stamp Charge	EVR
		Jason Halko
		May Laliberte
		
		CanmetENERGY
		Keith Ludlow
			• To understand the effect of incorporating Western Canadian Coal in stamp charge blend on resultant coke quality and coal blend stampability	**Canmet Stamp charge capability development**	• Benchmark single compartment box stamp charge with gravity charge results (A3)
					o Completed: Gravity charge (BD: 810 kg/m3) vs Box stamp charge (BD: 925 kg/m3)
					• Stamping apparatus development
					o Small scale coal blend densification test to understand compaction behavior of coal:
					  o 1x1x1 ft wooden box
					    o Coal particle size 85% <3mm
					    o 10% Moisture
					    o Achieve 978 kg/m3 dry BD
					  o 8" ID metal cylinder
					    o Coal particle size 100%<3mm; 73%<1mm; 43%<0.5mm
					    o 10% Moisture
					    o Achieve 1003 kg/m3 dry BD
					  o Proctor test equipment developed for soil compaction

					◦ Report CCRA93: 001/2020 Coal Stampability by Compaction with Adapted Soil Proctor Method (ASTM D1557) ◦ Examine the effect of coal particle size distribution on compaction energy ◦ Identify suitable particle size distribution and equipment to allow reaching 1000 kg/m3 dry BD for conducting MWO test
				Effect of WCC in stamp charge on resultant coke quality	• Formulation of base case stamp charge coal blend ◦ Lit review: CCRA 93:001/2019: A Review of Literatures on Stamp Charge Technology ◦ Coal blend formulation: CCRA TC 249 Dec 2019 ◦ **Base blend**: 45% PCI - 15%LV - 40% HVA ◦ **WCC Blend**: 40% PCI - 35% HVA - 25% WCC
					• MWO carbonization test plan (A3) ◦ Carbonization Test Plan ◦ Test 1: Gravity charge **BASE BLEND** at 820 kg/m3 dry BD and 2.5% moisture ◦ Test 2: Box charge **BASE BLEND** at 1000 kg/m3 dry BD and 10% moisture ◦ Test 3: Gravity charge **WCC BLEND** at 820 kg/m3 dry BD and 2.5% moisture ◦ Test 4: Box Charge **WCC BLEND** at 1000 kg/m3 dry BD and 10% moisture Test | 1 | 2 | 3 | 4 Blend | Base | Base | WCC | WCC Charge Method | Gravity | Box | Gravity | Box Particle Size | 80%<3mm | TBD | 80%<3mm | TBD BD(dry) | 820 | 1000 | 820 | 1000 Moisture | 2.5% | 10% | 2.5% | 10%
				Coal Stampability Assessment	• Project Status Review ◦ 268 TC Meeting Presentation • Coal Stampability Assessment ◦ 269 TC Meeting Presentation ◦ 270 TC Meeting Presentation

Test	1	2	3	4
Blend	Base	Base	WCC	WCC
Charge Method	Gravity	Box	Gravity	Box
Particle Size	80%<3mm	TBD	80%<3mm	TBD
BD(dry)	820	1000	820	1000
Moisture	2.5%	10%	2.5%	10%

CanmetENERGY MFL Facilities	Benchmarking of Movable Wall Ovens	CanmetENERGY
		Marc Saull
			• To ensure the reliability and repeatability of CanmetENERGY pilot scale coke ovens	**Conduct carbonization tests in 18in oven and in Carbolite with same coal blend**	○ 2020
					  ○ A3
					  ○ Report
					○ 2021
					  ○ A3
					○ 2022
					  ○ A3
					○ 2024
					  ○ A3
					  ○ TWT Report: MWO Benchmarking Study 2024
					○ 2025
					  ○ A3
					  ○ 269 TC Meeting Presentation

	Quarterly LQSI Round Robin	CanmetENERGY Marc Saull Kun Liu	• To ensure the reliability of equipment in CanmetENERGY for coal and coke analysis	**Participate in quarterly LQSI Round Robin**	○ On going

Completed Projects				
Program	**Projects**	**Project Objectives**	**Project Tasks**	
Fundamental of Coal Science	CCRA 54: ISO and ASTM Coal and Coke Standards	• Development of standards and procedures pertaining to Canadian Coal and Steel industries	**ISO Inter Lab Study on Dilatation**	• Normalization of dilatation measurement results to reference mass ○ Final Report: Inter Laboratory Study on Coal Dilatation under ISO/TC27 ○ METEC 2019: Findings of inter laboratory study on coal dilatation under ISO/TC27 and importance of correcting experimental dilatation results to a reference coal mass
			Effect of coal particle size on rheology measurement	• Fluidity and dilatation measurement of US coal samples at different size (A3) ○ METEC 2019: Coal rheology - A Practical Approach for Industry ○ AIST 2019: Coal Rheology — A Practical Approach for Industry
				• Fluidity and dilatation measurement of Canadian coal samples at different size (A3) ○ AM Dofasco Report: Coal Rheology- Effect of Coal Origin Rank and Particle size ○ AIST 2020: Coal Rheology- The Effect of Rand and Sample Preparation on Test Results ○ International Journal of Coal Preparation and Utilization: Coal Rheology – The Effect of Coal Origin, Rank and Particle Size
			Sapozhnikov Plastometery	• Equipment Commissioning (A3) ○ Report: CCRA 54:001/2020 Commissioning of CKIC Automatic Sapozhnikov Plastometer ○ Report: CCRA 54:002/2020 Automatic Sapozhnikov Plastometry Parameters Determination • Effect of Fines Content on Sapozhnikov Plastometry Measurement for ISO Standard Development ○ CCRA 54:001/2021 Effect of Fines Content on Sapozhnikov Plastometry Parameters • Interpretation of Sapozhnikov Measurement Data ○ TC 248 Technical Committee Presentation: Literature Review ○ CCRA 54: 003/2020: Automatic Sapozhnikov Plastometry Parameters Determination ○ CCRA 260 TC Meeting Presentation: Relationship between Sapozhnikov and Rheology ○ CCRA 261 TC Meeting Presentation: Relationship between Sapozhnikov and Rheology ○ Publication: Relationship between Coking Properties Measured by Automatic Sapozhnikov Plastometer with Other Measurements
	CCRA 86: Performance of Canadian Coals in High Inert Blends	• To understand how Western Canadian coals behave/work in high inert blends.	**High Inert Blends Performance**	○ Report: CCRA 86:001/2021 Hi Inert Blends Performance Program Update

	CCRA87: Technical Merits of Western Canadian Coals	• To develop fundamental studies that show the technical merits of Western Canadian coals.	**MOF Diagram Modification**	○ AIST 2013: Predictive Model for Blending Coking Coals Part 1 Canadian Coal
				○ AIST 2015: Predictive Model for Blending Coking Coals Part 2 US Coal
				○ METEC 2015 Predictive Model for Blending Coking Coals to Produce High Strength Coke
				○ Preparation for next phase with Australian Coal
				  ○ Test Plan
				  ○ Letter to ARCAP

Blast Furnace Ironmaking Process Carbon Efficiency Enhancement	CCRA 91: Blast Furnace Energy Reduction Initiatives using Auxiliary Fuel Injection	• To develop analytical method for monitoring the combustion efficiency of pulverized coal injection in industrial blast furnace • To determine the roles of coal rheology and petrographic properties on pulverized coal combustibility	**Preliminary Study**	○ AIST 2015: Evaluation of PCI Coals in New Injection Facility at CanmetENERGY-OTTAWA
			PCI rig setup	• Standard rig test procedure ○ CCRA Report (CCRA 91:001/2018): CanmetENERGY Pulverized Coal Injection Rig Repeatability Tests

				• Rig capability enhancement
				○ Natural gas/Coke oven gas- Coal co-injection (A3)
				  ○ CCRA Report (CCRA 91:003/2019): Re-Commissioning of Natural Gas-Coal Co-Injection Capability
				  ○ CCRA Report (CCRA 91:004/2019): Effect of Natural Gas Co-Injection on Pulverized Coal Combustion
				  ○ CCRA Report (CCRA 91:005/2019): Comparison between Combustion of Coke Oven Gas and Natural Gas

			Develop relationship between coal properties (petrography, rheology) and combustion behaviour	• Collection of coal properties data and combustion behavior ○ CCRA Report (CCRA91:002/2019): Carbonaceous Materials Transformation during Pulverized Coal Injection ○ AIST 2019: Carbonaceous Materials Transformation in Pulverized Coal Injection ○ METEC 2019: Effect of Coal Properties on Combustion Behavior during Pulverized Coal Injection
	CCRA 82: Factors Affecting Coke Bed Permeability	• To understand the effect of coke size and shape on bed permeability	**Analytical technique development characterizes size and shape of coke**	• Equipment setup for coke bed permeability measurement ○ Completed • Image analysis technique development for coke size and shape characterisation ○ AIST 2013 Coke Size and Shape Characterisation for Bed Permeability Estimation
			Relationship between coke size and shape and bed permeability	○ AIST 2017 Factors Affecting Coke Bed Permeability

CanmetENERGY MFL Facilities	High Temperature Furnace Re-Commissioning	• To upgrade the high temperature furnace for blast furnace iron ore reduction simulation	**HTF Re-commissioning**	○ System Functionality Test
				  ○ Completed (CCRA TC 255 June 2021)
				○ Work Instruction and Task Hazard Analysis
				  ○ Completed
				○ Commissioning Test
				  ○ Completed (CCRA TC 256 September 2021)