Canadian Carbonization Research Association

2017-2018 Annual Report

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The Canadian Carbonization Research Association (CCRA) was formed on September 2, 1965 – providing over 52 years of Research supporting the Canadian Coal and Carbonization Industries

Chairman's Remarks

Since its inception in 1965, the Canadian Carbonization Research Association (CCRA) has provided an excellent framework for technical/technological cooperation between government and industry, which has been very successful for both parties. The CCRA is a unique organization in being Canada's only technical support for the Canadian metallurgical coal and coking industries. This organization continues to be of real value to its member companies and to the financial health of the associated industries. The value of its research is becoming more recognized and appreciated on a global basis.

The role of the CCRA is to strive to meet its members' needs. Its technical research program continues to evolve constantly as the demands of the coal, cokemaking and ironmaking industry change with the issues facing Canada. With new members arise more ideas leading to potential solutions for some of the technical challenges facing the coal and steel industries. It is important to continue sharing our research findings with fellow researchers and industry. The CCRA has again published its work in several international journals and presented papers at both domestic and international conferences. These papers can be found on the CCRA website, www.cancarb.ca.

With the pilot Energy Recovery Coke Oven construction near completion and the new pulverized coal test rig up and running, the R&D capability of CCRA and CanmetENERGY has increased tremendously. There is a new wave of research the CCRA is undertaking with the development of bio-based carbon to mitigate GHG emissions in our industries. We look forward to these new technical challenges.

"The CCRA is a unique organization in being Canada's only technical support for the Canadian metallurgical coal and coking industries."

The CCRA continues to be supported by key members representing the coal sector (Teck), the cokemaking sector (SunCoke Energy) and the integrated ironmaking sector (ArcelorMittal Dofasco and Stelco). We remain in touch with past member companies and invite them to rejoin the association as they continue to grow their respective companies.

Globally, the Canadian Carbonization Research Association is autonomous in its ability to continue to expand and meet its members' requirements. This remarkable co-operative relationship between the coal industry, steel industry and government is truly unique, and its R&D program will continue to address and reflect its members needs for years to come.

Ted Todoschuk,
Chairman, Board of Directors

Technical Committee Report

TECHNICAL COMMITTEE MEETINGS

The CCRA Technical Committee held four meetings during Fiscal Year 2017-18:

Meeting No.	Location	Date
239	Ottawa, ON	June 6-7, 2017
240	Vancouver, BC	September 19-20, 2017
241	Ottawa, ON	December 5-6, 2017
242	Vancouver, BC	March 13-15, 2018

The 2017-18 Research Program consisted of four main research areas:

1. Energy and CO2 Reduction in the Coal and Steel Industry
2. Energy and Environment
3. Fundamental Aspects of Coal and Coke Utilization
4. Database, Standards and Procedures

In total, 11 projects were part of the active Research Program.

Major accomplishments/highlights:

1. During FY 2017-18, the CCRA published a paper on *'Value-In-Use of Renewable Biocarbon for Direct Injection in Blast Furnace Ironmaking'* in Ironmaking and Steelmaking journal; it 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).

2. On **Blast Furnace energy reduction initiatives** (CCRA 91), the PCI experimental rig 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 VM and FC and a new approach using TGA was developed to quantify the reactivity of combustion residues.

3. On the use of **Renewable energy for the steel industry** (CCRA 70), research was pursued on a few 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. The major challenges in industrial scale implementation of bio-carbon use in steel production arises from the lack of

biomass supply and bio-carbon production capacity in Canada. Commercialization of bio-carbon fuel production processes is challenging due mainly to fact that the entire supply chain of bio-carbon fuel is not properly established. The goal of this project is to assist bio-carbon producers in further expanding their production capacity. This is to be achieved by defining the specific technical properties of solid bio-carbon fuel required for substituting fossil fuel in steel production. The project will also evaluate the value-in-use of solid bio-carbon fuel in steel production. A review was made on solid biocarbon production technology development worldwide. The highest capacity technology is the conventional slow pyrolysis for charcoal production. In terms of new technology development, the most common one is torrefaction.

The major challenge in utilizing biochar in EAF steelmaking originates from the poor wetting of biochar by EAF slag (resulting in poor foaming capacity). The plan is to examine the carbon crystallinity of carbonaceous material by XRD, Raman and SEM and determine role of crystallinity on carbon/slag interaction. Steel melting tests with high carbon content bio-char will be conducted at CanmetMATERIALS in Hamilton using a closed system to analyze the off gas.

Adding biocarbon to a coal blend will decrease CSR. Experimental work using bio-briquetting found that the CSR of bio-coke with the overall incorporation of 10% biomass via bio-briquette is improved compared to the addition of 5% loose biocarbon. CSR was reduced from 56 to 49 and CRI increased from 31 to 41 so briquetting has a positive value. Coke texture analysis revealed the changes in the coke structure with the use of biocarbon. The presence of bio-carbon particles interrupts the continuity of the normal coke texture and thus the coal surrounding biocarbon particles was not fully coked. This results in a portion of coal that is under coked, which may affect the resultant coke size and ambient strength.

A techno-economic model was developed to evaluate the value-in-use (VIU) of biochar for substituting PCI. In brief, optimization of biochar chemical composition is required to maximize the VIU of biochar for direct injection. Severe pyrolysis is needed to produce biocarbon with high C and low O content. However, severe pyrolysis leads to concentration of the ash in resultant biocarbon, which means high P and K contents. It is impossible to keep P and K contents lower than coal while maintaining desired O/C ratio, but one could blend biocarbons produced by different technologies (HTC, Torrefaction, Slow pyrolysis) to address this issue. Low ash fusion temperature in biocarbon will be another barrier for using biocarbon as an injection fuel.

The CanmetENERGY Bioenegy group made progress on biochar production and handling. Among these, a small-scale HTC unit (40 L) was installed to further understand the process, methodology developed to quantify biochar grindability, and densification and pellet durability examined (transport and storage).

4. On **Energy Recovery Coke Oven** (CCRA 77), construction of Pilot Oven Facility continued with heat-up anticipated in May 2018 followed by cool and hot commissioning by October-November 2018.

SunCoke and AM Chicago reiterated their availability to provide assistance and expertise with the oven start up process. SunCoke Energy remarked on the importance of ensuring safety around the ERCO. More specifically, the need to prepare sound safety operation procedures (SOP), Failure Modes and Effects Analysis (FMEA), work procedures including pre-job task list and job safety.

CSIRO/QCAT (Australia) provided documents related to operation of their NRO, which could be applicable to ours and for preparing FMEA document. A draft A3 plan of research activities for the ERCO, including cool and hot commissioning, gauge r&R and potential R&D projects was prepared.

5. On **Coal resource quality evaluation** (CCRA 90), Phase 1 of Geoscience BC project (2017) which focused on comparing coal and coke quality upon washing four Western Canadian coals (easy/difficult to wash, fine/coarse and coarse samples) with organic liquids (float-sink) and water (jig) was completed under budget and on-time. A proposal and budget for Phase 2 (2018) focused on refining Roben Jig operation methodology to minimize misplaced material was submitted to Geoscience BC in November 2017. After receiving part of the funding requested from GBC, work with a reduced scope will proceed in 2018-19.

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.

A joint GBC/CCRA Letter of Interest was prepared and submitted towards the Clean Growth Program for funding of the jig work but was not selected to move forward. It is worth noting that Australia is revising its Float/Sink standard, investigating use of alternative liquids to organic

chemicals, and improving safety of test using organic chemicals with plan to develop standards to address other methods for density separation of coal that may include jigging.

6. On **Mineral matter and coke reactivity** (CCRA 81), coke textures were completed on Phase 1 of CCRA Mineral Addition project, revealing that carbonate minerals (Ca & Fe) negatively affect CSR and CRI of high CSR WC MV coking coal and that fine minerals have a greater effect than coarse ones due to higher surface area effects. Doping the WC Coal with 1% minerals of different size (coarse/fine) does not affect the overall textures with respect to those observed in 100% coal. However, local textures near the minerals were affected. It was noted that the minerals were located within and outside the coke matrix. Changes observed in CSR/CRI are attributed to a catalytic effect of the minerals present (mainly $CaCO_3$ & $FeCO_3$).

In Phase 2, Ca and Fe carbonate minerals in coarse and fine sizes were added to a US HV coking coal to determine effect on CSR/CRI and related analyses for comparing with findings on WC MV coking coal examined in Phase 1.

7. On **Factors affecting coke bed permeability** (CCRA 82), pilot and industrial oven data found that oven size/volume and operation had only a minor influence on coke shape and extent of stabilization led to narrower coke size distribution, reduced mean coke size and to no significant change (only slight reduction) in coke shape.

8. On **Standards** (CCRA 54), regular updates were presented on CanmetENERGY Met Fuels Lab performance in CPA coal petrography, LQSI CRI, Tumbler Test, MET Coal and HGI Round Robins. CanmetENERGY addressed issues of consistently low Ro measurement with CPA and consistently high ASTM coke stability and hardness by ensuring that ASTM drum thickness and lifter heights were meeting specifications of ASTM D 3402-16. Residual data for four test labs was found to be in line with stability and hardness R precision values, 4.5 and 3.4.

Canada participated in ISO/TC27 meeting in Australia (October 2017). Summary of Inter Laboratory Study (ILS) on Coal Dilatation was presented showing that %D2.5 correction tightened reproducibility (R) limits in ISO 23873, with respect to simply reporting %D. While inclusion of D2.5 in ISO 23873 was not accepted, Canada plans to use results of ILS as basis for revising ISO 349, currently at CD stage, to include the calculation of dilatation to a fixed mass of 2.5 g. It will also prepare a paper highlighting main findings of ILS supported with dilatation data, %D and %D2.5 for Canadian and foreign coals, and with marketing viewpoint from Canadian met coal producers.

An ILS will be conducted on Sapozhnikov plastometer test under ISO/TC27, which will include both automated and manual. Canada will provide test samples and participate. ASTM D05 will organise an ILS on HGI in 2019 in which both CanmetENERGY and AM Dofasco will participate.

9. On **International research collaboration** (CCRA 75), ACARP distributed a final report *International carbonization and coke testing round robin* (C25047) to the participant labs in May 2017.

Potential collaboration with BHP/CSIRO NRO on developing operation/work procedures for ERCO, conducting testing of individual seams of Canadian, US and Australian coals and examining minerals in coal and microstructure in coke and with U. Newcastle on developing reliable procedure to evaluate self-heating properties of coal.

CanmetENERGY needs to establish links with universities but first need to identify well defined project(s) from industrial company(ies). In the short to medium term, this could be a good mechanism to find/hire new scientists and speed up some of the priority CCRA research work.

10. On **Small-scale carbonization facility for cold & hot coke strength determination** (CCRA 88), a presentation was made on developing a new TGA technique to quantify chemical reactivity of coke. Results presented demonstrated that the chemical reactivity of coke samples produced by SHO and MWO are very similar; the technique requires modification to apply to PCI combustion residues.

On developing an alternative small-scale coking facility and/or smaller coke oven charges, several options to increase coking output/productivity at CanmetENERGY-Ottawa was presented. This includes (i) side charging CanmetENERGY 350 kg ovens with two separated coals or with lower weights of coal to meet the tumble test requirements or (ii) a smaller coke oven (Nippon Steel, China 70/90 kg or Carbolite 90 kg) that meets the 450 mm chamber width heating profile and coal charge criteria. Ultimately, small coking oven should meet the needs of every company and the quality of resulting coke was very important.

A number of organizations and individuals including Kim Hockings, QCAT/CSIRO, Australia, Merrick Mahoney, ex BHP, Drazen Gajic, DMT Germany and Seiji Nomura, Nippon Steel/Sumitomo Metal Japan will be consulted on their thoughts and experience surrounding small scale coke ovens.

11. On **Benchmarking of movable wall ovens** (CCRA 92), results of trials conducted in February 2018 using same steelmaker coal blend as for benchmarking work conducted in February 2016 found that resulting coke quality was very similar for both set of trials. As the variation in coke quality between the 18in oven and Carbolite was very small, both ovens continue to generate highly repeatable results.

12. On **Box charging/Stamp charging carbonization**, the design and building a charging table at Teck was completed on time and on budget and delivered to the Met Fuels Lab in Ottawa in May 2017. An updated A3 research plan on the work proposed on investigating the performance of Western Canadian Coals (rank, BD & inert level) under stamp charging was presented. As part of the 2018 Oven Benchmarking, a single compartment box charge test was done in the Carbolite oven in March 2018 and found coke quality to be very similar between gravity charge and box charge. This work will be pursued in 2018-19.

CCRA-CanmetENERGY Paper, 2017-2018

1. Ng, K.W., Giroux, L., Todoschuk, T. "Value-in-use of Biocarbon Fuel for Direct Injection in Blast Furnace Ironmaking", Ironmaking and Steelmaking, 2018, pp. 1-5 DOI: http://dx.doi.org/10.1080/03019233.2018.1457837

Conference Proceedings, 2017-18

1. Ng, K.W., Giroux, L. *"CanmetENERGY's Experience on Performing High-Temperature Dilatation Measurements"*, AISTech 2017 conference proceedings, Nashville, USA

2. Ng, K.W., Ray, S., Giroux, L., Bronson, B, Tourigny, G., Dutta, A., Todoschuk, T. *"Suitability of Bio-Chars from Different Production Technologies for Direct Blast Furnace Injection"*, AISTech 2017 conference proceedings, Nashville, USA

3. Ng, K.W., Giroux, L. *"Factors Affecting Blast Furnace Coke Bed Permeability",* AISTech 2017 conference proceedings, Nashville, USA

4. Zhang, Q., Price J.T., Ryan, B., Yang, Y., Giroux, L. *"Effect of Coal Mineral Type and Size on Coke Strength after Reaction"*, AISTech 2017 conference proceedings, Nashville, USA

Published Report, 2017-18

1. Mackay, M.L., Leeder, R.L., Giroux, L., Dexter, H., Holuszko, M., Halko, J., Howey, C. and Thomas, D. (2018): *"Producing clean coal from western Canadian coalfields using the water based Roben Jig process"*; in Geoscience BC Summary of Activities 2017: Minerals and Mining, Geoscience BC, Report 2018-1, p. 69–86

CanmetENERGY-Ottawa Met Fuels Facilities Utilization:

CanmetEnergy oven utilization statistics for 2017-18 (Table 1) shows the following in comparison with 2016-2017:

Sole-Heated Ovens

1. CCRA – 20 vs 20 trials (65% SHO1, 35% SHO3)

2. Coal Companies – 141 vs 166 trials (60% SHO1, 40% SHO3)

3. Steel Companies – 118 vs 113 (74% SHO1, 25% SHO3)

In total, usage of sole-heated ovens in 2017-18 was 279 trials - compared to 299 trials in 2016-17 (7% lower).

Sole-Heated Oven Coke Reheats - CSR

1. CCRA – 15 vs 18

2. Coal Companies – 19 vs 8

3. Steel Companies – 32 vs 39

In total, 66 reheats of sole-heated oven cokes for CSR determination – vs 65 in 2016-17 (2% higher).

MWO CSR Determination

1. CCRA – 5 vs 3

2. Coal Companies – 147 vs 148

3. Steel Companies – 51 vs 25

In total, 203 MWO CSR evaluations were performed – vs 176 in 2016-17 (15% higher). In addition, 19 CSRs were done on cokes received at CanmetENERGY-Ottawa Met Fuels (7 CSRs for CCRA, 6 CSRs for Coal Companies, and 6 CSRs for Steel Companies). Combining SHO, MWO and Cokes received at Met Fuels, 288 CSR tests were done in 2017-18 compared to 314 tests in 2016-17 (8% lower).

Coke Stabilization

No coke stabilization trials were done in 2017-18 vs 13 in 2016-17.

Movable Wall Ovens

1. CCRA – 6 vs 3 trials (3 in Carbolite and 3 in 18-inch oven)

2. Coal Companies – 137 vs 162 trials (111 in Carbolite, 26 in 18-inch oven)

3. Steel Companies – 60 vs 35 trials (All in 18-inch oven)

In total, usage of movable wall ovens in 2017-18 was 203 trials compared to 200 trials in 2016-17 (2% higher).

PCI

1. CCRA – 2 vs 9 tests

2. Coal Companies – 0 test (2017-18 & 2016-17)

3. Steel Companies – 0 vs 11 tests

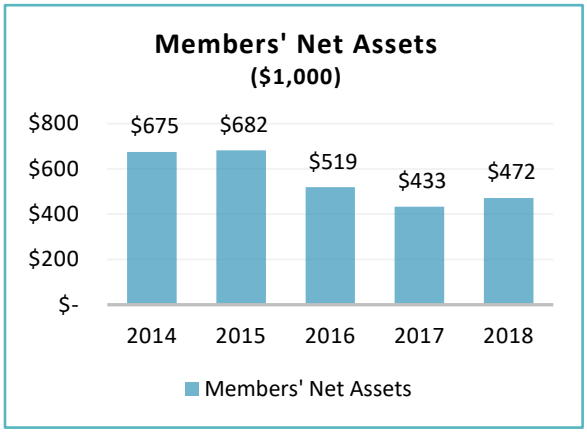
In total, 2 PCI tests were done in 2017-18 compared to 20 tests in 2016-17 (90% lower). In large this was due to the required upgrades to the PCI test facility.

Table 1 - Utilization of CanmetENERGY Facilities

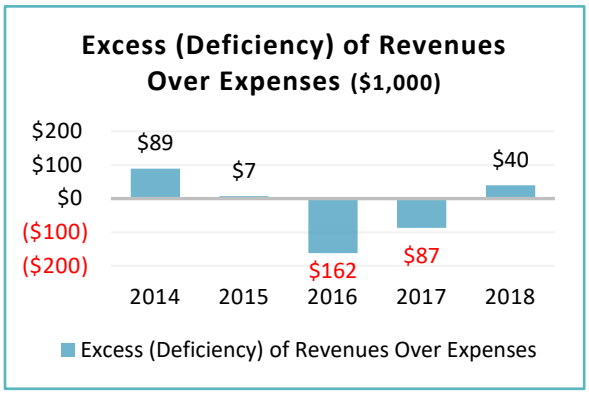
OVEN TESTS APRIL 1, 2017 – MARCH 31, 2018				
Oven	**CCRA**	**Coal Companies**	**Steel Companies**	**Totals**
SHO				
SHO1	13	84	88	**185**
SHO3	7	57	30	**94**
Total SHO	20	141	118	**279**
CSR				
SHO Coke Reheats/CSR	15	19	32	**66**
MWO CSR	5	147	51	**203**
Cokes for CSR	7	6	6	**19**
Total CSR	27	172	89	**288**
MOVABLE WALL OVEN				
18 Inch	3	26	60	**89**
Carbolite	3	111	0	**114**
Total MWO	6	137	60	**203**
PCI				
PCI	2	0	0	**2**

Year in Review

CCRA ended the 2017-18 fiscal year with a modest operating surplus due largely to increases in research levies and the addition of another member to the Association. Financially, Members' Net Assets at year-end totaled $472K reflecting a 9.1% increase to the level reported at the end of the 2016-2017 fiscal year and $209K lower than the most recent peak level of $682K reported at the end of the 2014-2015 fiscal year.



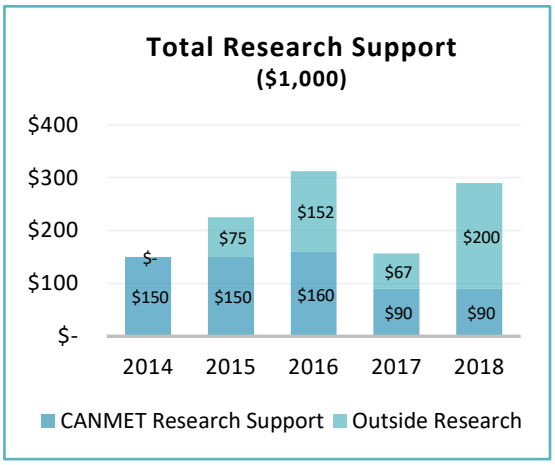
This increase reflects the impact of a $40K Excess of Revenues over Expenses for 2017-2018 representing the first operating surplus following two consecutive years of operating deficits.



Because of prudent financial planning, CCRA is able to absorb these temporary declines in membership allowing it to continue as a viable Association supporting CanmetENERGY through annual research support payments and confidential oven tests.

In February 2017, CCRA executed a funding agreement with Geoscience BC for research funding of up to $209K to study the production of clean coal from Western Canadian Coal Fields using the Water-based Roben Jig Process. By the end of the 2017-2018 fiscal year, CCRA had completed the first phase of this study and had begun a second phase.

Over the past five fiscal years, CCRA has invested a total of $1.134M in research support of which $640K or 56.4% was contributed to CanmetENERGY.



With respect to the confidential testing program for Members, CCRA incurred a total of $1.19M in testing during the 2017-2018 fiscal year which approximates the $1.21M annual average program spending over the last five years.

CCRA continues to restrict its administrative costs to maximize the amounts available to support research programs. During 2017-2018, CCRA expended a total of $26K towards management, professional fees and insurance representing a 7.1% reduction to the $28K incurred during the 2016-2017 fiscal year.

In summary, CCRA continues to remain in a strong financial position necessary to support its continued investment in research initiatives supporting the coal and carbonization industries in Canada.

Brian D'Amboise, CPA, CA
Treasurer

The Canadian Carbonization Research Association (CCRA) continues to be a source of reliable support to CanmetENERGY activities by investing over the last five years a total of $640K in direct Research Support plus $6.03M in Member Confidential Testing contributions.

Audited Financial Statements

crawford
smith &
swallow

CANADIAN CARBONIZATION RESEARCH ASSOCIATION

Financial Statements

March 31, 2018

crawford smith & swallow

CANADIAN CARBONIZATION RESEARCH ASSOCIATION

Financial Statements

March 31, 2018

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INDEPENDENT AUDITORS' REPORT

To the Members of the
Canadian Carbonization Research Association

We have audited the accompanying financial statements of the Canadian Carbonization Research Association, which comprise the statement of financial position as at March 31, 2018, and the statements of operations and changes in members' net assets and cash flows for the year then ended, and a summary of significant accounting policies and other explanatory information.

Management's Responsibility 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.

Auditors' Responsibility
Our responsibility is to express an opinion on these financial statements based on our audit. We conducted our audit in accordance with Canadian generally accepted auditing standards. Those standards require that we comply with ethical requirements and plan and perform the audit to obtain reasonable assurance about whether the financial statements are free from material misstatement.

An audit involves performing procedures to obtain audit evidence about the amounts and disclosures in the financial statements. The procedures selected depend on the auditors' judgment, including the assessment of the risks of material misstatement of the financial statements, whether due to fraud or error. In making those risk assessments, the auditors consider internal control relevant to the entity's preparation and fair presentation of the financial statements 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 entity's internal control. An audit also includes evaluating the appropriateness of accounting policies used and the reasonableness of accounting estimates made by management, as well as evaluating the overall presentation of the financial statements.

We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our audit opinion.

Opinion
In our opinion, the financial statements present fairly, in all material respects, the financial position of the Canadian Carbonization Research Association as at March 31, 2018, 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.

Niagara Falls, Ontario
June 20, 2018

CRAWFORD, SMITH AND SWALLOW
CHARTERED ACCOUNTANTS LLP

LICENSED PUBLIC ACCOUNTANTS

CANADIAN CARBONIZATION RESEARCH ASSOCIATION

STATEMENT OF FINANCIAL POSITION

March 31, 2018

Assets	2018 $	2017 $
Current Assets		
Cash	44,958	7,947
Temporary investments	526,361	600,933
Sales tax recoverable	2,205	4,076
Prepaid expenses	1,725	1,710
	575,249	**614,666**
Liabilities and Members' Net Assets		
Current Liabilities		
Accounts payable and accrued liabilities	17,282	19,940
Due to CANMET	22,500	22,500
Deferred revenue - note 2	63,454	139,669
	103,236	182,109
Contingent Liability - note 7		
Members' Net Assets	472,013	432,557
	575,249	**614,666**

Signed on behalf of the Board:

Director

Director

See accompanying notes

CANADIAN CARBONIZATION RESEARCH ASSOCIATION

STATEMENT OF OPERATIONS AND CHANGES IN MEMBERS' NET ASSETS

for the year ended March 31, 2018

	2018 $	2017 $
Revenue		
Confidential research and development	1,193,154	1,150,794
Research levies	160,000	90,000
Outside research grants	191,846	6,631
Consulting funding		3,000
Membership fees	400	300
Interest income	8,094	2,737
Other income	1,121	
	1,554,615	1,253,462
Operating Expenses		
Confidential research and development	1,193,154	1,150,794
CANMET research support	90,000	90,000
Consulting	5,800	4,500
Outside research	200,146	66,898
Office	16,449	19,884
Professional fees	7,045	7,238
Insurance	2,565	855
	1,515,159	1,340,169
Excess (Deficiency) of Revenue over Expenses	39,456	(86,707)
Members' Net Assets, Beginning of Year	432,557	519,264
Members' Net Assets, End of Year	**472,013**	**432,557**

See accompanying notes

CANADIAN CARBONIZATION RESEARCH ASSOCIATION

STATEMENT OF CASH FLOWS

for the year ended March 31, 2018

	2018 $	2017 $
Operating Activities		
Excess (deficiency) of revenue over expenses	39,456	(86,707)
Changes in working capital components – note 3	(77,017)	(248,452)
Funds used by operating activities	(37,561)	(335,159)
Investing Activities		
Decrease in temporary investments	74,572	81,905
Increase (Decrease) in Cash	37,011	(253,254)
Cash, Beginning of Year	7,947	261,201
Cash, End of Year	**44,958**	**7,947**

See accompanying notes

CANADIAN CARBONIZATION RESEARCH ASSOCIATION

NOTES TO FINANCIAL STATEMENTS

for the year ended March 31, 2018

Organization

Canadian Carbonization Research Association (the "Association") is a national organization which initiates, coordinates and provides funding towards research and development having particular importance to the coal and carbonization industries of Canada. 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

Membership fees, research levies, consulting funding and other income 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. Non-recovery contributions are voluntary in nature and recognized in the year of receipt.

Financial instruments

The Association's financial instruments consist of cash, temporary investments, accounts receivable, accounts payable and accrued liabilities and due to CANMET. Financial instruments 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 CARBONIZATION RESEARCH ASSOCIATION

NOTES TO FINANCIAL STATEMENTS

for the year ended March 31, 2018

2. Deferred Revenue

Deferred revenue represents unspent resources externally restricted for various purposes and restricted funding received in the current year to be spent at some point in the future. Changes in the deferred revenue balance are as follows:

	2018 $	2017 $
Balance, beginning of year	139,669	
Add restricted amounts received in the year	115,631	146,300
Less recognized in income during the year	(191,846)	(6,631)
Balance, end of year	**63,454**	**139,669**

3. Statement of Cash Flows

Changes in working capital components include:

	2018 $	2017 $
Accounts receivable		5
Sales tax recoverable	1,871	32,588
Prepaid expenses	(15)	(1,710)
Accounts payable and accrued liabilities	(2,658)	1,194
Due to CANMET		(420,198)
Deferred revenue	(76,215)	139,669
	(77,017)	**(248,452)**

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 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 $ 7,665 (2017 - $ 4,642). As a result of a decrease in temporary investments during the year, the Association's exposure to interest rate risk has decreased over the prior year.

CANADIAN CARBONIZATION RESEARCH ASSOCIATION

NOTES TO FINANCIAL STATEMENTS

for the year ended March 31, 2018

5. Related Party Transactions

Fees amounting to $ 15,308 (2017 - $ 10,530) were paid to the treasurer of the Association during the year for management and accounting services.

Fees amounting to nil (2017 - $ 5,681) were charged by Burlington Management Services Inc. ("BMSI") for the year. BMSI is owned by the previous Treasurer of the Association.

These transactions were recorded at the exchange amount.

6. Taxation Status

The Association is exempt from income taxes as it has complied with the necessary provisions of the Federal and Provincial Tax Acts. Consequently, no provision for income taxes is reflected in the accounts.

7. Contingent Liability

As at March 31, 2018, the Association has an outstanding claim against it relating to interest on overdue accounts payable in the amount of $ 40,037. This amount has not been accrued for in the financial statements. It is the Association's assertion that adequate defences are in effect for the settlement of these amounts.

CANADIAN CARBONIZATION RESEARCH ASSOCIATION

Schedule 1

FIVE YEAR FINANCIAL REVIEW

UNAUDITED STATEMENT OF OPERATIONS AND MEMBERS' NET ASSETS

for the year ended March 31, 2018

	2018 $	2017 $	2016 $	2015 $	2014 $
Revenues					
Confidential research and development	1,193,154	1,150,794	944,529	1,326,422	1,415,184
Research levies	160,000	90,000	165,000	190,000	190,000
Outside research grant	191,846	6,631			
Non-recovery oven contributions					67,000
Consulting funding		3,000	6,425	6,425	7,710
Membership fees	400	300	800	800	700
Interest income	8,094	2,737	5,699	8,481	7,183
Other income	1,121			55	1,733
PWC funding				60,000	
	1,554,615	1,253,462	1,122,453	1,592,183	1,689,510
Operating Expenses					
Confidential research and development	1,193,154	1,150,794	944,529	1,326,422	1,415,184
CANMET research support	90,000	90,000	160,000	150,000	150,000
Consulting	5,800	4,500	3,000	8,857	8,857
Outside research	200,146	66,898	151,727	75,213	
Meeting			816	834	
Office	16,449	19,884	17,192	17,562	16,639
Professional fees	7,045	7,238	7,385	6,415	9,542
Insurance	2,565	855			
	1,515,159	1,340,169	1,284,649	1,585,303	1,600,222
Excess (Deficiency) of Revenues over Expenses	39,456	(86,707)	(162,196)	6,880	89,288
Members' Net Assets, Beginning of Year	432,557	519,264	681,460	674,580	585,292
Members' Net Assets, End of Year	**472,013**	**432,557**	**519,264**	**681,460**	**674,580**

See accompanying notes

CANADIAN CARBONIZATION RESEARCH ASSOCIATION

Schedule 1 - continued

FIVE YEAR FINANCIAL REVIEW

UNAUDITED STATEMENT OF FINANCIAL POSITION

as at March 31, 2018

	2018 $	2017 $	2016 $	2015 $	2014 $
Assets					
Current Assets					
Cash	44,958	7,947	261,201	277,171	361
Temporary investments	526,361	600,933	682,838	1,350,413	1,359,655
Accounts receivable	2,205	4,076	36,669	32,784	313,845
Prepaid expenses	1,725	1,710			8,850
	575,249	**614,666**	**980,708**	**1,660,368**	**1,682,711**
Liabilities and Members' Net Assets					
Current Liabilities					
Accounts payable and accrued liabilities	17,282	19,940	18,746	10,200	8,661
Due to CANMET	22,500	22,500	442,698	968,708	979,470
Deferred revenue	63,454	139,669			20,000
	103,236	182,109	461,444	978,908	1,008,131
Members' Net Assets	472,013	432,557	519,264	681,460	674,580
	575,249	**614,666**	**980,708**	**1,660,368**	**1,682,711**

See accompanying notes

CCRA History

From Concept to Reality

During a visit to the Booth Street lab of Energy Mines & Resources (EMR), F.J. Pearce, who worked for The Steel Company of Canada, Limited was discussing the coke and coal situation with Dr. J. Walsh and J. Chisholm and it was apparent that Industry and EMR should develop a formal Research/Technical relationship. With the approval of senior government and Stelco management, F.J. Pearce was asked to contact all of the Canadian coal and steel companies in order to form the basis for the relationship.

From this initial discussion, the concept of the Canadian Carbonization Research Association was developed from the responses to F.J. Pearce's contacts. Dr. Walsh and J. Chisholm sought the approval of senior government management and A. Ignatieff of EMR was in complete support of the idea, and this cleared the way for the concept to become reality.

The Canadian Carbonization Research Association (CCRA) was formed on September 2, 1965

The Canadian Carbonization Research Association (CCRA) 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. The Association's original members were C.W. Drake of Algoma Steel Corporation, W.J. Riva of Canmore Mines Limited, J. John of Crows Nest Industries, J.E. Ludberg of Dominion Foundries and Steel Limited, T.G. Cassidy of Dominion Tar & Chemicals Ltd, R.P. Nicholson of Dosco Steel Ltd, F.J. Pearce of The Steel Company of Canada Limited and J. H. Walsh of The Mines Branch of Energy, Mines and Resources.

Others at this founding meeting were H.N. Paulencu of Stelco, A. Ignatieff, J.C. Botham, D.S. Montgomery and J.H. Hudson of CANMET. They were representatives of the major cokemaking steel producers, independent coke producer, major metallurgical coal miners, major coal tar users of the day and the Federal Government area involved with these Industries.

The first Chairman of the Board of Directors was C.W. Drake, with J. Ludberg as Treasurer and J. Walsh as Secretary. The Technical Committee Chairman was F. Pearce with R. Zavitz, R. Nicholson and J. Botham of EMR as Secretary.

CCRA is a unique co-operative research and development effort between Industry and Government which became a model for many other industry/government R&D joint efforts. CCRA and CANMET have had different opinions on what R&D priorities should be the focus of the Joint Program, however, through dialogue and discussion, these differences have always resulted in a consensus based program. The winner in this whole matter has been R&D in Canada and we look forward to the continuation of this joint effort for years to come.

The Early Years

The original members of CCRA 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 12inch Wide Pilot Coke Oven, a newly designed Sole heated Oven and the BM/AGA Coke Oven. J. Walsh managed this new facility and the other EMR staff helped with the operation including J.C. Botham, who later became the Technical Manager.

At first, the operation of the equipment was often performed by personnel from CCRA member companies and later CCRA employed personnel for this purpose. In 1968, a new facility location was chosen at Bells Corners, 20 km west of downtown Ottawa, where a laboratory was to be built. CCRA played a significant role in getting this new Laboratory. EMR provided the building facilities and CCRA members supplying much of the carbonization equipment for the new lab. The new lab was to center around a new 18 inch silica brick movable wall oven. A 30 pound coke oven was also part of the new facilities and the BM/AGA Oven was redesigned and rebuilt.

In December 1968, the group at the Mines Branch responsible for coal and ironmaking were also relocated to Bells Corners.

Expanding Activities in the 1970's

In 1970, J. Ludberg of Dofasco became Chairman of the Board. W. Gardner joined the research staff at CANMET and was charged with getting the new 18 inch oven operational, relocating the 12 inch oven to Bells Corners and redesigning the BM/AGA oven. The coal preparation plant from Booth Street was moved to Clover Bar in Western Canada. Research work was managed by J.C. Botham under the direction of the Technical Committee and centered on coal pipelining, additives to coking charges, hot briquetting, form coking 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 with alumina refractory. A mini fluidized bed was constructed for heating coal for hot briquetting as part of the form coke project. By 1974, this facility was operational. EMR hired Dr. J. Gransden and Dr. J. Price who became the backbone of the Technical program and have gained international recognition as carbonization scientists.

In the early 1970's a major concern of the CCRA research was reliability of petrography to predict the coking quality of Western Canadian coal and considerable work was done to address the issue of reactive semi-fusinite in coal. When the "energy crisis" developed in 1973/74 concern about energy self-sufficiency came to the forefront. A considerable amount of research was done to determine if Western Canadian coal blends could make satisfactory coke for Blast Furnace operations. This crisis also resulted in a number of oil companies getting involved in the coal mining business and Shell Canada, Esso Resources, BP Canada and Gulf Canada became CCRA members.

The organization underwent a substantial change in 1975 when the movable wall coke oven crew, which had grown to six, switched from being CCRA employees to becoming EMR term employees, to conform with Government policy. CCRA 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. Mr. G.A. Chapman was appointed Treasurer.

Incorporation of CCRA & Facility Changes – the 1980's

CCRA 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 for election to the Board of Directors, and Active members appointing each a Technical Committee member.

CCRA Objectives:

(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.

The administration of CCRA is the responsibility of the Board of Directors to whom the Officers and other appointed positions report. The objectives of CCRA 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 pilot ovens 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 battery number 6, 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 CCRA has to be the CCRA/NKK Technical Exchanges that took place, in 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.

The fourth exchange took place, in Tokyo Japan in 1983 with about 20 CCRA representatives participating in the technical meetings and the tours of the Japanese steel mills that followed.

By the latter part of the 1980's 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. Many new projects were initiated by the Technical Committee in this period, one of which was the upgrading of coking quality of Canadian coals through wash plant control, while others included CSR and carbon texture, vertical temperature distribution in a coke oven, effect of partial oxidation of a component coal on coke quality, to mention a few.

A project to study coal injection into a blast furnace was approved and a special facility was built at Bells Corners. CCRA and Canadian Steel Industries Research Association co-sponsored a study "Strategic Ironmaking Study " with CANMET to review where ironmaking technology might go over the following 20 years. This 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 1990's

Canadian coal exports had doubled over the past decade but global warming was becoming a concern because of the effect on the environment. Research was aimed at reducing the cost of coke and energy for Canadian steel makers and finding a niche for Canadian coal. PCI work became very important to both the coal and steel companies. The PCI facilities at Bells Corners was proving its value in the injection program. A CCRA 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, CCRA celebrated the 30th Anniversary of its founding. Because of difficult economic conditions in the coal and steel industries, membership had declined to eight members and EMR was undergoing a review and CCRA was asked to prepare an Impact statement for their review.

By 1997, the CCRA/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 eligible to join as full members but wished to be part of CCRA.

Consolidation of the Coal Industry and the challenges of the 2000's

The year 2000 saw another downturn in steel and coal industries with two of the three Canadian steel company members and one coal producer having to drop their CCRA memberships because of financial considerations. The reduction in members complicated CCRA'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 CCRA as there was now only one coal and steel member. The Association and CANMET co-operated to keep CCRA as a viable entity and hoped that new members could be attracted when the economy in these industries improved. R. Leeder remained as Chairman of the Board of Directors and T. Todoschuk as Chairman of the Technical Committee.

Membership levels are dependent on the number of Companies eligible for membership as well as the business climate. 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.

The cokemaking industry was down to three steel producers, and because of economic hardships, only one remained a CCRA member. CANMET has a special category membership in CCRA "Associate Member" which carries full representation and voting privileges without CCRA fees. Other membership categories are Connected, Affiliated, and Inactive.

The CCRA /CANMET relationship has evolved over the years and this was formally put into an "Understanding" or Agreement document created in 1984. This document was modified with the latest update completed in 2000.

International recognition has been achieved for the R&D work performed through the CCRA/CANMET partnership

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

The fields of R&D covered by the joint CCRA/CANMET program include energy and fuel conservation, 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 long term work necessary for the future.

The CCRA/CANMET R&D program has provided 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 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. Canada is one of the major exporting country of metallurgical coal and supplies a growing proportion of the coking coal used in Eastern Canada.

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

At the end of 2006, Dr. Ross Leeder , the longest serving member of the Board retired. 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 Chairman of the BOD in 1989-90 and again in 1999 to 2006. During the 35 years of his association with CCRA, Ross presented numerous papers on the industry.

In 2007, two new coal companies joined as Connected Members, Peace River Coal and Western Canadian Coal Corp and Dr. Barry Ryan joined as an Individual Connected Member representing the British Columbia Government.

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. The departure of Drs. Price and Gransden, both dedicated research scientists, represented a significant loss to the CCRA within a very short time period. CCRA thanked them for their valuable contributions to Carbonization in Canada and wished them all the best in their retirement. In the spring of 2009, the Algoma representative Bob Lamour retired after being a long-standing member on the Technical Committee and Board. Bob was replaced by Ms. Eila Kaukolin. Barry Ryan retired from the BC Government Ministry of Energy, Mines and Petroleum Resources and, as there was no replacement named, the BC Government abandoned its membership.

During 2008 and 2009, the steel and coal industries were faced with difficult economic climate as the world economic downturn caused a dramatic reduction in steel demand which resulted in a drop in metallurgical coal requirements.

For several years prior to 2008-09, Greenhouse gases (GHG) 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 an Energy Recovery Pilot coke oven for the joint CCRA/CANMET program to examine this alternative/new cokemaking technology. The elevated cost for building such a facility led the CCRA to seek Government participation at both the Federal and Provincial levels and include other parties such as Ontario Hydro Generation as partners.

The Current Decade

The 45th anniversary of CCRA's creation was celebrated in 2010. CCRA continued to advocate for an energy recovery pilot coke oven by meeting with the Minister of NRCan in December of that year. Shortly thereafter, a new Minister of NRCan was appointed and the letter authorizing the initiative was delayed. Work on the project however continued and an engineering study to develop a proposal and cost for the pilot facility was initiated. 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. The ERCO technology is an alternate approach to traditional slot coke oven and pilot facilities using ERCO technology are essentially non-existant, so R&D cannot be carried out. CCRA's goal for this project was to put Canada at the leading edge of this technology by having a facility where its members are able to investigate how coal behaves in this type of oven and determine information needed to allow the Canadian steel industry to evaluate this technology for controling emissions and coke product quality. This facility would also be used to showcase the cokemaking merits of Western Canadian coals using this technology globally.

The projected budget for the ERCO facility was nearly $1 million. It was hoped that funding would come from a variety of sources: Industry, Federal and Provincial governments and power generation firms as a feature of this technology is co-generation.

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

CCRA signed a contract with Hatch Engineering, Mississauga, Ontario to undertake the preliminary design of a pilot scale Energy Recovery Coke Oven with the final report due in the summer of 2012. Funds for this project were raised by some of the CCRA members contributing to a fund for this specific purpose. CCRA 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 during fiscal year2012-13. The new ERCO is to be located at Bells Corners CanmetENERGY facility with the other coking facilities. In 2011-12, SunCoke ENERGY was invited to join CCRA as a strategic partner in developing the energy recovery cokemaking technology as they have owned and operated commercial ovens using this technology for many years.

With the design of the pilot ERCO completed, planning on the location and support facilities were undertaken with one of the existing movable wall ovens (Carbolite) relocated to facilitate the required laboratory space for construction of the ERCO.

During the 2013/2014 fiscal year, CCRA 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 CCRA received it's "Certificate of Continuance" as Corporation Number 117455-0 Industry Canada.

CCRA has joined with CanmetENERGY to provide a website for Canadian Carbonization Research Association. It is accessible at *www.cancarb.ca* and contains timely information on the activities of CCRA/CanmetENERGY R&D programs along with other information on the Canadian Coal and Coke industry as a whole.

CCRA celebrated its 50th year milestone of providing research support to the Coal and Carbonization industries on September 2, 2015.

On September 30, 2016, Mr. George Chapman retired as Treasurer of CCRA. Mr. Chapman provided financial and administration stewardship of CCRA and support to the Board of Directors and Members since 1975 providing over 40 years of dedicated service to the Association. The Board of Directors appointed Mr. Brian D'Amboise CPA, CA to succeed Mr. Chapman as Treasurer effective October 1, 2017. Although new to the role, Mr. D'Amboise has over 25 years of involvement with CCRA as the former external auditor to the Association and in recent years providing Mr. Chapman assistance in completing the fiscal year end and related tax returns.

The CCRA began a new research collaboration with Geoscience BC in 2017-2018, which agreed to fund a study to produce clean coal from Western Canadian Coal Fields using the water-based Roben Jig Process.

Chair of the Board of Directors CCRA

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
1977-1977	J.T. Collier	DEVCO-SYSCO
1978 – 1979	W.A. Riva	Kaiser Resources Limited
1980 – 1980	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 – Current	T. Todoschuk	ArcelorMittel Dofasco Inc.

2017-2018 Board of Directors

COMPANY	NAME	PHONE (FAX)
CanmetENERGY	Dr. Brian Farnand S&T Director, Industrial Innovation Group CanmetENERGY Natural Resources Canada bfarnand@nrcan.gc.ca	613-996-7977 (613-995-9728)
ArcelorMittal Dofasco Inc.	Mr. Ted Todoschuk Principal Researcher ArcelorMittal Dofasco Global R&D - Hamilton ted.todoschuk@arcelormittal.com	905-548-4796 (905-548-4653)
Stelco	Mr. John D'Alessio Director - Process Technology Stelco - Lake Erie Works john.dalessio@stelco.com	(519) 587-4541 Ext. 5270 Cell: (905) 308-1253
Teck	Mr. Cam Howey Global Manager Technical Marketing Teck Coal Ltd. cam.howey@teck.com	403-806-7730 Cell: 403-921-4403 (403-263-7923)
SunCoke Energy, Inc.	Dr. John Quanci Vice President, Engineering and Technology SunCoke Energy, Inc. jfquanci@suncoke.com	630-824-1941 Cell: 610-496-5989

2017-2018 Corporate Officers

COMPANY	NAME	PHONE (FAX)	CCRA POSITION
ArcelorMittal Dofasco Inc.	Mr. Ted Todoschuk Principal Researcher ArcelorMittal Dofasco Global R&D - Hamilton ted.todoschuk@arcelormittal.com	905-548-4796 (905-548-4653)	Chair
Teck	Mr. Cam Howey Global Manager Technical Marketing Teck Coal Ltd. cam.howey@teck.com	403-806-7730 Cell: 403-921-4403 (403-263-7923)	Vice Chair
Brian G. D'Amboise Chartered Accountant	Mr. Brian D'Amboise, CPA, CA Brian G. D'Amboise Chartered Accountant BGDCA@sympatico.ca	905-938-2984	Treasurer
CanmetENERGY	Dr. Louis Giroux Research Scientist Industrial Innovation Group-Met Fuels CanmetENERGY Natural Resources Canada lgiroux@nrcan.gc.ca	613-996-7638 (613-995-9728)	Secretary

2017-2018 Technical Committee Members

COMPANY	NAME	PHONE (FAX)
CanmetENERGY	*CHAIR:* Dr. Louis Giroux Research Scientist CanmetENERGY Natural Resources Canada 1 Haanel Drive Ottawa, ON K1A 1M1 lgiroux@nrcan.gc.ca	613-996-7638 (613-995-9728)
ArcelorMittal Dofasco Inc.	*VICE CHAIR:* Mr. Ted Todoschuk Principal Researcher ArcelorMittal Dofasco Global R&D - Hamilton P.O. Box 2460 1330 Burlington St. E. Hamilton, ON L8N 3J5 ted.todoschuk@arcelormittal.com	905-548-4796 (905-548-4653)
CanmetENERGY	*SECRETARY:* Dr. Louis Giroux Research Scientist CanmetENERGY Natural Resources Canada 1 Haanel Drive Ottawa, ON K1A 1M1 lgiroux@nrcan.gc.ca	613-996-7638 (613-995-9728)
Stelco	Mr. 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
Teck	Dr. Qun Zhang Senior Researcher Teck Metals Ltd. PO Box 2000 Trail, BC V1R 4S4 qun.zhang@teck.com	250-364-4422 Cell: 250-921-4269 (250-364-4400)
SunCoke Energy, Inc.	Dr. Jonathan Perkins Coal/Coke Modeling Specialist SunCoke Energy, Inc. Suite 600, 1011 Warrenville Road Lisle, IL USA 60532 jhperkins@suncoke.com	630-824-1938 Cell: 610-858-7706

COMPANY	NAME	PHONE (FAX)
Pearson Coal Petrography	Dr. David Pearson Founder & CEO, Pearson Coal Petrography #1-740 Discovery St., Victoria, BC V8T 1H2 dpearson@coalpetrography.com	(778) 433-2982 Cell: (312) 953-7900
CCRA Guest Member	Ms. Melanie Mackay Professional Geoscientist 3360 Georgia Street Richmond, BC, V7E 2R6 mmackaygeo@gmail.com	604-323-6692
CCRA Consultant	Dr. Barry Ryan 62 Larson Road Gibsons, BC V0N 1V3 bryan@islandnet.com	604-886-1906
CCRA Consultant	Dr. John Price 28 Nanook Crescent Ottawa, ON K2L 2A7 j.t.price@rogers.com	613-592-4397
CCRA Consultant	Dr. J.F. Gransden 75 Nanook Crescent Ottawa, ON K2L 2B2 gransdenjk@sympatico.ca	613-592-2684
Sr Technical Consultant - Teck Coal Ltd.	Dr. Ross Leeder 12686 Ocean Cliff Drive Surrey, BC V4A 6N1 ross.leeder@teck.com	604-531-1944 Cell: 604-317-7412

Appendix 1 – CCRA Technical Committee Active Planning Table for 2017-2018

Program	Projects	Team	Project Objectives	Project Tasks	Deliverables for March 2018 Meeting

Energy and CO_2 Reduction in the Coal and Steel Industry	**CCRA 91**
	
	Blast Furnace Energy Reduction Initiatives
		AM Dofasco
		
		T. Todoschuk
		
		Stelco
		J. D'Alessio
		
		N. Ward
		
		CanmetENERGY
		
		K.W. Ng
		
		X. Huang
			• To address importance of PCI burnout of different rank coals in simulated Blast Furnace tuyere-raceway rig
			
			• To develop analytical method to quantify source of carbon (coal, char, coke) in Blast Furnace dust & sludge
				• PCI rig setup
				• Develop new TGA methodology to examine reactivity of combustion residues
				• Validate ash tracer assumption for burnout calculation
				• Benchmark rig data to industrial data
				• Develop relationship between coal properties (petrography, rheology) and combustion behaviour
				• Promote CanmetENERGY PCI rig to increase cost recovery benefits
					• PCI rig setup
					  ○ Complete the rig upgrade
					  ○ Test stability of injectant feed rate
					  ○ Establish upper and lower limits in operating valuables (injectant feed rate, blast rate and composition, etc.)
					  ○ Establish test rig repeatability
					  ○ Benchmark Carbon Type Differentiation (CTD) in CanmetENERGY with AMD
					• Develop new TGA methodology to examine reactivity of combustion residues
					  ○ Validate the proposed TGA technique
					  ○ Establish repeatability including rig test
					  ○ Relate reactivity to combustion residues carbon type composition
					• Validate ash tracer assumption for burnout calculation
					  ○ None
					• Benchmarking rig data to industrial data
					  ○ None
					• Develop relationship between coal properties (petrography, rheology) and combustion behaviour
					  ○ None
					• Promote CanmetENERGY PCI rig to increase cost recovery benefits
					  ○ Abstract submitted to ICSTI 2018
					  ○ Re-examine AM Maizières test results and discussion with client

	CCRA 70
	
	Renewable Energy for the Steel Industry
		AM Dofasco
		
		T. Todoschuk
		
		Stelco
		J. D'Alessio
		
		N. Ward
		
		CanmetENERGY
		
		K.W. Ng
		
		X. Huang
			• To minimize GHG in the Canadian steel industry
			
			• To promote bio-based carbon in Canadian bio-economy
			
			• To develop a value chain for use of bio-materials for Canadian industry
				• Raw Biomass Supply
				  ○ Evaluate feedstock type, location, quality, and quantity
				  ○ Establish partnership with raw biomass suppliers
				
				• Pyrolysis Technology Assessment and Development
				  ○ Assessment of existing pyrolysis technologies
				  ○ Establish benchmark reference on effect of feedstock (Saw dust, Roadside, Barks and C&D Wood) and pyrolysis technology (torrefaction, fast pyrolysis and HTC) on product properties
				  ○ Further develop HTC process
				  ○ Develop technology for pyrolysis solid biocarbon product upgrade
				  ○ Explore feasibility to utilize pyrolysis co-products in steel production
				  ○ Integrated Carbonization and Densification (ICD) Development
				  ○ Bio-pellet/briquette quality evaluation standard procedures development
				
				• Utilization of Solid Biocarbon in Steel Production
				  ○ Develop biocarbon VIU in evaluation methodology
				  ○ Handling and Storage of Bio-Pellet
				  ○ Incorporation of Solid Biocarbon in Cokemaking by Briquetting with Coal
				  ○ Direct Injection of Solid Biocarbon in Blast Furnace
				  ○ Nut coke replacement
				  ○ Solid biocarbon for EAF Steelmaking
				
				• Proof of concept trials
					• Raw Biomass Supply
					  ○ Follow up of Nov 30, 2017 meeting
					  ○ Meet with raw biomass supply stakeholder in Jan 2018
					
					• Pyrolysis Technology Assessment and Development
					  ○ Assessment of existing pyrolysis technologies
					  a. Pyrolysis technology assessment report
					  ○ Establish benchmark reference on effect of feedstock and pyrolysis technology
					  a. Complete HTC of C&D wood sample
					  b. Complete torrefaction of roadside, barks and C&D wood
					  ○ Further develop HTC process
					  a. Complete setup of 20L HTC reactor in CanmetENERGY
					  b. Benchmark CanmetENERGY HTC reactor with U of Guelph
					  ○ Develop technology for pyrolysis solid biocarbon product upgrade
					  a. None
					  ○ Explore feasibility to utilize pyrolysis co-product in steel production
					  a. None
					  ○ ICD Development
					  a. None
					  ○ Quality Evaluation Standard Development
					  a. None
					
					• Utilization of Solid Biocarbon in Steel Production
					  ○ Develop biocarbon VIU in evaluation methodology
					  a. Extend VIU model to cokemaking
					  ○ Handling and Storage of Bio-Pellet
					  a. Test plan of biocarbon grindability and co-grinding with coal

Program	Projects	Team	Project Objectives	Project Tasks	Deliverables for March 2018 Meeting
				○ Support industrial partners for demonstration trials ○ Assist in determining technical resources required to develop bio-economy	b. Review of different HGI determination procedures ○ Cokemaking a. SHO test for bio-briquette composition optimization b. Briquetting coal using tar as binder to establish reference on briquette strength for comparison with bio-briquette c. MWO test with partial briquetting ○ Direct Injection a. Collect biochar from industrial partners for PCI rig test (BC Carbon, Torr Coal, Airex) b. Chemical Characterization c. Paper submitted to Biomass and Bioenergy ○ Nut coke replacement a. Methodology for evaluation of briquette suitability for direct charging in blast furnace ○ EAF Steelmaking a. Biocarbon foaming capacity b. CMAT 25kg steel melting tests c. Discussion with Stanley Sun (AMD) on progress • Proof of concept trials ○ Support Clean Growth Fund LOI submission ○ Follow up of Nov 30, 2017 meeting to establish partnership with BC biocarbon, CHAR technology, Arterran and Ensyn
Energy and Environment	**CCRA 77** **Coke and Power - Energy Recovery Cokemaking**	SunCoke Energy J. Perkins CanmetENERGY L. Giroux K. Wittich	• To prepare Canadian steel industry transition to ERCO cokemaking technology • To improve energy efficiency and reduce criteria air contaminates and particulates emissions of Canadian steel industry	• Pilot Scale ERCO Construction • Standard Operating Procedures and Task Hazard Analysis • Failure Mode and Effect Analysis • Hot commissioning plan and standard operating conditions	• Pilot Scale ERCO Construction ○ Complete in Q4 2017-18 (February 2018) • Standard Operating Procedures and Task Hazard Analysis ○ Draft SOP and THA ○ SOP and THA review by SunCoke and AM Chicago ○ Conduct dry run (cold) to prove SOP • Failure Mode and Effect Analysis ○ None • Hot commissioning plan and standard operating conditions ○ Develop standard operating conditions (BD, heating profile, coking time, coke quality, gas composition, etc.) ○ Develop work plan for ERCO hot commissioning
Fundamental Aspects of Coal and Coke Utilization	**CCRA 90** **Coal Resource Quality Evaluation**	CCRA Consultant M. Mackay CanmetENERGY L. Giroux	• To investigate the effects of organic liquids, Roben Jig and alternative liquids in the coal washing process on coal and coke quality • To investigate alternative liquids (non-PCE) for use in float/sink procedure	• Setup Roben Jig • Compare coal washing method on clean coal quality: Roben Jig vs organic liquid float/sink • Refine Roben Jig operation methodology • Evaluate performance of Roben jig on coal from different geographical location - future work dependent on sample availability and funding • Investigate collaboration with 3M to do a review of their liquids • Identify and cost out other potential liquids • Float/sink in all alternative liquids with comparison to Float/Sink in PCE plus review effects on coal rheology and coke strength	• Roben Jig Setup ○ Completed (GBC, Phase 1, 2017) • Effect of coal washing method on clean coal quality: Roben Jig vs organic liquid float/sink ○ Completed (GBC, Phase 1, 2017) • Refine Roben Jig operation methodology - 2018

Program	Projects	Team	Project Objectives	Project Tasks	Deliverables for March 2018 Meeting
			• To determine which "oxidation/aging" parameters best reflect the caking/coking ability of each circuit and coal	• Oxidation/aging parameters – review of previous work and data ➢ Testing of variable coal samples using different methods	• Evaluate performance of Roben jig on coal from different geographical location ○ None • Investigate collaboration with 3M to do a review of their liquids ○ None • Identify and cost out other potential liquids ○ None • Float/sink in all alternative liquids with comparison to Float/Sink in PCE plus review effects on coal rheology and coke strength ○ None • Oxidation/aging parameters – review of previous work and data ➢ Testing of variable coal samples using different methods
	CCRA 81 **Mineral Matter and Coke Reactivity**	Teck Q. Zhang CanmetENERGY K.W. Ng L. Giroux	• To study the effects of mineral type and size on CRI and CSR • To examine the mineral type and size naturally occur in WCC and Appalachian coal	• Examine effect of mineral type and size on resultant coke properties by addition of known mineral to WCC • Examine effect of mineral type and size on resultant coke properties by addition of known mineral to US Appalachian coal • Develop technique to analyze in-situ minerals type and size in coal	• Examine effect of mineral type and size on resultant coke properties by addition of known mineral to WCC ○ Coke texture analysis results ○ TGA assessment of coke reactivity • Examine effect of mineral type and size on resultant coke properties by addition of known mineral to US Appalachian coal ○ Update of test results • Develop technique to analyse in-situ minerals type and size in coal ○ Planning: Determine how many and what coal to be studied ○ Analysis technique
	CCRA 82 **Factors affecting Coke Bed Permeability**	Teck Q. Zhang CanmetENERGY K.W. Ng K. Wittich	• To determine how bed permeability changes with size and shape consist	• Develop image analysis technique to characterize size and shape of coke • Develop relationship between coke size and shape and bed permeability • Effect of oven on coke size and shape • Effect of coal properties on coke size and shape	• Develop image analysis technique to characterize size and shape of coke ○ Completed • Develop relationship between coke size and shape and bed permeability ○ Completed • Effect of MWO oven on coke size and shape ○ Save coke samples from oven benchmarking (CCRA 92) for future image analysis for establishing effect of oven on coke size and shape • Effect of coal properties on coke size and shape ○ None

Program	Projects	Team	Project Objectives	Project Tasks	Deliverables for March 2018 Meeting

Database, Standard and Procedures	**CCRA 54**
	
	Standards
		AM Dofasco
		
		T. Todoschuk
		
		Stelco
		J. D'Alessio
		
		N. Ward
		
		CanmetENERGY
		L. Giroux
			• The CanmetENERGY business plan includes the development of standards and procedures pertaining to Canadian Coal and Steel industries	• ILS on ISO Coal Dilatation Determination
				• Sapozhnikov plastometer commissioning
				• Benchmarking of automated coke texture analysis with manual analysis
				• Examination of coal oxidation information
					• ILS on ISO Coal Dilatation Determination
					  ○ Final Report
					
					• Sapozhnikov plastometer commissioning
					  ○ On hold due to lab renovation
					
					• Benchmarking of automated coke texture analysis with manual analysis
					  ○ None
					
					• Examination of coal oxidation information (CCRA consultants)
					  ○ None

	CCRA 75 **Research Collaboration**	AM Dofasco T. Todoschuk Stelco J. D'Alessio N. Ward CanmetENERGY L. Giroux	• To establish technical exchanges or co-operative research studies with National and International Research groups	• Develop relationship with universities and research institutes on Bio carbon and ERCO • Expose CanmetENERGY globally • Engage with ACARP, BHP/CSIRO (QCAT), MEFOS, DMT, Aachen, NSSMC, CPM	• Work on developing better relationships with Canadian Universities ○ In progress

	CCRA 88
	
	Small-Scale Carbonization Facility for Cold & Hot Coke Strength Determination
		AM Dofasco
		
		T. Todoschuk
		
		Stelco
		J. D'Alessio
		
		N. Ward
		
		CanmetENERGY
		K.W. Ng
		
		X. Huang
			• To develop the use of small-scale carbonization apparatus for yielding valuable and meaningful coke quality indicators	• Business case development by industrial members
				• Current capability and needs by members
				• Small scale carbonization technology assessment
				• Small scale carbonization oven design
					• Small scale carbonization technology assessment
					  ○ Literature review
					  ○ Review of ACARP international carbonization and coke testing round robin results
					
					• Small scale carbonization oven design
					  ○ Not started

Program	Projects	Team	Project Objectives	Project Tasks	Deliverables for March 2018 Meeting

	CCRA 92
	
	Benchmarking of Movable Wall Ovens
		AM Dofasco
		
		T. Todoschuk
		
		CanmetENERGY
		K.W. Ng
		
		L. Giroux
			• To ensure reliable and repeatable pilot oven wall and gas pressure measurements along with coke quality data	• Benchmarking of CanmetENERGY 18" and Carbolite ovens to ensure coking performance consistence	• Benchmarking of CanmetENERGY 18" and Carbolite ovens
					  ○ Conduct duplicate carbonization tests using AMD standard blend in CanmetENERGY 18" and Carbolite ovens during Jan-Feb 2018
					  ○ Comparison of resultant coke qualities

	CCRA 93
	
	Stamp Charging
		Teck
		
		Q. Zhang
		
		Consultant
		
		J. Price
		
		CanmetENERGY
		K.W. Ng
		L. Giroux
			• To develop box charge capability and demonstrate the technical feasibility of multi-compartment box charge
			
			• To study the role of Ro and inert in stamp charge
			
			• To achieve wide range of moisture and bulk density for examining its effect on coke quality and coking conditions (coking time and wall pressure)
				• Apparatus fabrication and procedure development
				• Develop procedure for box charging
				• Conduct box charge test on Teck coal (controlled BD)
				• Benchmark box charge results with gravity charge results
				• Coke quality consistence of multi-compartment box charge
				• Effect of Ro in stamp charge (1100 kg/m^3)
				• Performance of high inert coal in stamp charge (1100 kg/m^3)
				• Effect of moisture and BD on coke quality and coking conditions (coking time and wall pressure)
					• Apparatus fabrication and procedure development
					  ○ Completed
					• Develop procedure for box charging
					  ○ Completed
					• Conduct box charge test on Teck coal (controlled BD)
					  ○ Completed
					• Benchmark box charge results with gravity charge results
					  ○ None
					• Coke quality consistence of multi-compartment box charge
					  ○ None
					• Effect of Ro in stamp charge
					  ○ None
					• Performance of high inert coal in stamp charge
					  ○ None
					• Effect of moisture and BD on coke quality and coking conditions
					  ○ None